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ABSTRACT

The 370 conference papers on information technology and teacher education are presented in two volumes. The 183 papers in the first volume include the following topics: use and evaluation of educational software; preservice and inservice training issues; multimedia portfolios; distance education; diversity and international perspectives; the educational computing course; educational leadership; faculty development; graduate and inservice education; instructional design; Mathematics; and new media. The 187 papers in the second volume address the following topics: preservice teacher education; reading, language arts and literacy; technology applications in research; science; computer simulations; social studies; technology-assisted instruction for special needs students; technology diffusion in elementary, secondary and postsecondary institutions; graduate, preservice, inservice and faculty use of telecommunications; telecommunications systems and services; educational theory; and technology use with young children. The papers are divided into sections according to topic, and an introduction to, and summary of papers is presented at the beginning of each section. An author index is also included in this volume. (AEF)

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Volume I

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Table of Contents

DEDICATION

To Brent Robinson

This Annual is dedicated to the memory of Brent Robinson of Cambridge University, whose enthusiasm and energy went far in making the Technology and Teacher Education Conference, the Annual, and the Journal of Technology and Teacher Education a success. Brent died in September of 1996 and he will be sorely missed. It is difficult to write this dedication to him because he influenced the field in so many ways. He was a scholar who made significant contributions to the literature on technology and teacher education. His papers and his presentations were given careful attention because he had important things to say that went beyond the surface. His "Cambridge model" of technology infusion in teacher education, for example, has been used as a model by programs around the world. Brent was also an outstanding editor and mentor. As the founding editor of the Journal of Information Technology for Teacher Education, he established that journal as a seminal resource and, at the same time, encouraged and mentored many teacher educators who had important things to say but who were still maturing as writers and scholars. His kind and gentle approach encouraged and, at the same time, set goals fo important legacy whose personality and style are in great part a reflection o

Brent was not, however, always kind and gentle. He believed in and practiced the type of combative intellectual discourse that he saw as one of the critical ingredients of "the Cambridge experience". I spent many hours in hot debate with him, as did quite a few other members of SITE. For example, on a long drive from Houston to Lohn, Texas, we debated the implications of several options for the organizational structure of SITE. When I travel that road now I still associate places with the particular points being made in the discussion. To those who are accustomed to strong debate being a sign of individuals who have closed their minds to alternative positions, Brent was a little hard to understand. That is because he did change his mind when presented with what he considered superior arguments. He, of course, expected you to change as well if serious flaws in your position were revealed. My own debates with Brent, on topics ranging from semiotics to technology integration to religion and politics, had more impact on me than any other experience I have had. And, after Brent's death, several other people made the same comments. His conversations had impact.

He influenced both of students and professors. In the summer of 1996, Brent taught a short course at Cambridge for a group of graduate students from the University of Houston. His influence on that group was far more significant than was typical of someone who taught a single course in their program. That was in part because of his style of teaching, which draws students in and makes them a part of the discussion, and in part because he was a broadly trained scholar who both understood and could communicate the interconnections between different special areas of knowledge. It was also because Brent liked people. He enjoyed them and he enjoyed working with others. The Houston students remember particularly Brent taking them on a cruise down the River Ouse. He equipped his boat with sterling provisions, from beer to strawberries, and as they motored from one historic pub to the next, he told stories about the history of the Fens, the area of England he loved.

There were also two other sides to Brent. One was his gregarious, hard drinking, social side. Brent was frequently a center of attention at social events associated with conferences. Many people at both SITE and the ITTE (Information Technology for Teacher Education) conference in the UK spent productive and entertaining hours in bars and pubs with Brent, who managed to keep up his part, and more, of stimulating conversations while drinking an amazing amount of liquor. Many of the lasting memories of Brent are from informal contacts. In the months before his death Brent resolved to drink much less, and when he gave the Houston students a fascinating guided tour of Cambridge pubs last summer, he drank non-alcoholic brews.

The last side of Brent I would like to celebrate was his international interests. Brent believed the issue of technology preparation for teachers was a critical one, and he devoted much of his time to encouraging and supporting international work. He made many trips to Russia and other countries; he worked with colleagues all over the world - from Europe to Africa to Asia and Australia. He had both the will and the energy to make a difference. In this area, he was often a diplomat. He respected the culture and traditions of groups he worked with, he learned from them as well as contributed to their development, and he always sought to bring people together to share solutions as well as problems, differences as well as similarities.

Brent Robinson will be sorely missed in this field. Just before he died, Brent was temporarily living in Houston while he taught a course on change and diffusion at the University of Houston. He took two weeks off for his annual sailing vacation in September and flew back to London. The year before, he and his sailing friends had rented a boat and sailed around the Irish coast. The year before it was Scotland. In 1996, it was to be the south of France. Brent died on the ferry from England to France from what may have been a heart attack. Few people in the field of technology and teacher education, if any, did as much in as many areas as he did. We cannot replace him, but perhaps we can continue to make progress in the areas he felt were important.

Jerry Willis
SITE Founder

CONCEPTS AND PROCEDURES

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Ronald Sarner, *SUNY Institute of Technology at Utica/Rome*
Rosemary Mullick, *SUNY Institute of Technology at Utica/Rome*
Deborah Bauder, *SUNY Institute of Technology at Utica/Rome*

The papers in this section are organized around four themes: (1) use and evaluation of educational software; (2) preservice and inservice training issues; (3) multimedia portfolios; and (4) technology in the curriculum. In the first selection, Netiva Caftori of Northeastern Illinois University and Marcin Paprzycki of the University of Texas of the Permian Basin note that there is "...insufficient emphasis on the evaluation of the quality of educational software..." They note, for example, that left unsupervised, children may fail to achieve the learning objectives of a simulation by altering the intended objective. They may do so by choosing to get through the simulation in the shortest period of time instead of exercising all of the features of the simulation. The authors proceed to describe social and educational issues which they assert should be factored into software evaluation criteria and to identify changes in curriculum, classroom management, and teacher preparation that come with increased use of software in the K-12 classroom.

In the second paper, Jan Rader of the University of Mississippi describes two strategies for the use of computer-assisted instruction. In the first approach, Teacher-Aligned Lesson Sequence or TALS, teachers customize the CAI software to select the CAI lessons that are most appropriate to their particular instructional objectives. In the second approach, the student is simply presented with CAI material in whatever fashion or sequence the software vendor selected. Using a quasi-experimental design, Rader assigned second, fourth, and sixth grade students to either group. Teachers using the TALS approach were trained in customizing the CAI lessons. Using measures of alignment protocols, Rader concludes that there was significantly greater alignment between CAI and classroom instruction where the TALS approach was used.

In the third selection James Kusch and Alex Pan both at the University of Wisconsin-Whitewater, Gigi Bohm of Union Grove Elementary School and Heide Stein of Cambridge Elementary School used the elementary school students in Stein's and Bohm's classes to evaluate software. The authors describe a four stage evaluation process that they employed.

The second group of presentations cluster deal with issues relating to preservice or inservice teacher training. In the first selection, Thomas Drazdowski from King's College provides a description of the transition of a Methods of Instructional Media course to a Multimedia Design course, pointing out the trials and tribulations faced by students and instructors. In the second selection, Carolyn Thorsen and Robert Barr, both of Boise State University, describe the development of computer competencies to be required in the State of Idaho as they apply to teachers and ultimately to students. They further identify changes that will be required in preservice teacher training and methods of assessment. In the final selection in this group, Michael Szabo from the University of Alberta and Kathy Schwarz from New Brunswick Community College present the results of a survey designed to assess the level of training, infrastructure, and teacher empowerment. Their instrument was sent to a random sample of 1000 teachers within the Province of Alberta.

The third group consists of two presentations on the use of multimedia portfolios. In the first selection Donna Read and Ralph Cafolla from Florida Atlantic University describe a project in which they have their preservice teachers produce HTML-based presentations incorporating audio, video, documents and photographs. They have set up a station that their students employ to convert videotape into compressed video format for computer storage. Sarah Irvine, Judith Barlow, and Elizabeth Nibley, all from American University, together with Sheila Ford from Horace Mann Elementary School describe a project to use digital student portfolios as an instructional, assessment, and evaluation tool. Learning-disabled students worked with teachers and used HyperStudio to produce individual portfolios incorporating electronic stories. The authors report statistically significant improvements computer attitude and aptitude on the part of participating teachers and students alike, and similar improvements in standardized test scores for oral and written language and communication assessment for participating students.

The last group of presentations consider other aspects of technology. In the first selection, Sara Pankaskie, Martha Lue, Debby Mitchell, Sheila Smalley and Jennifer Platt, all of the University of Central Florida present descriptions of four technologies in use in their preservice and inservice classes. Included in their description are electronic mail, distance education, the manufacture and use of laser videodiscs, and the use of videotaped presentations to deliver timely information to teachers regarding changes to statewide graduation requirements.

In the second selection, Anna Chan and Beverly Ginsburg, both from the City & Country School in New York City describe the infusion of technology into a progressive school, and in particular reflect upon the changes that it brings to the eighth grade American History curriculum.

In the third selection, Susan Anderson of Texas Christian University describes the use of a computer club that served as a laboratory for experimenting with technologies with children. In addition to the various projects produced by the elementary school children, the club provided the author with a large number of "real life" stories to share with her preservice university students.

In the final selection, Nira Krumholtz from Technion - the Israel Institute of Technology reports on the development of LEGO-Logic, an environment that builds upon the LEGO DACTA Logo product. The LEGO-Logic environment was primarily developed to alleviate the problems that Israeli-students encountered using the earlier product; the command structure was English-based, and English was not the native language for these children.

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The Design, Evaluation and Usage of Educational Software

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In recent years a proliferation of educational software can be observed in all school levels as well as at home and in the workplace. One of the important reasons for this situation seems to be that by interacting with a computer unsupervised learning is possible (more than three students per teacher with no educational guidelines; see Caftori, 1996). At home overburdened parents can leave their children unattended using a program that has a "educational" label and expect that learning may occur while playing. A similar situation may occur in schools, where supplementary learning can be furnished in a computer laboratory. Finally, in the professional arena many firms opt for training through computer based instruction as a cost-cutting measure. It is much cheaper and more flexible to provide employees with training software than to organize a workshop with a paid trainer.

Results of a recent study of educational software use in unsupervised settings were rather disturbing, showing that children did not learn what they were expected (Caftori, 1994a). It was also shown how this learning environment leads to the development of a gender gap (Caftori, 1994a, 1994b). Part of the problem can be traced to the insufficient emphasis on evaluation of the quality of educational software by the educators themselves (Paprzycki & Caftori, 1996). The aims of this paper are to summarize the possible effects of unsupervised usage of the educational software and to suggest a number of changes necessary to avoid future problems. These changes will be related to: a) educational software evaluation, b) technology-based lesson delivery and c) university curricula.

Educational Software

A typical example of software use in educational practice was presented by Caftori (1994a). She describes how, in a Junior High School, a number of computer terminals have been set up so that students can interact with the educational software and learn in an unsupervised mode. It should be stressed that the software installed is clearly designated as educational. It was found that this educational software does not play an educational role in many cases, or at least not the educational role it was intended to play.

An informative example is based on the *Oregon Trail* game. This game is a history simulation with the educational goal of introducing children to the life of covered-wagon travelers on their way from the Missouri River to Oregon in 1848. In its educational objectives it is suggested that this game induces students to make intelligent decisions based on a limited amount of data and consider alternative solutions when the circumstances suddenly change. It contains a number of problem-solving situations, like river crossing, money and food management and dealing with disease outbreaks. It is also supposed to teach students to arrange the data they have gathered into the "bigger picture" and to establish interrelations between the facts so that they can make appropriate decisions. The overall effect of all the decisions made determines the final outcome of the game. A number of pedagogical problems were observed (for a complete discussion see Caftori 1994a):

- Children concentrate on reaching the end of the trail as fast as possible without regard for their companions or oxen.
- Children take no time to visit the landmarks and learn their history.
- Children shoot animals for the sake of shooting becomes an objective in itself; the type of the terrain and the animals associated with it are not noticed and/or learned by the student.

A number of similar problems were observed when studying how students interacted with other games:

- using trial and error strategies instead of calculations in games like *Paper Plane Pilot* and *Wood Car Rally*,
- not playing *Where in the World is Carmen San Diego?* as the game takes a long time for completion,

- playing the game of *Odell Lake* with the goal of swallowing fish to enjoy the sound effects (instead of learning the predator-prey relationship and the food chain).

In addition to these general problems some interesting observations have been made related to the gender differences in approaching the games (for a detailed discussion see Caftori 1994a and 1994b). Some of these observations match those presented in Christie, (1996), Fryer (1995), Goldstein, Olivares, and Valmont (1996) and Underwood and Underwood (1996), where additional examples can be found.

- Girls were less visible in the computer laboratory and thus participated in the supplementary learning less often.
- Girls in early grades prefer word games (such as *Hangman*) to construction with geometric figures (such as *Mosaic*).
- Overall, boys like fast, shooting, fighting, or killing games involving battle or space ships while girls prefer slower games involving writing or school work.
- Even when playing the same game (*Oregon Trail*) girls have pursued different goals such as reaching the destination (the original goal of the game), or writing epitaphs on tombstones),
- Girls do not like software that does not allow them to quit a section in the middle; boys do not like software that does not provide them with an appropriate feedback.

Summarizing, even though students were interacting with the educational software, they were able to do it in such a way that at least some (if not all) of the specified educational objectives have been missed. Software attributes that were intended to attract children to the game (e.g. competitiveness, animations) actually diverted their attention from the objectives. The observational results confirm also that much software is designed to appeal to boys without consideration of the effect it has on girls (see also Huff & Cooper, 1987).

It is easy to specify what types of changes could have made the Oregon Trail game a more valuable educational tool. For example, when a poor decision is made by the student while traveling on the trail, the software should hint that a more efficient way may exist. When the student strays away from the set goal there should be a reminder provided about the major objective of the game. Similar suggestions can be easily made for the remaining games.

We were more interested in finding out why these deficiencies were not spotted when the games were evaluated, before the label "educational" or "good" was attached to them. We have searched for the criteria that are applied to evaluate educational software. To find the answer we have, initially, studied three issues of the *Technology and Teacher Education Annual* (Carey, Carey, Willis & Willis, 1993; Willis, Robin & Willis, 1994; Willis, Robin & Willis, 1995) *Proceedings of Society for Information Technology and Teacher Education.* Our assumption was that since this is one of the biggest conferences addressing the usage of technology in education, our findings will be representative of the state of the art in the area. Later, we have also looked into the most current Proceedings volume (Robin, Price, Willis & Willis, 1996). We were definitely surprised by our findings. First, there is almost no material related to the unsupervised learning. Second, we have located only a total of six papers related somewhat to the issue of educational software classification and evaluation: Byrum (1993), Byrum (1994), Maddux (1993), Paprzycki & Caftori (1996), Persichitte (1995) and Valmont (1994). This is especially astonishing while compared with the number of papers suggesting that teachers should write their own educational software. How are these teachers supposed to do a good job at it if they have no background in evaluating educational software and differentiating between good and bad to start with?

We should point out that in the past there have been numerous papers discussing software evaluation (see for instance Bitter & Wighton, 1987). That was before new powerful hardware and multimedia became widespread leading to the development of new generations of educational software. In Paprzycki & Caftori (1996), we have shown how Oregon Trail can pass the elaborate set of evaluation criteria proposed by Persichitte (1995) and none of the problems reported above can be predicted. However, the topic of evaluation criteria for the educational software does not seem to be very popular at one of the largest forums where such a discussion should take place. This fact, combined with the problems indicated with the educational software, lead us to believe that not only a discussion of these issues should be initiated, but also other areas require additional attention.

Educational Software Evaluation

Since one of the more important problems with the educational software seem to stem from the lack of modern criteria to judge its educational quality we would like to present two groups of issues that need to be taken into account when such a judgment is being passed. This list is very preliminary and should be treated as a starting point for future research.

Social Issues

As discussed above, there exist substantial differences between the ways that boys and girls interact with the educational software and inappropriate usage of such software can further deepen the gender gaps. This seems to suggest that the following issues should be considered:

a) Does the interaction involve hand-eye coordination, problem solving, verbal interaction, or interaction between the students themselves in a cooperative/collaborative mode of learning?
b) Does the software provide a diversity across genders/races among the leading characters?
c) Does the game perpetuate gender/racial stereotypes or prejudices?

Educational Objectives

This group of criteria is supposed to address the problem of children playing the game without reaching the expected educational outcomes.

a) Are the educational goals precisely defined by the software developers?
b) Does the software vendor provide any instruction about how the software can be used in-class and at-home so that the best results can be expected?
c) Does the software encourage reaching these goals by penalizing various misuses or providing guidance toward reaching the goals?
d) Does the software discourage trial-and-error type behavior while favoring decisions resulting from thought processes?
e) are the special or interactive effects overwhelming the objectives of the game?
f) Can the educational objectives or a reasonable subset be reached in a limited or prescribed time?

These two groups of criteria should be supplemented by detailed evaluations related to the particular medium and its usage in the classroom or unsupervised setting. For instance, there seems to be a body of experience mounting that may lead to the development of such evaluation criteria for CD-ROM's used in reading courses (see Goldstein et. al. 1996, Land & Taylor 1995, Matthew 1996, Underwood & Underwood 1996 and Valmont 1994).

Changes in the Classroom

The problems described above indicate that even if the quality of the educational software improves the teacher will still be needed in the classroom where computers will be used in a lab or studio environment. At the same time the teacher will have to work as hard, if not harder, to make sure the software employed is appropriate and is used in a manner that enhances the material to be learned. The basic work will be concentrated on developing lesson plans built around the software. Anyone who has observed a lesson delivered in the computer laboratory realizes immediately that such a lesson changes the position of the teacher. As soon as students start working on the computers their attention is diverted from the teacher and it is extremely difficult to get their attention back. As a consequence, the teacher is no longer at the front of the classroom as a center of attention and the class dissolves into units working either individually or in groups. Each such unit pursues knowledge independently and at a different pace. This means that the in-class situation resembles very closely the unsupervised learning. Therefore the lesson plans will have to address this new, different role of the teacher, as guide or helper instead of information provider. An extended discussion of this new role can be found in Caftori (1996).

Curricular Changes

Finally, changes aimed at addressing the problems indicated above should also appear in the university curricula. Our observations of the way that educational software is used singled out at least three areas where serious problems can surface. First, at home, where parents invest in the educational software and hope that this will help their children to succeed. Second, in schools, where undertrained teachers use educational programs in the unsupervised mode to furnish students with supplementary learning. Finally, among educational software developers, who may not be aware of what happens when their software is used in real-life situations by real-life learners. We would like to suggest that this indicates three corresponding areas where the introduction of computers into our everyday lives imposes the need for the curricular update: computer education for the general student population, teacher preparation (pre-service and in-service), and the computer science curriculum itself.

Computer Education for the General Student Body

It may be assumed that most of the students are current or prospective parents and thus they are (will be) the ones who (will) buy the educational software for their children. They should learn that the educational software is not a remedy for the lack of supervised learning and interaction with their children. They should be made aware of what the basic problems related to the unsupervised usage of educational software are. It seems that the most natural course for transferring this knowledge would be the Computer Literacy course. Unfortunately, currently this course is used primarily to teach basic application packages. The situation would change if the idea of "computers across curriculum" suggested in Paprzycki, (1996) and used in a few universities, were to be accepted. In this model the Computer Literacy course is being removed from the curriculum. The computer component is introduced to all courses offered in the curriculum. This solution can free a slot to offer a capstone course devoted to the social and ethical issues related to the usage of computers. In this course the considerations related to the usage of educational software could naturally find a home.

Computer Education in Teacher Preparation

Not all Colleges of Education provide the courses necessary for training teachers to integrate computers into the curriculum (this should be distinguished from the courses devoted to the usage of technology in the classroom settings, which are relatively popular). The need for such an integration and preparation of "informationally literate" teachers has been very well summarized in Niederhauser (1996). Pressure must be exerted to include an Educational Software Methods course into the pre-service teacher preparation core curriculum for all teaching fields. This course should be also introduced and promoted as an important part of in-service teacher training. The content of this course should contain issues related to the in-class usage of educational software as well as unsupervised usage of educational software. A substantial component discussing criteria and methodology of educational software evaluation (including exercises) should also be included. (For a description of a course that could be modified to meet these objectives see Mitchell and Paprzycki, 1993, and the references cited there.)

It should be pointed out, that our proposal goes against suggestions similar to that of Loehr (1996) and Valde et. al. (1996). The first proposal is much too narrow and seems to suggest concentration on the mechanics of technology usage which is a remedial subject that should not be a part of the university curriculum. The second proposal is clearly misguided by suggesting that teachers should have knowledge of computing in a pseudo-programming language. This is not the type of knowledge that will be ever useful to the teachers as they need to know how to utilize the ready-to-use software only and will never be involved in any form of computer programming.

Computer Science Curriculum.

First, let us observe that typically most CS students are taught **how** to write software, **how** to write it fast, **how** to write it well (where well means without errors). Almost no attention is given to the content of the created product. In other words, CS students are as efficient in writing good quality educational software as in writing educational software that does not educate at all. They do as well in developing a good quality human-computer interfaces as creating a bad one. What is badly needed is a course that would concentrate on the variety of issues related to what can be called human-oriented software. The proposed topics could include a selection out of the following:

- computers as a medium of communication,
- elements of computer graphics,
- computers and society,
- psychology of human-computer interaction,
- design of computer-human interfaces,
- design of educational software,
- design of software for handicapped users,
- ethical issues of computer usage,
- gender issues in computer use.

Taking into account the important role computers play in our lives and how they have become an integral part of society, we would like to suggest that such a course should be required of every graduating Computer Science major interested in pursuing software design career. A special track may be offered or even a new minor or major concentration as is suggested by McGuire (1995). He describes how at the American University (Washington, DC) the Art and the Computer Science and Information Systems Departments have combined in a similar effort. It should be pointed out that, in most cases, this will be the role of the School of Education to pressure the Department of Computer Science to develop an appropriate course.

Conclusion

In this paper we have tried to suggest to the reader that what is labeled as "educational software" may not be very educational after all. We have also argued that issues related to the educational software evaluation seem not to be very high on the list of researchers in the pedagogical sciences. It is true that evaluating software is part of some existing teacher preparation courses; however, these courses themselves have not been recently evaluated and their outcomes assessed. These considerations led us to propose changes in three related areas: academic curricula, software evaluation and software in-class usage. Whereas our proposals are very preliminary, the point is to generate discussion and stimulate research in these areas.

Educational Software

Educational software products mentioned in this text are available from the Minnesota Educational Computing Consortium (MECC), an educational software developer and distributor from Minneapolis, MN.

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Vendors Versus Teachers: Who's Best at Aligning Classroom and Computer-Assisted Instruction?

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Experts in the field of educational technology have stressed the importance of integrating classroom instruction and computer-assisted instruction (CAI) (Shore & Johnson, 1993; Blickhan, 1993). However, no research studies examine this process or offer implementation models to assist teachers in aligning classroom instruction and CAI in a computer lab setting using an instructional learning systems (ILS). Many school districts have purchased ILSs as a "turnkey" solution to providing technology for their students, not realizing that the "integration of ILS instruction with classroom curriculum . . . is perhaps the most important element in successful implementation" (Shore & Johnson, 1993, p. 85). "In many labs, the students' regular classroom teacher is often neither present nor directly involved with the integration of instruction received in the lab with what students are learning outside their lab experience" (Komoski, 1990, p. 378).

Due to the complexity of many ILSs, "teachers frequently feel they simply do not have the time or energy to master and integrate an instructional device which is perceived as complex and as only marginally relevant to the existing curriculum" (Shore & Johnson, 1993, p. 88). Consequently, "scheduled computer lab time has been viewed by the classroom teacher as either prep time or free time and rarely as part of regular classroom instruction" (Shore & Johnson, 1993, p. 89).

Purpose

If teachers are not in the computer lab, directing the CAI of their students, who is? The answer is simple—the ILS vendors. According to Komoski (1990, p. 380), "No commercial company should be expected to—or, in fact, allowed to do that job for the schools." Therefore, the purpose of this study was to provide an implementation model for ILSs that would make it easy for teachers to integrate CAI and classroom instruction.

This study introduced the Alignment Implementation Model (AIM) for CAI and assessed the curriculum alignment obtained using AIM in a computer lab setting. AIM was developed by the researcher for use with the Jostens Learning ILS, since nearly five million children in over 12,000 schools across the country use this ILS on a daily basis (Brannick, 1995).

AIM for CAI

AIM was designed as an easy-to-use implementation model, no more difficult to complete than a lesson plan. Using AIM, the teacher:

1. identifies the classroom instructional objectives;
2. matches the objectives to CAI objectives;
3. lists all potentially appropriate CAI lessons with matching instructional objectives;
4. selects the most appropriate CAI lessons;
5. designs the most appropriate sequence of CAI lessons;
6. adds assessment, enrichment, remediation, and reward features as necessary;
7. describes the teacher-aligned lesson sequence (TALS) and adds other required ILS information as necessary; and
8. delivers the TALS to the computer-lab system attendant for building into the ILS and assigning to designated students.

Research Study

Research Question

Are teachers able to develop TALS of math CAI more closely aligned with classroom math instruction than vendor-developed lesson sequences (VDLS) of math CAI?

Research Design

A two-group design with repeated measures was used to determine the degree of curriculum alignment between VDLS of math CAI and classroom math instruction, as well as the degree of curriculum alignment between TALS of math CAI and classroom math instruction.

Participants

Three classroom teachers, one computer-lab system attendant, and fifty-one second-, fourth-, and sixth-grade students participated in this twelve-week study in San Marcos, California, in 1994.

Procedures

Student subjects were randomly assigned to one of two groups, E1 or E2. E1 subjects received VDLS of math CAI in the computer lab. (VDLS were developed by curriculum specialists at Jostens Learning.) E2 subjects received TALS of math CAI in the computer lab. (TALS were developed by teachers who participated in the study.)

Participant Training

During weekly 40-minute training sessions, teachers learned how to align classroom math instruction and math CAI using the AIM for CAI. The computer-lab system attendant learned how to build the TALS of math CAI into the ILS and assign them to E2 subjects.

Instrumentation

In order to determine the degree of curriculum alignment between classroom math instruction and math CAI in the computer lab, the Measurement of Alignment (MA) was developed by the researcher. This instrument consisted of several components, including a MA Curriculum Mapping form, a MA Student Subject Score Sheet, and a MA Scoring Protocol.

Data Collection

The teachers completed a MA Curriculum Mapping form daily, recording the instructional objectives taught in math. They attached all relevant instructional materials, including hand-outs, worksheets, homework, quizzes, etc.

The computer-lab attendant and the research assistant generated ILS reports daily. These reports listed the names of the students, the math CAI lessons assigned in the computer lab, and their associated instructional objectives.

Data Analysis and Findings

The math CAI objectives taught to each student were recorded on a MA Student Subject Score Sheet and compared to the math instructional objectives taught in the classroom. Using the MA Scoring Protocol, an alignment score from 0 to 5 was entered for each comparison. For example, an alignment score of 5 indicated that the instructional objective taught in the computer lab was also taught in the classroom on the same school day. Alignment scores were compiled into twelve weekly MA scores for each student subject.

Mean Scores

Mean scores for the MA are shown in Figure 1. Second-grade E1 subjects obtained an overall mean score of 1.34 and E2 subjects obtained an overall mean score of 15.34. Fourth-grade E1 subjects obtained an overall mean score of 0.04 and E2 subjects obtained an overall mean score of 9.13. Sixth-grade E1 subjects obtained an overall mean score of 0.00 and E2 subjects obtained an overall mean score of 12.73.

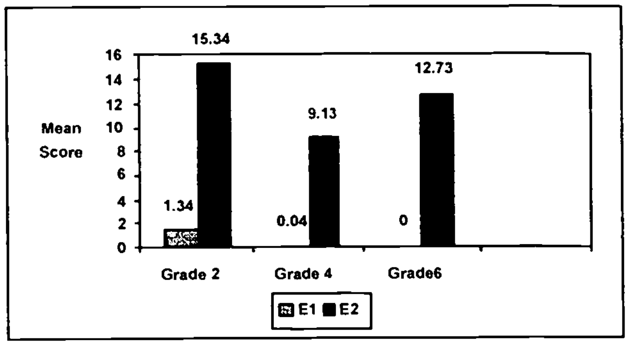

Figure 1. Comparison of Mean Scores for the Measurement of Alignment.

ANOVA

A two-group ANOVA with repeated measures of the MA (weeks 1 through 12) was performed to compare the mean group scores. For second-grade subjects, the overall results for the MA, $F(1, 16) = 244.34$ and $p < .0001$, were significant. For fourth-grade subjects, the overall results for the MA, $F(1, 14) = 234.19$ and $p < .0001$, were significant. For sixth-grade subjects, the overall results for the MA, $F(1, 15) = 332.85$ and $p < .0001$, were significant. These results are displayed in Table 1.

Table 1.
Measurement of Alignment ANOVA Summary

Source	*df*	F Second	*df*	F Fourth	*df*	F Sixth
Groups	1	244.34*	1	234.19*	1	332.85*
within-group error	16	(3.61)	14	(1.41)	15	(2.06)

Note. Values enclosed in parentheses represent mean square errors.

*p < .0001

Discussion

Results indicate that teachers can align classroom instruction and CAI in a computer lab setting significantly better than vendors using AIM. These findings also support Taylor's contention that the "Jostens ILS is a flexible tool which teachers can use as they decide [what is] most appropriate to their particular instructional needs" (1990, p. 4).

The researcher recommends that further studies be conducted using AIM to determine the degree of alignment that can be obtained over longer periods of time, at all instructional levels, and with a wider range of subjects in the both lab and distributed settings. It is further recommended that research be conducted using AIM with other ILSs.

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TEACHERS AND STUDENTS EVALUATE SOFTWARE

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Personal computers have been used in education for nearly two decades. Although there are still many issues concerning computers in the school, such as proper administrative support, sufficient time, computer software and hardware, and access, computers are commonly available in the classroom. Most teachers have adopted the ideas of integrating computers in their curriculum. There are many successful cases of using computers to increase teachers' work efficiency and teaching effectiveness. For example, teachers use computers to generate newsletters, prepare handouts, organize student databases, create weekly or monthly calendars, and produce report cards. Teachers can also engage students in such dynamic learning activities as reinforcing knowledge and skills via individualized drill and practice and inspiring individual students to think creatively and critically with multimedia authoring systems or simulation applications.

Software companies have been trying to produce educational programs that are motivating for children and are appropriately related to subject matters. Thousands of titles are available today to address instructional needs. However, the value of these programs are unknown to most teachers. Alternately, the educational benefit to some of these programs is hard to detect.

According to Maddux (1993), software can fall into one of the two categories. He states, "Type I software makes it quicker, easier, or otherwise convenient to continue teaching in traditional ways. Type II software makes new and better teaching methods available - methods that would not be possible with the use of computer" (p.212). To gain a better understanding of the value of useful educational programs, the authors set a goal to search for computer software that is educationally appropriate and appeals to children, in other words, motivational software.

What features of software programs enhance instruction and learning? Why should students care about learning with software? Bohm and Stein, two elementary schoolteachers in rural Wisconsin schools, developed a inquiry by which they might assess if software programs enhance the learning of their students and if software programs actually serve their instructional objectives. Bohm is a Title 1 teacher who teaches thirty-seven second-fourth grade students who have been identified as remedial readers, although among the second graders, six are known to be non-readers. Stein is a fourth grade teacher who teaches nineteen students, four of whom are identified as learning disabled. Bohm and Stein based their study upon an action research model in which they reflected upon the use of software programs (Kusch, 1996), created a plan for action, outlined a way to implement the plan, and evaluated the plan. Their inquiry focused on two related questions: What is motivational software and how do we identify or create software that both enhances and aids instruction and learning?

Purpose

While we as teachers appreciate the potential value of using educational software programs in our classrooms, we are concerned with the quality of software programs. Too often we see educational software that is full of fluff or graphic or audio "junk" (Tufte, 1983). Software junk does not achieve the goals of its creators. We feel that the value of software programs that we and our students use is in the clarity through which they communicate concepts. Sometimes sound, color, and animation enhance what software programs attempt to do but frequently they turn boring or repetitious programs into disasters, and fail to rescue mediocre ideas.

Many times teachers cannot find software that fits or enhances a unit of study; alternatively teachers find that software is fragmented. There may be only a small portion of a particular software program that is geared towards the skills that they choose to teach. So, we look for a quality of mobility within software programs where only a portion of the program serves the skill we wish to develop.

Many educational programs are in drill and practice format with a very weak link between real life and program material. Skills presented in a drill and practice format tend not to take our students beyond rote learning activity and fall short of the potential that software programs possess.

We are interested in exploring the educational benefit of any software programs from the viewpoint of both ourselves as teachers and from the viewpoint of our students. We pursue this question with an awareness that the educational benefits of many software programs is hard to detect. Thus, our goal as classroom teachers is to search for computer software that is educationally appropriate and also appealing to our students.

Methodology

The methodology included four stages: 1) reflection, 2) plan, 3) action, and 4) reflection.

Reflection

Children as well as adults, should be motivated to do tasks. The purpose of an activity should be clear and concise. Tasks that are interesting to students tend to keep their attention.

We use the term "motivation" in relation to computer software. Motivation is the common bond that links students and teachers to the same software program. Motivation is an ambiguous term that is often used and is difficult to define. We define software programs that possess at least the following five qualities as motivational—challenging, applicable, appealing, standard, and coherent:

- Challenging software takes students' understanding to a place where they might gain awareness of things that they already know.
- Applicable software relates explicitly and directly to the day-to-day experience of students both in and out of the classroom;
- Appealing software keeps students' interest; graphics, sound, and format ties into the concepts and ideas that the software provides;
- Standard software content adheres to skills and standards established by state and school curricular guides;
- Coherent software enhances the curriculum the teacher already is covering, it is not a set of fragmented facts.

Plan

Based on our criteria of what constitutes motivational software, we looked for capabilities between programs through informal interviewing, informal observation, surveys, and lists. To find common features we employed four steps:

- Collect software for teachers and students to evaluate. Make a list of all the software titles in our building. Catalog the software by subject categories.
- Create a survey which students and teachers use to document their interests. Brainstorm with children qualities that they like in computer programs. Formulate a feature matrix in which to compare different software programs from this brainstorming activity.
- Ask children to take a documenting worksheet to mark their subject area interests. Students choose software titles on the worksheet that correspond with their interests in different subjects.
- After children experiment with the programs and after both informal observations and interviews are complete, have students record their opinions of each software program on a pre-established feature matrix.

Action

Five action steps follow:

- Give children the option of working in pairs or by themselves.
- Ask children to pick up their feature matrix. The children are also asked to choose one software program to work with based upon the initial interest survey.
- Children experiment with each software program, rating each noted feature on the matrix for each individual software program. If the children note an unlisted feature of the program that they review they record their observation in the section titled other.
- The process continues by filling out the feature matrix for each software program, until all programs are reviewed.
- After all programs are evaluated and opinions are documented, the children get together with the teacher to draw up and post in the classroom a set of conclusions to the study.

Reflection

After the teacher and her students discuss their findings and the collected data from the feature matrix they complete a software conclusion form. The form consists of ratings for each software program, identification of software programs rated highest on the feature matrix, a listing and narrative description completed by students and teacher of three favorite software program titles with explanations of why the particular programs were favorites, and a brief essay that discussed differences between favorite software programs and those that scored high on the feature matrix.

Findings

Nineteen students from the Stein's class and thirty-seven students from the Bohm's class participated in the software evaluation process. We learned that children are excited about their computer experience and have actually appreciated the value that computers can provide by asking for more time. We also find that most children tend to stay using programs that are challenging, fun, are familiar from past experience.

Stein's class has PC-based computers and Apple II systems while Bohm's class has Macintosh-based computers and Apple II systems. Students in both classes have tried some programs on two platforms. No data is collected to compare the difference between the PCs and Macs. Almost all students do not like to use the Apple II systems.

Computers individualize instruction where students can work on a particular subject based on their personal interests, paces, and learning needs. Such a non-threatening experience can yield higher appreciation and ensure positive attitude in learning with reduced anxiety.

Teachers' Input

Findings drawn from teachers' personal insights and classroom observation together with findings drawn from students' evaluation on the feature matrix illustrate how software programs enhance instruction and learning. Additionally, findings suggest ways that collaborative evaluation of software programs informs us of which software programs are motivational from the viewpoints of students and teachers.

There were differences in the ways that Bohm and Stein surveyed students' attitudes and understood how software programs serve to enhance students' learning. The differences are attributed to the way in which the teachers organize instruction with software programs and to the arrangement of students in the two classrooms.

Programs that asked children to operate by using the combination of I, J, K, and M were the most difficult for children in all grades to use since using these keys related to knowledge of left/right and up/down orientation. Bohm found that some of her students had great difficulty working with the I, J, K, and M keys because of their little fingers and their inability to tell left from right.

Insights-Bohm

Bohm found that there were differences in the way that students evaluated software programs, since a number of her students were non-readers. Bohm studied the documentation that producers supplied with the software programs. She found that there were differences in the way that software targeted students by their age. For example, software programs for younger students included more animation and sound while programs for older students did not. She stated that software programs that included heavy use of animation and sound attracted users, but offered little useful value for non-readers.

The operational and instructional directions that software programs give influence learning. Bohm found that students generally benefited from directions that stated procedures clearly and with readable language. She cited clarity and readability of language in directions and the number of words with more than two syllables as factors. Bohm stated that her students paid close attention to directions and asked her to clarify them when the directions were vague. She also found that students who were non-readers tended to ignore directions and merely play with keys that made the cursor move.

Bohm found that the ways that students needed to use certain keyboard combinations impeded students use of software. Bohm's students felt that the real life application criteria was most significant.

Insights-Stein

Stein made insights based upon whether the software related to content that she covered. She noted that most software programs that she evaluated gave drill and practice for reinforcing computation work that she taught in mathematics. Such software programs added little that was new or different to instruction. Drill and practice programs tended to include a greater number of problem situations repetitively.

She found that there were other software programs which enabled her students to identify new instances of concepts they already learned in studying fractions. Specifically, the program "Speedway Math," depicted toys. It asked students to identify a group of toys of one variety and to name that group as a fraction. Stein found that the Speedway Math use of animation to remove or highlight sets of toys as a fraction enabled students to understand fractions in a different way than the way the textbook described fractions. Another software program "Dinosauring," presented an overview of different geological eras in which dinosaurs lived. Students knew terms such as Jurassic or Cambrian from books they owned or from watching movies. Using the software made it clear to the students that Jurassic or Cambrian referred to distinct periods of time. She observed that her students tended to be drawn toward using software programs which challenged them and diverged from the textbook.

Stein noted that some programs are "user friendly," and so invite students' use. She identified user friendly programs as those which operate without the use of function keys. Unlike Mrs. Bohm's class, Stein found that the quality of visual display in the computer graphics of the programs was motivating. Programs that appeared grainy and slow received low marks. Programs that were crisp and quick received high marks. Stein's students felt the challenge criteria was most important.

Insights-Students

The two categories of software as suggested by Maddux (1993) match the software being evaluated. Type I programs support traditional types of instruction and the Type II programs are mostly user-centered and are often more exciting and challenging. Type I programs are mostly available in the school; there are fewer Type II programs available to our subjects.

Partnerships made using software programs are collaborative. Individuals shared thoughts that influenced the choices that their counterparts made about the software programs. Some students competed with their partner to assign numerical values on the matrix. Other pairs of students were comfortable with hearing different opinions and "bounced" ideas back and forth as to whether the content in the software related to content they had learned in their textbook. In some pairs where there were differences in ability, less able students were less expressive. Students who were non-readers gave high evaluations to programs that contained the most attractive animation and sound. Students who were high achievers sought software programs that challenged them.

Students evaluated software honestly and critically. They participated eagerly and felt that their opinions were recognized and rewarded. Pairs of students from each class cited animation and sound as important and all students listed clear directions as important.

Conclusion

Teachers in this study examined the views of thirty pairs of students who gave a range of opinions about the value of software. Students' evaluations benefited from their collaboration. As students communicated their ideas with one another, they learned to clarify and refine their thinking. Partnership evaluation gives an orderly way to evaluate software since teachers can limit the number of students and type of software programs in the evaluation.

When students reviewed software programs in this study they gained a greater sense of understanding about the software and about content they already learned in their class-work. When partners evaluate software programs they gain a tool to apply in two contexts. They can reuse ideas from the feature matrix since it places participation and thinking at the heart of instruction. The feature matrix helps students relate evaluation to concepts and gives an activity they may use to explain their thinking. Partnerships make both teachers' and students' ideas open to question and comment from others. Partnerships set a standard for evaluation that helps kids explore the relation between things done in school with things done out of school. Thus, kids can see where they need to improve. They can self-assess and work at software programs independently to improve skills.

Implications

Teachers should pair students and encourage cooperation, having students with better skills share experience with one another and encourage less able students to explore new programs. Although computers are an exciting medium for students and teachers, most teachers do not have solid experience in using the software for optimized teaching. Teachers should spend time to learn with students and build a firm relationship when teaching with educational software.

Type I and Type II programs serve different students' needs and can be used for different purposes. In the school, most programs are old and belong to the Type I category. Although most Type II programs seem more challenging and fun, we should not ignore the value of the Type I programs which may serve to support traditional instruction.

Since there are many educational programs on the market today, availability is not an issue, appropriateness is (Willis, Stephens, & Matthew, 1996). In using computer software for instructional purpose, appropriate software must fit in to address the following issues: subject matter, efficiency, ease of use, appeal, adaptability, compatibility.

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Preservice Teachers and Multimedia Design: A Report From Year One

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Several national reports, such as *Teachers and Technology: Making the Connection* (U. S. Congress, 1995) and the recent *What Matters Most: Teaching For America's Future* (National Commission on Teaching & America's Future, 1996), have criticized teacher education programs for not adequately preparing their graduates to use technology effectively in their professional practice. In response to such reports, many teacher education departments are attempting to rewrite their curricula in order to infuse technology use throughout their programs (Kortecamp & Croninger, 1994; Levin & Waugh, 1995; Thompson, Schmidt, & Hadjiyianni, 1995; Valde, Bower, & Thomas, 1996) and are also attempting to design new courses to prepare preservice teachers to use advanced multimedia technologies (Abate & Benghiat, 1993; Abramson, 1995; Beichner, 1993; Hatfield, 1996; Hoskisson, Stammen, & Nelson, 1996; Licht, 1996; Woodrow, 1995). As previously reported (Drazdowski, Holodick, & Scappaticci, 1996), the teacher education department of King's College met in the spring of 1994 to brainstorm and formulate a technology action plan. The result was the creation of a three year technology infusion plan for the department as well as a proposal to restructure the traditional "Methods of Instructional Media" course to become a "Multimedia Design " course. This paper will report on the course restructuring efforts to date.

'Twas the Night before Classes. . .

If I had taken a stress test on the night before I was to begin teaching the multimedia course, I'm certain my test results would have been off the chart. This change in course structure was also accompanied by the total relocation of our department to refurbished facilities. As is often the case in such endeavors, the construction timeline did not neatly coincide with the beginning of the spring semester. The night before classes found me in our new computer lab, feverishly trying to load software and shake down machinery, while men on ladders where still cutting ceiling panels and applying touch-up paint. I would not recommend this implementation schedule to anyone because it does not allow enough time to work out potential problems. It does, however, keep a "change facilitator" (Hall, Hord, Huling-Austin, & Rutherford, 1987) from having a boring life. Begin the next day we did, and having our inquisitive students bring life and wonder to the room assured me that together we would work through any opening day bugs, bumps, and crashes.

In keeping with Spradley's (1980) concept of the "grand tour," I'll briefly describe the context for the multimedia course. The computer lab consists of the following components: 12 PowerMac student workstations each connected to a Pioneer Laser Disc V2600 player with separate Sony color video monitors; 1 Apple LaserWriter Select 360 and 1 Hewlett Packard 560C Inkjet Printer; 1 Apple Color One Flatbed Scanner; 1 Apple QuickTake 150 Digital Camera; 1 Panasonic VHS Reporter Video Camera, VCR, and monitor (to produce QuickTime Movies); a large DA-LITE Screen; and a teacher station with like equipment on a multimedia cart that also includes a Syquest 135 EZ Drive and a Sharp Color LCD panel and 3M overhead projector (this panel was upgraded this fall to a Sharp ceiling-mounted LCD projection system). The main software packages utilized in the course are HyperStudio 3.0 (Roger Wagner Publishing) and PowerPoint 4.0 (Microsoft). The main student text is *HyperStudio 3.0 In One Hour* by Vicki F. Sharp (1995) {see Drazdowski, 1996, for a review of this text}. *The Visual Almanac* from Apple Computer is available for the laser disc players. All computers are linked to the college network and Netscape Navigator 2.0 is available for Internet browsing.

The majority of the students in the course tend to be senior education majors, both elementary and secondary, who are in their "Professional Semester" and are about to begin their student teaching experience. Most of the students have completed the course, *Computer Applications for Educators,* which deals primarily with integrating word processing, database, spreadsheet, drawing programs, and the Internet into the instructional process. To maintain the integrity of the previous schedule, the multimedia course meets every afternoon for two hours during the first three weeks of the semester, with additional lab time for student teams to develop their projects. Students then spend the remainder of the semester student teaching.

Initial Findings

Judging from the early entries of student learning logs, I was not alone in suffering some anxiety about trying something new. Some sample student comments follow:

> When I first walked into the new computer lab, I was totally amazed. After the initial excitement wore off, I started to worry. It all looks so complicated. I am what you might call 'electronically challenged.
>
> Since all I know about Macintoshs is how to open them up and use the word processor, I'm in for an interesting ride.
>
> I must admit, walking into the multimedia room, I was a little intimidated.
>
> These computers have so many accessories, how does one know how to begin?
>
> While I was looking at sample stacks I did start to worry. I was concerned because I really do not know if I can make these things on my own and actually have them work.
>
> I feel I am a little behind in this new computer generation and I am nervous in the fact that this class may be over my head.
>
> As I was sitting in class today, I had the same feeling as the first day of *Computer Applications* class - I was nervous about 'goofing-up' or worse, breaking something!!

Along with these initial fears, there were also signs of excitement and hope:

> This lab is truly awesome! Never before have I wished that I was not going to graduate just so I could spend more time learning about all the new technology in this room.
>
> As an older student (many years out of high school) I can see the tremendous benefits that computers have for children today. After our overview of HyperStudio today I know it is something I want (need) to take advantage of during my teaching career.
>
> I'm sure kids would love multimedia. It makes everything come to life and is so much more advanced and interesting than a textbook. This is a giant step in the direction of making learning fun.
>
> I never realized what potential computers had. This class is opening a whole new world of possibilities.

As the students learned the authoring program and became more comfortable with the equipment, they made the transition from nervous novice to power user, with many even beginning to push the limits of the technology and the teacher. By the conclusion of the course students had created many effective multimedia stacks on a plethora of topics, ranging from mitosis and the solar system to beginning Spanish, from eating healthy and dental hygiene to black history, from evolution and English grammar to the battle of Gettysburg, the plays of Shakespeare, and a tour of Paris. Besides giving students the opportunity to utilize advanced technologies and create educational multimedia for classroom use, the course also provides the professor with the opportunity to model constructivist learning theory (Brooks & Brooks, 1993; Collins, 1991; Jonassen, 1996; Vygotsky, 1962, 1978) and cooperative learning concepts (Johnson & Johnson,1985, 1994; Johnson, Johnson, Holubec, & Roy, 1984; Kagan, 1990; Slavin,1983). Students were working in collaborative teams, actively constructing knowledge, researching and solving problems, accessing and evaluating information as they worked on authentic, challenging tasks. The classroom environment shifted from teacher-centered to learner-centered, from teacher as fact teller to teacher as guide, coach, and scaffold builder, from teacher always being the expert to teacher very often becoming the learner. The teacher in this situation should be prepared for the kind of movement in their framework of thinking that Kuhn (1962) would refer to as a "paradigm shift," the kind of deep, fundamental shift that will forever alter your perspectives and practices. As Elmore, Peterson, and McCarthy (1996) observe, internal structures of teachers must change if they are to teach better.

Barriers to Change

In his study, Pink (1989) identified twelve barriers to innovation effectiveness, including such things as: too little time for teachers to plan for and learn new skills and practices, lack of sustained administrative support, underfunding or trying to do too much with too little support, and too many competing demands or overload on those attempting change. I have found these same barriers to be present, in varying degrees. Limited funding in the recent budget has not allowed the department to implement its technology plan on its intended schedule. There has been administrative discussion about turning the college into a single-platform campus, a plan, if implemented, that would exclude the computer platform (Macintosh) on which the multimedia course and the department's three year technology plan is based. And as I'm certain any facilitator of change can attest to, finding the extra time and energy to make meaningful change on the college level with so many competing professional and personal demands is a constant struggle.

The biggest barrier to change I have found to date is the lack of technology-rich environments and technology-using cooperating teachers in our students' field placement settings. Finding school cultures that promote and encourage innovation can be a difficult task. As the OTA report (U.S. Congress, 1995) on teachers and technology pointed out, "technology does not appear to play a significant role in student teacher assignments" (p.186) and "often, the preservice teachers knew more about technology use than the practicing teachers supervising them" (p.187). I agree with the finding of Hill and Somers (1996), "the extent to which faculty value the benefits of using technology is one of the most significant determinants of its use" (p.310). As a short term solution to the technology access problem, our department has purchased two laptop computers and color LCD panels that can be checked out for field use by our student teachers. Many have taken the opportunity to do so. Hopefully as more colleges of education and local school districts form partnerships, appropriate training, support, and access to technology for all the stake holders involved in preparing new teachers will be addressed.

Conclusions

Though generally pleased with our initial efforts and student outcomes in the area of multimedia design, the course restructuring process described in this paper is very much a continuing work in progress. During the next semester I intend to focus more on design theory and the importance of carefully planning multimedia projects, as suggested by McBride and Luntz (1996). It is also critical that I continue personal modeling, for as Jackson (1986) says in his discussion on transformative teaching, "it is essential to success within that tradition that teachers who are trying to bring about transformative changes personify the very qualities they seek to engender in their students" (p.124). I can only hope that as I visit the future classrooms of our graduates, I will find their students actively and collaboratively engaged in their learning, being guided by caring, effective, technology using educators who, in their own ways, have become agents of change.

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Computer Competencies For Teacher Educators

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Computers have become a part of teacher education faster than colleges of education have had time to develop a curriculum for them. Political entities are requesting that teachers be technology literate in exchange for funding; school superintendents want to hire teachers who know how to integrate computers into the teaching/learning process; and finally, many teachers themselves are asking, "What should we know?" The Idaho State Legislature has provided money for both public schools and Teacher Education Programs in the state. Idaho schools receive 10.2 million dollars per year in technology money, and the Boise State University (BSU) Teacher Education Program receives $350,000 per year to re-train 5,000 teachers in its service to use computers and other technology in the teaching/learning process. The legislators demand accountability. They want to know what teachers and students should learn to do and how long it will take. They also want to know how to evaluate teachers' use of computer technology in the teaching/learning process. Finally, both educators and those who provide funding want to know how student performance will improve because of the influx of machines and training.

The Solution

As a result of requests from legislators, BSU "Technology Outreach Program" (TOP), created a panel of teachers, technology coordinators, and administrators as well as representatives of the local business community. The panel developed a set of computer competencies for K-12 students, a set of 132 competencies for teachers, and a computer-based technology competency test for teachers.

The panel recognizes that "technology" includes other kinds of machines and instructional techniques other than computers. However, it narrowed its focus to computer technology competencies for two reasons. First, most Idaho school districts are using their technology grants for computers and/or networks. Secondly, of the many technologies available, computers are in almost every workplace. They have changed the way the world works and does business. By focusing on computer technology, the panel is providing a decisive definition of computer skills Idaho students will need to be productive citizens in an information-based society.

Assumptions

In order to work from a common baseline, the panel made a number of assumptions regarding hardware and software availability. The panel also used the current level of state funding for technology as a basis for its projections. Given that the current level of funding will remain constant for the next three years, it is reasonable to assume that the resources listed below will exist in most Idaho schools by the year 2000.

Hardware

Because of the growing standardization within the computer industry, the panel felt that platforms (PC or Mac) are becoming less of an issue. Either platform will run all of the software listed below, and in many cases, the software looks the same on both platforms. Consequently, all recommendations in this report apply to either Macs or PCs. In addition, the vintage of the computers is not critical. Ninety percent of competency recommendations can be accomplished on x386 and above PCs or Mac SEs and above. The panel makes the following assumptions regarding hardware and access:

1. A computer (1 hour per day access is possible with ratio of 1 computer to 5 students),
2. A printer (1 per 25 students), and
3. A modem or network connection (1 per 25 students).

Software

Students will have access to the software listed below. If a student is trained to use one specific brand of a software genre and has a reasonable comfort level with computers, then using a different brand of the same genre is a matter of a few hours of self-teaching. For example, all data bases are built around the same model. If students understand the function of a data base, (i.e. to do sorts and queries which result in inferences), it is only a matter of learning to follow a different system of menus to use a different data base.

Specialized skills with software and hardware appropriate to vocational education, such as CAD/CAM, network maintenance and hardware repair, and diagnostic software for automobile repair are not included in the listed competencies. Also not included are competencies related to video technology except for those related to digitizing and graphics. The panel recognizes the importance of these kinds of technological experiences for students, but is focusing the current investigation on computer tools that will speed and deepen student learning in the four basic content areas: language arts (English), social studies, science, and mathematics. Vocational computer technology competencies are sufficiently significant to demand a separate competency investigation.

Following are the genres of software considered by the panel to be fundamental to computer literacy and required to speed and expand student learning:

1. Word processor,
2. Data Base,
3. Spreadsheet,
4. Telecommunications,
5. Presentation/hypermedia software, and
6. Instructional/Reference software.

Teacher Skills

The panel has developed a subset of skills for each category listed above. For word processing there are 22 operational (making a piece of software work) skills and 9 instructional skills. Examples of operational skills include cut, copy, paste, and page orientation. Examples of instructional skills include knowing how and when to use a word processor for targeted learning problems like ordering and classification; substitution exercises; grammar; and logical sequencing. Additional instructional skills for word processing include knowing how to use word processors to assist in high level analysis including editing and revision; information analysis including research reports, journal writing, lab reports, and note taking; creating newspapers; group investigations/brainstorming; and composition including creative writing, letters, and writing roulette. Many of these teaching techniques are adaptable across content and grade level.

There are 19 skills in the subset of skills for databases. Those skills include knowing how to do sorts and queries (finds), information formatting (like date, text, and number formats) and the use of conjunctions. Instructional skills include knowing how to set up a lesson in which students uses databases to reach a conclusion; analyzing and describing results, and making a prediction.

The panel suggests a subset of 11 skills for spreadsheets including writing formulas and using functions as well as understanding basic spreadsheet terms such as x and y axis. Instructional skills for using spreadsheets include: using spreadsheets to solve story problems; using spreadsheets to do "what if" thinking;, using them to teach estimation; and using spreadsheets to show relationships.

For presentation software and graphics and hypermedia software, the panel recommends 19 sub-skills. Examples of some of these skills include understanding of the following: branching, hypertext, foreground, background, and grouping. Instructional skills for presentation/hypermedia software include knowing how to teach students to interpret and present information using this genre of software to enhance speeches and creating non-linear reports.

Recommendations for basic skills in telecommunications include: send and receive e-mail, use the Internet (including uploading and downloading information), and create simple HTML documents. Instructional strategies that teachers should know in conjunction with the Internet include: using telecommunications to talk with an expert, creating simulations, setting up and supervising role playing lessons, and engaging in peer tutoring, data collection and analysis, the electronic debate, and joint document creation.

Additional recommendations for teachers who use instructional/reference software involve learning how to manage the whole classroom for maximum learning assisted by computers. Teachers need to know cooperative learning models like jigsaw as well as how to plan curriculum for use in centers.

Finally, teachers need some basic file management and hardware skills. There are 35 skills associated with hardware and file management. Teachers need to know how to estimate space on diskettes, understand the meaning of different file formats, and how to use operating systems like Windows and the Mac operating systems.

Student Skills

The panel listed student skills by grade level. Student skills can be classified into two categories: operational and intellectual, much like teachers' skills.. Operational skills include the ability to use computers effectively in a workplace environment, and the fundamental experience and knowledge that will allow students to adapt to specialized software and operating systems. Intellectual skills include giving students the ability to use the tools (word processor, database, etc.) to solve problems in the content areas (Language Arts, Social Science, Mathematics, and Science). This two-pronged approach will give students the skills that they need in the work world and should speed and deepen student learning in the academic world.

Skills at each grade level build on skills from the previous grade level ultimately providing a senior high student with a full range of tools and procedures for solving problems. In addition, students should know which tools and processes are most appropriate for a given problem. Kindergartners learn five file management skills, four word processing skills, four different kinds of intellectual skills from instructional software, two graphics skills, and are exposed to presentation software.

Senior high students on the other hand, move beyond learning operational skills and spend the bulk of their time using computers to work faster and smarter. The goal is for the computer to become as transparent to students as pencils and paper.

Vision and Philosophy

Appropriate Use of Computer Technology In Public School Classrooms

The genres of software listed above are the standard tools that business, industry, and science use to record, store, transmit, and manipulate information to get "thinking work" done or to produce a product. They are useful for teachers and students for the same reasons that they are useful in the world of work. Their integration into the public school curriculum represents a "value added" dimension to the use of computers in classrooms. Although these tools are sometimes taught as classes by themselves, it is the unanimous opinion of the panel that their most appropriate use is to speed or deepen student learning in the content areas. There is no value in teaching a student to use a word processor, the Internet etc. unless the student learns to apply the tool to a problem. These problems would most logically be associated the content areas. As students use data bases to study history or spreadsheets to study math they develop many of the same skills that they will be using after graduation in the work world.

Teacher Training

Pre-service Teacher Training

Implementing the student competencies listed below is dependent on how well teachers are trained to integrate computers into the teaching/learning process. Teachers graduating from universities should enter classrooms fully trained in software use and curriculum integration and teaching methodologies appropriate to their grade level. The panel recommends the following:

1. a basic course in appropriate software,
2. an introduction to teaching techniques essential in technology enhanced classrooms,
3. a supervised field experience in which students work with master teachers using technology, and
4. an advanced course in the junior/senior year taught in conjunction with methods courses. This course should focus on integrating technology into instruction along with advanced work with appropriate software.

Inservice Teacher Training

Teachers already in the field should be re-trained. The panel recommends that teachers be trained in the kinds of software listed above in a series of short, single concept classes. In each course, teachers learn a software application and the teaching methodologies necessary to use that software to teach content. They then need time to train children to use the software and to implement technology supported lesson plans. It is a process that unfolds over semesters.

Support

Following training, teachers need continuing support and eventually will need re-training as computer technology and software change. This support should ultimately come from local school district technology coordinators supported by regional centers that are now established at Idaho colleges and universities. Teachers and district technology coordinators need access to technical support (telephone, e-mail, on-site visits by trained BSU staff, and assistance with initial student training).

Products For Assessment and Testing

Because the legislature is interested in results, BSU has developed and piloted several instruments to help technology trainers assess the level of knowledge of teachers before training, test teachers after training, and assess the level of student performance in the classrooms of teachers who have been trained.

Profile

Sometimes BSU trainers are asked to do training in districts where no training other than "word of mouth" training has taken place, or, a patchwork of training has occurred with no coordination or goal. For this reason, BSU turned the competencies into a technology "profile" that can be given to teachers on a bubble sheet. The bubble sheet lists the competencies and teachers respond by saying whether or not they can perform each listed skill. The bubble sheets are then fed into a computer and the results are analyzed. An administrator or a trainer can get a sense of how much and what kind of training is needed in a school or in a district. This, in turn can help administrators project training costs and prioritize topics for in-service days. With equipment, appropriate training topics, and time, teachers master the skills and accumulate the curriculum materials they need to begin using computers as a part of the teaching/learning process. Observations indicate that the time between the appearance of five computers in a classroom and the time when there is measurable change in student behavior and/or performance is three years. Neophyte computer-using teachers progress from using the computer as a reward for good behavior or work and for drill to a sophisticated integration into the teaching/learning process in about three years . At the end of three years they achieve a mastery both they and the students use the machine to gather and manipulate information at speeds yet unequaled in an average classroom.

Competency Test For Teachers

Funding providers are extremely interested measuring teachers' ability to use computers in their classrooms. For other topics in educators' preparation, simply passing a class is enough. However, in the case of computers, a complex topic that cannot be measured by a grade in one class, BSU offers but does not require a competency test. Approximately 20 percent of the students who take the class fail the test. Superintendents in the BSU service area have been notified that if BSU graduate looking for jobs in their district say they know technology and have taken the class but do not have the certificate, BSU does not guarantee their technology competency.

The test itself is given on computer and consists of 80 questions drawn randomly from a pool of 200 questions, a practical exercise using a database, and the development of a lesson plan that demonstrates an understanding of classroom management in a five-computer classroom. In this lesson plan, students describe use of one of the tools to teach a topic effectively. They describe curriculum materials, classroom management strategies, and evaluation of student work. The test is constantly under revision. New questions are added as the competencies evolve. Questions are carefully written to require thought and reasoning rather than rote memory. The test is applicable to either the Windows or Mac environment, and students do not know in which environment they will be tested. The objective portion of the test is graded by the computer, and students know instantly whether or not they have passed. The lesson plan is assessed by three graders who have developed a uniform grading scale. If one grader fails a lesson plan and another passes it, it is read by the third grader.

The competency test by itself is not complete. There is a great distance between a teacher who knows how to operate software and one who knows how to create meaningful technology-based lessons that improve students' learning and behavior. For this reason, BSU is also developing an instrument that will measure the quality of student products. In this way administrators or legislators who must evaluate the use of computer technology in classrooms and its influence on students will have a reliable assessment method. The assessment itself will be done by comparing student work to examples of student work that have been sorted by age level, tool, and location on Bloom's taxonomy and have been collected into a portfolio. The portfolio will be a result of a Delphi study in which experts (teachers who have used computer technology successfully in their classrooms) have sorted hundreds of examples of student products along with the accompanying lesson plans and placed them in their proper location in the portfolio. This project should be at a pilot stage by spring of 1997.

Student Skills Assessment

A student skills assessment instrument is currently under development and being piloted by BSU personnel. This tool measures student skills against the expectations of the list of K-12 competencies

Conclusion

One of the biggest challenges facing teachers and teacher training institutions is to identify what teachers need to know about computer technology and to have a process whereby that knowledge can be tested and verified. Teachers need two areas of expertise with computers. They should have computer skills and working knowledge of computer integration methodologies. If teachers are missing either of these kinds of knowledge, they will be less effective in using expensive resources and in teaching their students. By narrowing and defining the knowledge base, BSU has helped reduce the anxiety teachers feel about the inevitable re-training in which they will participate. By developing an integrated set of testing instruments, BSU is providing administrators and legislators with the information they need allocate precious resources toward making schools more responsive to 21st century needs.

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A Survey of Training, Infrastructure and Empowerment Opportunities for the Instructional Use of Computers in Schools

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Instructional technology has great but unrealized potential for reforming educational systems, e.g., increased use of technology in daily classrooms and some fundamental restructuring of the way education is viewed and carried out. Past explorations of why the potential is unrealized have focused upon attempts to get people to change and the complexities of instructional use of computers. Failure of these attempts has led us to turn to the innovative nature of the issues. Our study has led us to conclude that although innovation is widely lauded as a concept, it is rarely carried out to a successful end, either in education or other fields of endeavor. Those rare instances of successful innovation have a common set of characteristics, including the presence of training, a supportive infrastructure, empowerment of those who carry out the work, and a visionary who puts aside common goals to achieve the dream. We call this person or group "the keeper of the dream."

These elements comprise only a partial list of the environment of successful innovation but they have been described elsewhere (Szabo, 1996). We focused on three areas for the current study: Training, Infrastructure and Empowerment. Training involves the acquisition of competencies necessary to 1) add instructional computing, 2) apply it to issues of curriculum, instruction, and evaluation, and 3) provide leadership to colleagues in teaching and administrative positions. To this list we would add that reform must have a large mass of teachers who are competent in instructional computing. A simple analysis shows there are currently not enough trainers to do the job. We must find alternative ways to prepare educators.

Infrastructure requires hardware, software and telecommunications. Beyond that, however, it demands the strong vision which is held by senior administrators and shared by everyone else in the system. Vision is critical in innovation since very few can predict the ultimate direction innovation will take. Infrastructure also involves a significant commitment of time and other resources. Innovation is inherently risky and a tolerance for making progress through risk-taking characterizes successful innovation. Infrastructure also means immediate access to credible and understandable support for all aspects of the application of instructional computing to teaching.

Empowerment simply means the granting of authority to adapt the vision to local needs while preserving its basic goals. It also means providing temporary teams of people and enabling them to decide how their organizational unit will play out the vision to reality. It rests on the premise that if people share a vision, are given the task to carry out the vision along with the freedom to decide what the vision will look like, they are more likely to become committed to it, to own it, and become keepers of the dream.

Purpose of the Survey

With the framework of training, infrastructure and empowerment conceptualized, the next step was to identify the extent to which these elements are perceived as present or absent by public school teachers. A key assumption of the survey is that ideal learning occurs in a learner-centered environment. In this environment, instructional computing is used as a tool to solve problems and accomplish tasks, and as a tutor to promote effective, efficient and affective or enjoyable learning.

The research sought to answer the question "What is the status of training, infrastructure and empowerment in support of instructional computing as applied to applications of tool and tutor usage and to promote reform. The status was based on the perceptions of practicing full time public school teachers in the Province of Alberta.

Methodology

A survey technique was used to gather data. Three categories of training, infrastructure and empowerment were created for the survey. Specific items were developed for the categories of Organizational, Training and Resource Needs. The last two categories were further subdivided into current levels and future needs for promoting the use of instructional computing. A separate research question sought to ascertain differences in these categories among four different divisions of teachers, K-3, 4-6, 7-9 and 10-12.

Eighty eight items were developed for these categories, plus six demographic questions. Respondents were also given the opportunity to add open-ended responses to the questions. To reduce the burden of completing such a large survey, the questions were largely restricted choice and every respondent was given a subsection to complete. The survey was mailed to teachers as part of a regular mailing of the Alberta Teachers Association. Respondents were give stamped and addressed envelopes in which to return the surveys.

Sample and Data

The sample consisted of a random sample of 1000 full time teachers from each of the four divisions drawn from 26,500 employees in the Province of Alberta in 1995-1996. The data were summarized as percentages according to the categories and divisions represented.

Findings

A sampling of the findings is placed here. Teachers indicated agreement with the following statements from each of the categories:

Infrastructure

Teachers suggested that the following are needed:

- access to both newer equipment and computers
- more administrative support,
- easier scheduling of facilities,
- more emphasis on computers,
- network administrators,
- local training, and on call help,
- information about software,
- higher quality, c urriculum-specific software,
- tech assistance in each building,
- access to tutorials. projection pads, manuals, periodicals, class sets of software, and
- rapid repairs to equipment.

Empowerment

Teachers suggest that the following are required for empowerment to occur:

- subject matter integration,
- access to timely technical on-site help,
- more input into software purchase,
- more input into hardware purchase,
- more student centered instruction,
- teaming with experienced teacher,
- more input on computer usage,
- teachers developed long range plans,
- team approach to computer usage,
- effective classroom methods,
- effective classroom (lab) management,
- incorporation of computers in curriculum,
- evaluation strategies
- strategies to teach computer tool use,
- encouragement for group work,
- strategies to teach specific subjects,
- time to experiment with use, and
- peer support.

Training

The following are necessary:

- hands-on training,
- modeling,
- demonstration,
- observation of sound practices,
- continuous training to build confidence,
- team teaching, and
- time to learn. usage

Opinion of the respondents toward selected aspects of instructional computing were also obtained as part of the survey. Six hundred ninety eight completed surveys contained the following information. While most respondents stated that students at all division levels should use computers, the response was stronger as a function of grade level. A considerable number of teachers stated that K-3 students need not use computers.

When asked who should use computers with students, 71% of the sample responded "only those[teachers] interested in doing so." Ninety nine percent indicated the ideal number of minutes per week of computer use by students should fall between 30 minutes and 8 hours. The ideal ratio of computers to students was considered to be between 1:1 and 1:2 according to 87%.

A Plan for Action

Vision for use of instructional computing together with planning for ways in which to achieve the vision are critical. The vision and planning need to begin with Education Departments and continue through the school district, school building and classroom level. The vision and plan cannot be dictated; rather, it must be shared and the plans adapted for local application. At each level, the training, infrastructure and empowerment issues must be addressed simultaneously if instructional computing is to grow and have an impact on the reform of public education.

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Multimedia Portfolios for Preservice Teachers: From Theory to Practice

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Over the last five years, educators have discovered the validity of portfolios for evaluating students in elementary and secondary settings. However, using portfolios for preservice teachers at the university level is relatively new (Rogers, 1995; Taylor & Nolan, 1995; Smyser, 1994; McKinney & Ohlhausen, 1995). Another obvious trend in education is the increased use of advanced technology, particularly multimedia technology. This paper will report the results of a project undertaken to allow preservice teachers to combine the validity of authentic assessment using a portfolio with multimedia technology.

The paper is divided into four sections. The first section discusses the theoretical underpinnings of portfolio assessment including a brief overview of Constructivist theory. The next section gives an overview of current research on portfolio assessment in general, with a focus on the use of technology in portfolio development. The third section presents an overview of the hardware and software considerations in the development of this project. This section describes the state-of-the-art multimedia technology used, including scanners, digital still cameras, digital video cameras, and audio input devices to capture work for portfolios. Section four presents a brief explanation of the processes that the preservice teacher would follow to develop a multimedia portfolio. The paper concludes with a discussion of some of the challenges faced in developing the portfolios and gives an update on the projects current status and future directions.

Portfolio Assessment: Theoretical Background

Constructivist Theory

Preservice teacher portfolios are based on the Constructivist Theory of learning, a paradigm which views learners as actively involved in the construction of their own representations of knowledge. According to this view, learning is the process of building knowledge structure by connecting what is known to new information, ideas, and concepts and integrating them to form new understandings. The implications of this theory for teaching are numerous. Table 1 shows some of the differences between this theory and traditional models.

Table 1.
Constructivist Theory versus Traditional Learning Theory

Traditional Learning Theory	Constructivism
Mastering "the facts"	Constructing knowledge
Data centered curriculum	Learner centered curriculum
Product oriented	Process oriented
Teacher as expert	Teacher as mentor
Working alone	Working in a group

According to Constructivist theory, teachers and students who cooperatively determine performance activities used in the classroom are more likely to engage in real-world experiences, and develop learning skills and concepts in a more meaningful manner. In order to assess the validity and accuracy of learning, the theory maintains that learning is a developmental process; and that the process for completing a piece of work is just as important as the product.

Research on Portfolio Assessment

In recent years, many educators have come to the conclusion that traditional assessments do not provide an adequate means of evaluating preservice student progress. Formal and informal assessment measures such as standardized and criterion-referenced tests fail to reflect the actual learning that takes place during instruction. In response to this disparity, educators at the university level have begun to use portfolios in deciding about goals and standards for excellence in teaching, determining evaluation of these standards, revising curriculum, and planning professional development as they mentor preservice teachers into the teaching profession (Adams, 1995; O'Malley, 1995; Pedras, 1994; Reisetter and Fager, 1995; Slater, 1995).

A preservice teacher portfolio is a developmental record of a career; it seeks to capture an individual's capabilities over time. Portfolios reveal growth and performance in areas such as planning, instruction, teaching strategies, classroom management, community service, self-reflection, cross-cultural experiences and professional activities under a variety of conditions. Because they focus on process as well as product, they can be used to diagnose strengths and weaknesses, monitor student progress, and provide feedback on the effectiveness of instruction (Adams, 1995; Barry, 1994; Morin, 1995; O'Malley, 1995).

While there is an enormous amount of literature on portfolios, the research on preservice teacher portfolios is meager. However, a review of the literature suggests three trends that support the use of portfolios for preservice teachers. The first trend is an emerging emphasis on attitudes and self-evaluation of preservice teachers. Second is the increase in the use of alternative assessment and evaluation techniques. Finally is the trend towards implementing portfolios in methods courses and across the curriculum. These trends are discussed below.

Attitudes toward portfolios and self-reflection qualities are emphasized by Barry (1994), Morin (1995) and Matanzo (1996). Barry (1994) points out specific activities that promote reflective teaching including: (a) teaching experiences, (b) journal writing, (c) peer observation, (d) receiving notes/feedback from peer observations, (e) self-assessment, and (f) consultation with the university supervisor. In this study, students seemed to feel that teaching experiences required the most thought and reflection. Morin (1995) recommends that the development of portfolios by preservice teachers encourages self-reflection, since students must demonstrate their teaching effectiveness and growth. Matanzo (1996) used a pre/post test measure to help preservice teachers note perceived growth in a reading/children's literature class. She notes that a vast majority of her preservice students felt they gained increased self-confidence in their abilities and knowledge to work effectively with elementary students. These articles stress that self-evaluation can be a powerful tool in helping preservice teachers gain insight into their own achievement.

Assessing preservice and beginning teachers by using alternative instruments tends to provide a more accurate picture of the competency of future teachers. Adams (1995) suggests the use of portfolio artifacts in a variety of categories i.e., professionalism or communication, followed by a written rationale for inclusion in portfolios. Reisetter and Fager (1995) explain how a goals based university program which actively involves preservice teachers in a multifaceted approach to assessment is effective. Taylor and Nolan (1995) focus on validity as an important aspect of portfolios. They compared preservice teachers using portfolios with students in more traditional assessment courses. The results of their research support the usefulness of portfolios. Faust and Kieffer (1995) explored the portfolio evaluation process of students by having teachers develop portfolios of their own to evaluate their teaching. This qualitative research project indicated that diverse and sometimes conflicting purposes for evaluation were used by teachers. He discovered that in the process of developing portfolios, both learners and teachers discovered a way to come to a consensus about rubrics used. Standerford (1996) investigated the use of formative and summative evaluation of elementary students by preservice teachers who, in turn, engage in formative evaluation of themselves. Her conclusions point out that interactions with her preservice teachers, and their engagement in formative evaluation with elementary students helped them become reflective practitioners. In summary, these studies point out that alternative assessment and evaluation allows for a multidimensional view of students.

Currently, articles which deal with implementing preservice teacher portfolios in methods courses appear to be the most plentiful. Anderson (1996), Gambro (1995), McKinney & Ohlhausen (1995), Slater ((1995) and Wickliff (1995) touch on developing portfolios in literacy, children's literature, educational psychology, physics, music and writing courses. Hoag (1995) describes a project involving preservice teachers in a methods course with training and experiences in authentic performance based assessment with an elementary school. Students learned about rubrics, diagnosis of oral reading, word recognition analysis; and how this performance could be evaluated as part of a student's portfolio. This cross-educational collaboration model shows how a university and elementary school benefit each other in the development of portfolios for preservice teachers and elementary students. Using portfolios across the curriculum to encourage reflections is explained by McFadden (1994). Portfolios are used in the liberal arts, applied science and teacher education programs at his university. McFadden discusses a variety of models and specific items such as essays, teacher conferences, and reflection as part of a preservice teacher portfolio. All of these authors discuss how they successfully organized and integrated their course objectives using preservice teacher portfolios. Some suggest that students assessed by portfolios feel less anxious about learning course content, contributing to intrinsic motivation for learning. The guidelines provided by these authors suggest that portfolios can be used successfully with preservice teachers and that there are many ways of implementing them. Additionally, pitfalls can be avoided as faculty share their experiences with each other.

Another area of emphasis in the literature is constructing preservice teacher portfolios by incorporating professional teaching standards. Guillaume, Yopp & Hallie (1995), Rogers (1995), and Tracz (1995) all recommend that incorporating national, state, and college goals fosters development and improves the evaluation of portfolios. Pedras (1994) presents the portfolio design used at his university, and suggests that these portfolios include a teaching resume, educational philosophy, lesson plans and many other items. Guillaume, Rogers and Tracz note that careful construction of portfolios by paying attention to quantitative and qualitative data serves to guide future directions of portfolios at their institutions.

Technology and Portfolio Assessment

There is very limited research about the use of technology to support alternative assessment, including portfolios. Employing technology, however, offers tremendous possibilities for preservice teacher portfolios. Campbell (1992) describes how laser discs are used in portfolios and notes the importance of parents, staff, and students working together in the development of portfolios. Palmer (1995) suggests the use of integrating disciplines and creating video portfolios of student work. It is clear that there is a definite need to use technology if we are to move ahead in education; developing preservice teacher portfolios is an authentic performance activity for assisting students in achieving a meaningful goal.

A Multimedia Portfolio

Rather than taking a traditional linear, book-like approach to portfolio creation, this project opted to use emerging multimedia technology as the media. Every school in Florida has, by law, at least one multimedia computer. Preservice teachers completing this project would have their entire multimedia portfolio on a read/write compact disk, commonly called a CD-ROM. This CD-ROM could be brought to a job interview with a reasonable assurance that the school would have the equipment needed to view the portfolio.

The multimedia portfolios were designed to use various type of media including: computer graphics, photographs, scanned documents, recorded sound, and digital video. The portfolios also integrate the concept of hypermedia, which allows certain text or graphics to act as *hot links* or *buttons*. Using the mouse to select highlighted text or an icon links to other parts of the portfolio. This means that the portfolio would not necessarily be presented in the exact same order every time it was used. The interest of the user, in this case a perspective employer, determines the order.

The goal of utilizing multimedia presented several challenges. Each of the types of multimedia described above can be stored on a computer in many different file formats. This makes it difficult to ensure that the multimedia will work on a variety of computer platforms. While each school has a multimedia computer, there is no way of knowing what type of computer it is. Therefore, it became necessary to find a way to create a multimedia, hypertext portfolio that could be read by the largest number of computers.

Fortunately, this problems is quite similar to the one faced by the designers of the World Wide Web. To allow many different types of computers to share multimedia elements, the Web designers developed a language called the HyperText Markup Language (HTML). This allows one to describe the appearance and function of a Web page. Special software called a browser creates, or renders, the page.

Therefore, the developers decided to base the multimedia portfolio on the HTML language. This decision had several implications for the project. First, since it would be created in the language of the Web, it could be placed on the Web without modification. While this institution does not currently have the resources to place the pages on the Web, several students have indicated that they will make provisions with their Internet service providers to take advantage of this feature. It is expected that all of the multimedia portfolios will be placed on the Web in the near future.

The decision to use Web browser software also determined the file format for the multimedia features. The following file types were used.

Multimedia Function	File Type
Audio	*.wav
Video	*.avi
Scanned Documents	*.gif
Photographs	*.jpg

Developing the Portfolio

The process for developing the multimedia portfolio includes student participation in four seminars on campus. The first seminar introduces the preservice teacher to the creation of the multimedia portfolio. Students are instructed in using HTML files, gathering student samples, obtaining graphics (photographs, illustrations, certificates, etc.), locating demonstration teaching videos, and developing sound recordings. At the second seminar students use the multimedia portfolio program and import their text files and artifacts collected onto a Zip Diskette using an Iomega Zip™ Drive. In this way, any new information can be added whenever necessary. Seminars three and four are devoted to importing the video and audio components of the preservice teacher multimedia portfolio, and recording work onto a CD-ROM.

As a future improvement an additional seminar will be added to help students place their multimedia portfolio on the Internet. The preservice multimedia portfolio was originally designed to encourage students to develop a portfolio and they are beginning to move in this direction as they use technology to search for employment. To further describe the process of creating the multimedia portfolio, The next section describes the computer hardware and software used in the creation of the portfolios.

The Creation Stations

Two identical workstations, dubbed the ***Creation Stations***, were purchased for use in this project. The first component was a sufficiently powerful multimedia personal computer, Pentium 133 with stereo sound, CD-ROM player, and digital video capture card. The capture card is needed to convert analog video from either a video camera, television, or VCR to compressed video for storage on the computer. A microphone was also purchased to allow the preservice teachers to record their own voices for inclusion in the portfolio. Because of the large size of multimedia computer files, Iomega Zip™ Drives were purchased. Each participant is expected to purchase their own Zip™ disk to hold their files. This disk is used as working storage as the project develops and as a final testing and storage area for the final version to be transferred to the CD-ROM. Two read/write CD-ROM players were purchased to create the final product. Other equipment included digital still cameras for photographs, digital video cameras for live video, video cassette recorders to digitize videos taken with regular video cameras, and color scanners for documents.

Software

Much of the software used in this project came with the various media devices purchased. The digital still camera, scanner, and video capture cards came supplied with appropriate software. Generic HTML documents, to be replaced by the preservice teacher as described above, were created with Hot Dog Professional (Sausage Software, 1996) an HTML editor that can be evaluated for free for thirty days.

The student HTML documents were created with Microsoft Word with Internet Assistant (Microsoft, 1996). Internet Assistant is available for free from Microsoft. Participants created their pages in Word and saved them in HTML format. Most modern word processors including WordPerfect and Claris Works allows this.

As the project progressed, it became obvious that software was needed to manipulate the graphic images and convert them to formats recognized by Web software. This was accomplished using LView Pro shareware (MMedia, 1996). This program was used to rotate, size, and convert file formats. Also, since many different preservice teachers would be using the Creation Stations, McAfee Virus Scan (McAfee, 1996) was installed on both computers.

Conclusion

The research on preservice teacher portfolios is growing and appears to be extremely useful in the development of portfolios at the university level. Students engage in self-evaluation and become more responsible for their learning. For the most part, faculty, staff and administrators seem to support this new method of authentic performance, assessment and evaluation. It appears that the greatest problem facing universities is how to manage portfolios college-wide. Developing and implementing multimedia preservice teacher portfolios is an enormous responsibility and task. It requires the cooperation of students, faculty, staff and administrators. Financial support for equipment and technical support to maintain equipment is essential if the project is to succeed. The team in charge of the project must continually revise procedures, be aware of problems, seek solutions to problems, and keep students, staff, and faculty motivated as they move into the future. As preservice teachers pass through their courses, they must be continually reminded by faculty to seek artifacts that are meaningful representations of their capabilities as growing adults and future teachers.

Preservice teacher multimedia portfolios represent a breakthrough in education and technology. As we move into the 21st century, we have an obligation as professional educators to help our preservice students learn how to utilize technology by forming accurate, meaningful, holistic, yet creative portraits of themselves.

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THE DIGITAL PORTFOLIO AS A LEARNING AND ASSESSMENT TOOL

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This project, designed in conjunction with two K-12 schools in the Washington, DC area (one private school and one public school), examined the use of digital student portfolios as an instructional, assessment, and evaluation tool. This project demonstrates the process through which pre-service and in-service teachers work with students with and without learning disabilities to create digital portfolios using the HyperStudio Authoring Program. These portfolios were then published on CD ROM and on the Internet on the schools' web pages.

Project Objectives

The major project objectives were:

1. increasing students understanding and use of narrative structure in written and oral storytelling;
2. developing an effective teacher-training tool for the use of technology in education;
3. designing an assessment tool for evaluating students' technology-mediated projects; and
4. increasing strategies by which students can better learn to use technology as an artistic and performance outlet.

Recommendations to incorporate electronic student portfolios into school-wide curricula were examined, including a focus on teacher training, accountability to district-wide criteria, and maintenance of the program. Following this research-based project, teachers worked with technical advisors to develop a school-wide portfolio system to support performance-based education in a classroom.

Theoretical Framework

The complex task of educating the nation's youth precludes such simple prescriptions as: "computers improve learning" or "give technology to teachers first". There is no one right answer, either in terms of specific technologies, uses of technology or how to introduce technology into a school. However, it is clear that technology itself is not the answer to this nation's educational problems. The power of technology will come from its combination with serious educational reform. Schools must first rethink their missions and structure, starting with the needs of students and instructional principles, before they can understand the way technology will facilitate teaching and learning (Means, 1994). From this point, schools can restructure to meet the demands of preparing students to act as global citizens in the 21st century.

Portfolio assessment and performance-based education are methods by which school can restructure. Portfolios can empower students and teachers to reflect upon the teaching and learning process (Herbert, 1992). Performance-based education is used to give teachers practical information on student learning and to provide opportunities for school communities to engage in a recursive process of self-reflection, self-critique, self-correction, and self-renewal (Darling-Hammond, 1994). The theory of multiple intelligences presented by Gardner (1993) states that children may demonstrate different intelligences (musical, spatial, bodily-kinetic) that may be overlooked by traditional assessment and instructional methods. Using Gardner's theory as a model, schools and school districts across the nation have begun to use portfolios as a assessment tool. Students and teachers can develop portfolios that present a student's progress over time, and provide more in-depth information than typical testing and grading procedures used in schools. The next step in portfolio assessment involves bringing current and emerging technology into the model, providing a multi-media presentation of the student's learning and development.

Standardized tests have been used for some time in schools, and educators are familiar with the different aspects of this type of testing. School systems publish the schools' standardized scores in local newspapers. The school board then goes into the highest ranking schools to see what programming is being used to achieve the high scores. This allows schools and teachers to reevaluate what they are doing and make the necessary changes. Some middle schools and high schools have developed classes to specifically meet these needs. Teachers in the state of

Maryland have used standardized test results to group students in math and reading, although much of the time, the test and the instructional program do not coincide. Standardized tests are generally used once every three years. They test students' long-term progress; however, the small increments of a student's growth often go unnoticed. Standardized tests examine singular problems that call for particular, circumscribed elements of knowledge and problem-solving skills (Resnick & Resnick, 1992; Means, 1994).

Performance Assessments (sometimes referred to as authentic or alternative assessments) differ from traditional short-answer paper-and-pencil assessments in a number of ways. They use the actual work of the students or teachers as objective assessments (Means, 1994). They measure incremental (or short-term) progress, enabling teachers to look at a student's specific learning problems, strengths. and weaknesses. Performance assessments have indicated that a change in curriculum could be necessary. Instead of facts and figures, teaches are stressing opinions and thought provoking "why" questions. Like tasks or activities that individuals carry out in the real world, the performance tasks to be assessed encompass extended activities that allow for multiple approaches and a range of acceptable products and results. A performance assessment allows students to work as individuals and in groups. It further encourages the motivation and challenges that go along with working in a group. Performance assessment tasks may also require students to write investigative reports and debate conclusions (such as history/social science assessments in the California Learning Assessment). Students may carry out inquiry projects in a chosen subject and create exhibitions that culminate in describing and defending their projects to an audience (Collins, Hawkins, & Frederiksen, 1990; Hawkins, Collins, & Frederiksen, 1990; McDonald, 1993; Means 1994).

The evaluation criteria for performance assessments have to be developed according to expected outcomes. Students must be aware of the objectives for the criteria, and educators must help to foster the learning surrounding objectives. Performance assessments must provide evidence about students' learning and performance in relation to established standards. It is this evaluative perspective on student performance that makes assessments particularly powerful vehicles for learning as well as sources of information for students, teachers, and other audiences (Means, 1994). Many school districts and states are beginning to develop these criteria and have evaluated the criteria with actual work done by students. California is one state that is currently developing standards for its performance-based assessment system. State assessment guidelines for students' mathematical problem solving include: producing clear and coherent diagrams and explanations; communicating effectively; understanding important mathematical ideas and processes; and presenting strong arguments that include effective examples and counter examples (California State Department of Education, 1989; Means, 1994).

The HyperStudio Authoring System (Roger Wagner Publishing Inc., 1996) is a computer program that can be used as an individualized and interactive system for instruction. Instructional units to address content areas or deficiencies can be designed for and by students. The program has potential to be a useful tool for educators who need to customize or create their own applications. By combining the computer technology in the HyperStudio application for data display and retrieval, instructional delivery can be enhanced. Improved focus and attention of students are definite advantages gained when instructors use a hypermedia graphic organizer for the lesson's content. The teacher can also appreciate the subsequent data modification capabilities that HyperStudio affords and the easy storage of charts, maps, or graphs. For example, HyperStudio can enhance a lesson plan on the interpretation of bar graphs by providing examples of such graphs and computer graphics of the sources from which the data are taken. HyperStudio material can be designed specifically for classroom uses. For example, other researchers have used HyperStudio stacks with laser discs and CD-ROM discs to allow students to have access to information on the discs. As teachers designed customized stacks for their own students, the teachers found increased success in their students and felt more comfortable with using computers in the classroom.

Methods

In this project, pre-service and in-service teachers worked to facilitate the design and development of the students' digital portfolios. As an instructional technique, the teachers created their own digital portfolios and modeled the use of hardware and software for the students. Teachers investigated portfolios as a tool for assessment and evaluation of learning outcomes, and documented the process of developing the teaching tool. Each in-service and pre-service teacher was expected to contribute his or her own expertise in content areas of the project, as well as in the creation of personal portfolios. Teachers were expected to gain the skills and strategies needed to continue to develop both teaching and technology methods.

Forty students with diagnosed learning disabilities, four in-service teachers, and two pre-service teachers from the teacher-training program at a local university were participants in the project. The focus group of in-service and pre-service teachers was given initial computer aptitude and attitude surveys, and then trained to use the HyperStudio software.

The 40 students in this program had varying types of learning disabilities, including visual discrimination, language/communication, verbal and motor difficulties, and processing disorders. Other students had no documented learning disabilities. The students were given a standardized test of oral and written language, a computer attitude and aptitude survey, and an oral evaluation of their storytelling/narrative structure skills by one of the in-service teachers.

The program was conducted in a series of phases over six-weeks during the summer of 1996. The program began with oral storytelling activities, with the in-service teachers and pre-service teachers serving as models. Using a Macintosh computer, student were encouraged to develop characters, and tell an oral story about those characters. Students were then trained in using HyperStudio to tell stories that incorporate sound, animation, video and digital images. HyperStudio was also used as a presentation tool for the students to share their work.

All students worked with the teachers to create individual portfolios that included all electronic stories. These portfolios were then pressed to CD ROMs and uploaded to the schools' web sites. Portfolios were evaluated by the in-service and pre-service teachers for development of narrative structure, storytelling strategies, and writing skills such as sentence structure and punctuation. Following the instruction, students were given a post-intervention standardized test, an attitude and aptitude survey, and a follow-up evaluation of oral communication skills. Teachers also completed an attitude and aptitude survey of computer skills at the completion of the program.

Results/Conclusions

As students and teachers became more adept at using both teaching and technology techniques, modules created by the students became more sophisticated, and used more in-depth, advanced features. By carefully monitoring all participant progress (students, teachers, and trainers), it was possible to make accurate statements regarding the effectiveness of the project. This work provided teachers and teacher-educators with a model program in which collaboration, student-centered learning and technology can come together in a meaningful way.

The purpose of this study was training teachers to use available technology to determine the relationship between student developed computer-based instruction and skill mastery. This relation was considered through various perspectives including mastery of objectives, consultant feedback and direction, and portfolio assessment. The students themselves indicated that the instruction in HyperStudio was valuable to them and they felt confident in their ability to create useful and innovative lessons. In addition, students appeared to value the opportunity to develop their computer skills via the HyperStudio system.

Technology has become a large part of students' lives in and out of the classroom. New technology in the workplace includes the continuing development of hardware and software for the future. This technology has helped to automate many aspects of students' lives, such as family banking and grocery shopping. Computers and the use of the Internet have become prevalent and widespread. Schools have also begun to incorporate technology, and, based on positive results, will more than likely continue to incorporate it. School media centers are using computers with encyclopedias on CD-ROM as well as the encyclopedias on the shelves. Educators are using computer-assisted instruction (CAI). Based on these facts and ever expanding computer technology, traditional assessment practices, such as the text-based standardized tests discussed above, may not be appropriate. Instead, performance-based assessments, which do not rely solely on writing and text, could be more realistic.

When performance-based assessment is employed, students can use and present the work they have done in a variety of formats, including technological ones. They can use spreadsheets, graphing tools, word processing and sound tools and have access to the world through the World Wide Web and e-mail. Students' horizons and self-esteem can be expanded by giving them the chance to publish their work on the Internet for the world to see.

In addition, as technology becomes more advanced, special educators can provide adaptive and assistive devices beyond what is currently possible. Global technologies offer mobility, multiple modes of communication, translation, and other opportunities to all students, despite the disabling condition. Students can create their own learning environments, thus matching their own learning styles. As research in technology-based education progresses, further uses are certain to be discovered.

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Using Technology in Preservice and Inservice Teacher Education Programs

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The use of technology has become more sophisticated and varied in education. This article presents four distinct uses of technology to enhance preservice and inservice teacher training: e-mail between two universities thousands of miles apart to allow students the opportunity to communicate and problem solve about common problems encountered during student internships; compressed video to provide required courses to students on area campuses; laser videodiscs to deliver instruction in the area of gymnastics; and training on technical information using videotape prepared by an "expert" and delivered with the assistance of a cadre of trained on-site facilitators.

Using Technology in Preservice and Inservice Teacher Education Programs

Technology can be a powerful vehicle for changing teaching and learning in teacher education programs in our colleges and universities (Barnes, 1992). Computer networking and satellite communications technologies facilitate local and long distance collaboration and communication among students in teacher education programs. Compressed, interactive video presentations permit the transmission of college courses through distance education. Multimedia technologies assist preservice and inservice teachers to design professional, motivating products of their own creation. All of these uses of technology can contribute to preservice and inservice teacher education programs that facilitate and encourage our students' engagement, collaboration, creativity, and active learning. This article describes the use of four distinct types of technology in personnel preparation programs developed and/or delivered by faculty at one institution of higher education.

Using E-mail for Problem Solving

"As the world moves into the information age, telecommunications networks have the potential to change the nature of teaching and learning in all aspects of education" (Schrum, 1995, p. 221). The use of educational telecommunication networks can encourage social, collegial, and professional development activities (Schrum, 1995). Preservice and inservice educators who want to increase the use of telecommunications technologies for professional development are developing ways to incorporate technological innovations into their instruction.

One traditional and time-honored method of instruction, the class discussion, has been positively influenced by educational telecommunications networks, including the use of electronic mail (E-mail). E-mail is currently being used in higher education classrooms in journalism, engineering, English, business education, writing, and nursing (Lowry, Koneman, Osman-Jouchoux, & Wilson, 1994). Discussions via electronic mail assist students to reflect upon, share, and express ideas. It also may help them brainstorm and generate solutions to problems and to function as a community of learners.

Project Description

The intent of the project was to create a community of learners who would conduct discussions through the interactive use of electronic mail (E-mail) and brainstorm solutions to real problems. Special Education majors at the University of Central Florida and the University of San Diego used E-mail to communicate scenarios which they developed from problems encountered in their internships. The university students were enrolled in learning disabilities curriculum classes and were also completing a student teaching experience. All participants had received instruction in how to use E-mail. Most students had used E-mail in a previous course to complete an assignment with another student.

Students from each university program were randomly matched to a partner at the other institution. Though they did not meet in person, students exchanged faxed photos and introduced themselves via E-mail. Each week throughout the fifteen week semester, students were asked to describe a problem they had encountered in their internship and send it to their partner. Partners E-mailed their suggestions for addressing the problem. Students were expected to generate at least ten of their own scenarios and respond to their partner's ten. All E-mail transmissions were made outside of class time. The expectation was that students would apply the content from their curriculum classes to the scenarios.

Students E-mailed copies of each of their transmissions to the course instructor. This gave the instructors the opportunity to verify that students were communicating, and enabled them to refer to some of the scenario topics during class, thus increasing the relevancy of course content.

Project Outcomes

Several outcomes were realized from this project:

1. Students participated in a "hands on" project which enabled them to use technology as a tool to enhance communication in a non-threatening environment. Students shared information and asked questions of their partners that they might not ordinarily have asked of their instructor or their supervising teacher.
2. Students applied course content to solve real life problems collaboratively with their colleagues.
3. Students were able to share information about diverse groups of children in two extremely different public school settings, and vicariously benefit from an additional field experience or internship.
4. The use of technology resulted in a natural support network for participants by linking together individuals with similar challenges and eliminating the feelings of isolation and helplessness frequently experienced by student teachers.
5. The professional interaction and active involvement provided through the use of technology encouraged further dialogue beyond course topics and stimulated a collegial, working relationship for these developing professionals. Through the use of electronic mail, a community of learners was truly established.

Discussion

This project proved to be successful in addressing the problem of isolation that many Special Education teachers/student teachers face. The use of electronic mail allowed the participants to serve as mentors for each other, and to become empowered with a wider repertoire of teaching strategies through collaborative problem solving. When evaluated by the participants at its conclusion, the project was found to be highly successful with just a few suggestions for improvement. Students occasionally could not access E-mail if the university system was down. Other students had difficulty using passwords. Some students had difficulty scheduling time in the computer lab to use E-mail. Attempts were made throughout the semester to address these problems as they occurred in order to enhance each student's chances for a successful experience.

Using Distance Education to Reach Students on Area Campuses

The concept of distance education is not a new one. Pennsylvania State University offered its first agricultural courses in the 1890s and added credit correspondence courses for professional engineers in 1918 (Burgess, 1994). The current usage of the term, however, carries a connotation of technology. Distance education now refers to teaching and learning in which electronic devices and print materials are used to deliver instruction to learners who are geographically separated from each other and their teacher (Lane, 1992).

Project Description

The University of Central Florida, located in Orlando, currently has a student enrollment of approximately 28,000. It is comprised of three campuses: the main campus in Orlando and area campuses in Cocoa and Daytona, Florida. One course in the Department of Exceptional and Physical Education, Introduction to Mental Retardation, was targeted for distance education for several reasons. It is a required course for all Exceptional Education majors specializing in the area of Mental Retardation. Due to the limited enrollment, this course is offered only on the main campus. Students on area campuses with an interest in the area of mental retardation have been reluctant to pursue this specialization because of the unavailability of the required courses on their campus and one hour commute to access them on the main campus.

The main site is a carefully constructed, technologically advanced electronic classroom located in the library at the main campus. Monitors were set up on each of the area campuses. Prior to the beginning of class, training in the use of distance learning was given to the instructor for two sessions. (Additional instruction will be provided for future sessions on an as-needed basis.)

Training for the instructor included a thorough explanation of the equipment, dressing and presenting for television, the use of videographics and other media, and a discussion on the use of educational materials.

Project Outcomes

Summative outcomes are unavailable because the course has not been offered in the compressed video format as of this writing. From a formative point of view, however, some things can be said. Historically, the total enrollment in this course has been around 25. With the availability of distance learning on the two area campuses, approximately 40 students have enrolled for the Spring, 1997 semester (approximately 30 on the main campus and seven at each of the area campus). This is an important increase because there is a critical shortage of trained teachers in this specialization area. Much has been learned about the process of delivering distance learning. These lessons can be applied in the future by the instructor involved and shared with colleagues. The most important lesson is to embrace technology, not fear it. Use it as a tool, view it as a step forward, and learn as much about it as you can.

Making and Using Laser Videodiscs for Instruction

Many educators are seeking ways to integrate technology into their curriculum. Physical educators are no exception. There was a need, for example, to find innovative ways to deliver quality, consistent instruction to gymnastics classes in a physical education teacher preparation program. In traditional gymnastics classes, the instructor (or a talented student) had to perform each of the gymnastic skills. This is not only time consuming, but difficult to perform repeatedly with precise movement. The use of a laserdisc allowed the instructor to show slow or freeze frames so students could see consistent and correct skill performances. Also, unlike live performances, movements could be stopped in mid-motion for students to see the body positioning. Reported benefits of using videodiscs in instruction include a reduction in learning time, increased mastery of subject matter, increased retention, more consistency in instruction, faster and easier access to information, and greater motivation and learning enjoyment (Baumbach, Bird, & Brewer, 1993; Hasselbring & Bransford, 1988; Miller, 1990).

Project Description

The first step in developing a laserdisc is to determine what subject matter should be included. In the current case, this was determined by looking at the skills students had to master as a part of the course (e.g., floor, vault, balance beam stunts, etc.). The required skills were performed by a gymnast and videotaped. Following the taping, the instructor assisted with editing and provided a narration. Once the filming and editing had been done and the narration added, the tape was ready for transfer to the preferred medium - laserdisc. The format chosen for this laserdisc was CAV (constant angular velocity). This format was selected because it could be accessed by a laser barcode reader. This provided immediate access to specific frames, a very useful feature for a gymnastics class. In addition, barcodes allowed portions of the laserdisc program to be cut, copied, and pasted in lesson plans.

Project Outcomes

Many different ways to use the laserdisc were discovered during the course of the semester including (a) large group presentations, (b) small group work, and (c) individual viewing.

The most exciting and active use of the gymnastics laserdisc was with cooperative learning groups. Groups rotated through stations at which different skills were viewed, analyzed, and then performed. During station work, small groups would view the skill they were working on as many times as needed. Students welcomed this move to cooperative learning groups and center-focused learning. They began to see each other as resources and the atmosphere was one of excitement as they guided their own learning.

Discussion

Gymnastics requires active learning and hands-on experiences, so a passive use of technology would not be a solution. Production of a laser videodisc with an active application was the answer.

Providing Technical Information to Teachers Through Videotaped Training

Providing training to teachers using video has become fairly common (Lane, 1992)). It is an effective way to teach a new approach to a familiar topic (Lambert, Heaton, & Ball, 1994), and an efficient way to deliver training to large numbers of busy teachers in schools scattered over large districts. Special care must be taken, however, when the training content is highly technical and has high-stakes implications for students. A school district in South Florida found the approach described below to be especially useful for "just in time" training on how to implement a new graduation option for students with disabilities.

Project Description

Florida is one of the few states that allows school districts to award differentiated diplomas to students with disabilities. In June 1994, the State Board of Education added another option. This second special diploma option, unlike the earlier one, is not based on course credits and mastery of the state-developed student performance standards. It is based on documented employment and on mastery of a set of exit competencies developed for each individual student.

Requirements for graduation under various diploma options are technical and complex, and implications for young adults with disabilities in their choice of diploma options far reaching. Staff responsible for training teachers were concerned about delivering precise and thorough information about Special Diploma Option 2 in time for implementation within a few months. They felt it would be better to develop a video tape with an "expert" providing the technical information and to train area and district personnel to facilitate teachers while they watched the tape. The original developer of the Special Diploma Option 2 concept was hired to make a videotape and to train special education personnel in how to use it to train middle and high school teachers.

This service delivery format accomplished the following:

1. It assured that identical and accurate information was provided to all the people who were going to implement Special Diploma Option Two.

2. It recognized the time and travel constraints.
3. It gave teachers immediate access to an area level person who had already had training in Special Diploma Option Two, so specific school/area concerns can be addressed immediately.

Process

The two keys to this type of training are to have (1) a video tape with accurate, clearly presented information, and (2) well trained facilitators. Area and district personnel were trained in the use of the video tape. Training tips included general best practices before the training, such as how to schedule training sessions, arrange for the site, invite participants, gather materials and equipment, and prepare the agenda/schedule of training session

Facilitators were instructed in good practice for training, such as previewing the materials with the participants, facilitating the hands-on activities at various intervals during the tape, leading the problem solving session and accessing resource materials referenced on the tape.

Project Outcomes

Training was delivered to over 400 middle and high school teachers in 40 schools. Participants reported being pleased with the quality of the video presentation and felt the content was covered clearly and comprehensively. They especially enjoyed the still pictures of local students and teachers and the role play depicting a meeting to develop the graduation competencies.

Discussion

In the past, technical information was transmitted to teachers in hard copy, in large group settings, or in smaller groups by people who were not expert in the material. The advent of video technology solves only part of the problem - accurate information from a primary source. A trained person on-site addresses that very human need to interact with a real person who shares goals and concerns.

Summary and Conclusion

Technology and education are natural partners. The four examples of education/technology partnerships described above are just a few of the ways these two fields, one very old and one comparatively new, can work together. It demonstrated technology as an integral part of these teacher training programs not as an afterthought or an add on. Technology did not significantly change the content or purpose of the training. Rather it was used to address student/consumer demand for collaboration across geographic boundaries, convenient service delivery, precision and accuracy in instruction, and shorter turn-around time for training. As with any partnership, it will take time to see how it works. If they grow together, learn from each other, and remain open to change, it will continue to be a productive and exciting partnership.

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Learning From Children: A Progressive School Approach to Technology

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In order to develop our view of the revolution that technology is creating in education, it is helpful to briefly consider how technology has revolutionized American culture, and how it has left our educators rushing to catch up (Strommen & Lincoln, 1992, p. 1). Technology has revolutionized American culture, and what better way to teach American history then by following the evolution of technology. City & Country School is dedicated to the philosophy of giving children experiences and materials that fit their stage of development. We believe technology is an extension of their learning, another medium in which to creatively engage and organize their experiences. In this paper we present an alternative American history curriculum, one which includes a complete integration of technology, a study of how the advancement of communication affects the social and economic history of America, and the evolution of modern journalism.

City & Country School

From the very beginning of his education, the child should experience the joy of discovery. The discovery which he has to make, is that general ideas give an understanding of that stream of events which pours through his life, which is his life (Whitehead, 1967, p. 2).

City & Country School, founded by Caroline Pratt in 1914, is the oldest continuously operating progressive elementary school in the state of New York, and is recognized throughout the worldwide educational community as a leading model of progressive education. At the heart of this curriculum is "The Jobs Program," which plays a central role in groups VIII's through XIII's (3rd - 8th grades).

City & Country is dedicated to the belief that the desire to learn is one of the strongest of all human drives and that the most important responsibility of educators is to nurture this drive in every constructive way. To fulfill this responsibility, we must remain true to the philosophy of Caroline Pratt — fit the school to the child, not the child to the school. This holds true when using computers as well. We integrate technology into the curriculum to provide a meaningful experience for each individual student. We do not bombard the child with "bells and whistles" software, but instead, introduce the basics of word and database processing, Hypermedia programming, desktop publishing, design and multimedia. Children use the computer as another tool, mastering it through experimentation, research and self-discovery. At City & Country, we value the process of education in our mission to create life-long learners.

The Jobs Program

Childhood's work is learning, and it is in his play — before he ever gets into the hands of teachers in organized education — that the child works at his job. No child ever lavished on a history book the energy he poured into a game of cowboys and Indians. But cowboys and Indians are a part of the history of our country which he must learn. What is wrong with learning history by playing it (Pratt, 1948, p. 8)?

As children grow and the quest for knowledge becomes increasingly based on written text, they are taught the necessary academic skills — reading, writing, and arithmetic. Simultaneously, they begin to investigate the nature of human interaction from a historical point of view. Each group has a specific job related to the school's functioning as an integrated community. Our students, like inventors throughout the ages, are in the process of figuring out how people communicate. They trace the process of communication and various technological advancements via their school jobs and history curricula — be it the study of native American Indians and Dutch colonies and the need for the post office in the VIII's (3rd grade); westward expansion and the need for the general store in the IX's (4th grade); the study of the Middle Ages, illuminated manuscript writing and sign making in the X's (5th grade); the emergence of paper and the advent of the printing press in Ancient China in the XI's (6th grade); in the XII's (7th grade), the spread of philosophy and ideas in Ancient Greece, book writing and child care with the IVs; and finally, their City & Country careers culminate in the

XIII's (eighth grade) with the study of newspapers and American history.

The Learner

> . . . there is an intimate and necessary relation between the processes of actual experience and education (Dewey, 1938, p. 20).

Within the City & Country community, teachers strive to create learners who are independent, engaged and who enjoy learning. Education is a continual growth process that never ceases. We believe that the process of acquisition and application of knowledge is more important than a piece of knowledge in and of itself. By way of bringing process or "hands-on" experience to a child, City & Country hopes to arouse a child's curiosity and strengthen his/her initiative and motivation. On behalf of the learner, we encourage educational freedom, prompting the student to use his/her physical and social environments to build upon their confidence and then to further their understanding and ideas. Simply providing the setting is not enough. These experiences should be ones that lead to personal growth as an individual learner and within a dynamic group. This is where technology can be useful. More than ever, our world is rapidly changing and we need to guide our children so they can adapt to and deal with changes. Computers can be powerful tools and resources for communication, research, organizing information, and artistic expression. Our children can use these skills to help themselves gain the valuable information they need to explore and participate in their world.

Technology at City & Country School

> ...new tools alone do not create educational change. The power is not in the tool but in the community that can be brought together and the collective vision that they share for redefining classroom learning (Riel, 1990, p. 35).

City & Country and the Institute for Learning Technologies at Columbia University designed and recently installed an "Intranet" or "inner office" computer system for the entire school. All of the Middle and Upper School (3rd - 8th grade) classrooms and administrative offices are wired and connected to a central computer system. Each of the school's 37 computers acts as a workstation for the students, faculty and staff to access information from any location in our two buildings. Students are able to communicate with each other and staff members by way of student-run electronic message centers, interschool faxing, and in-house electronic bulletin boards. The students also have access to their personal files and the Library's database system. City & Country is not yet physically hooked up to the Internet, but will be in the coming months. Until then, teachers are downloading web sites locally for student research and curriculum development. These little "bytes" of technology continue Caroline Pratt's progressive vision to make information available to a child when it is developmentally appropriate without overwhelming them.

When integrating computers into the culture of the City & Country community, careful consideration is given to the following factors: evaluating the developmental appropriateness of computers, in general, and of particular programs or techniques; demystifying the complexity of computers and their accompanying technology; using computers to enhance the children's learning without becoming "virtual reality"; achieving equity among boys and girls and among those who have or do not have computers at home; and establishing appropriate ethics and responsibilities in the use of computers.

City & Country views computers as another basic or open-ended material, much like blocks, paint, clay, or books, which can nurture a child's natural desire to learn. Faculty members provide students access to a wide range of experiences and disciplines with computers, tailoring their lessons to encourage problem solving, creativity, and exploration without fear of failure. These lessons include technology when it is necessary, whether it is the telephone, fax machine, computer or Internet. Making sure students have access to computers freely is essential. Empowering students with various forms of technology is the key to a successful curriculum and is at the core of the educational philosophy at City & Country School.

Currently, the students use computers for daily activities to complement and support the their social studies, English and mathematics curricula. They use computers to extend their real-world experiences by keeping electronic journals, schedules and records of their notes, as well as developing multimedia and HyperCard presentations for their research. In addition to writing interactive papers on the computer, they create electronic databases and publish or "post" their work on the School's Intranet. These programs allow the students to add still images, video and sound clips into their text. In essence, the students and faculty of City & Country are creating a microcosm of the real "Internet" on a level that is meaningful and manageable to everyone.

8th Grade American History Curriculum

> When discovery learning strategies are employed . . . there is always something to be gained through exploratory and analytical discussion and reflection (Romiszowski, 1992, p. 330).

Prior to the 8th grade, our children study the history of publication from illuminated manuscripts to the spread of the printing press in China, Europe and America. In the 17th and 18th centuries, printers needed woodcuts, movable type, and leather ink balls to produce enough copies to communicate with the masses. Later on, rotary presses, linotype and keyboards came along and led to the practice of paste up. This is where the students begin when they publish their own penny press newspapers in September. Throughout the year, technology is carefully introduced in stages which corresponds directly with the subject they are studying and researching in class.

In the 1830s, Americans were introduced to the first "modern" newspaper — the penny press. Readers included the literate working class and immigrants; they were hungry for news about neighborhoods and cities, and, most importantly, politics. At City & Country, the students created their own competing penny press papers. This year the "Democratic Demo" and the "Republican Review" took on the characteristics of these 19th century papers and were slanted and biased in their political reporting. In addition, great emphasis was placed on school news. To publish their papers, the students utilized word processing skills from previous years simply to write, format, and print their articles. The children were not allowed to use electronic desktop publishing programs because they were still learning the ins and outs of physically laying out and copying a newspaper.

As our American History study moves into the 20th century, we find that technology affects every aspect of the newspaper industry, from the pressroom to the news stand, from yellow journalism to investigative reporting, from family run newspapers to huge media conglomerates. Over time, newspapers have become more sophisticated in layout, design, and technology. Our students use these models to add new dimensions to their own newspapers. Following their penny press papers, the children use computers to experiment with fonts, color and photographic images. They add Pagemaker, Quark, Photoshop, and Freehand to their software palette. From November to March, they produce their weekly newspapers completely on the computer, paying close attention to all aspects of design. In their final stage of their journalism study, the students abandon their "paper" newspaper and create "electronic" papers. These electronic "zines" and web sites are published on the City & Country Intranet.

In American History, pamphlets and newspapers were essential and powerful vehicles by which to spread ideas and news. As years passed, technological advancements dramatically downplayed the influence and power of the printed word; television and radio became faster vehicles by which Americans got their messages out. To understand this, we examine questions such as, How does a visual image affect the public? Why are certain images of people used and others not? How has television and multimedia changed newsprint? Other questions arise about how technology influences the "permanence" of information. How will technology affect their readership? Who are their primary consumers?

Integrated into the newspaper curriculum is the study of the electoral process which begins in the Fall and ends on Election Day in November. At the beginning of the school year, the XIII's were split into Democrats and Republicans and were expected to run a mock presidential campaign in school. They gave speeches, held debates for the students and faculty, distributed their position papers and campaign handouts, and published their penny press newspapers. The students used the computer as their central tool to accomplish all research, writing and publishing. Except for the penny press, they worked completely on the computer, publishing interactive biographical and political information about their political candidates, complete with polling information, photographs, and commercials. They also developed Quicktime movies and electronic sound bites; when you turned on a computer, you automatically received election information and advertising. They began to discover how computers are often more efficient and inexpensive in getting the message out. They followed real world models and found interactive mediums to be more elaborate and potentially more engaging and attractive to their target audience. Experimenting with the technology led them to placing more information in the hands of the reader.

All in all, the XIII's experienced what it was like to run a presidential campaign. They learned how to make story boards, video tape and edit commercials, write speeches, campaign, interview and even deal with political mudslinging. They did not just read about the election process, but they experienced it.

In the Spring, the children will continue their study of 19th and 20th century mass culture and will again present their research and analyses using multimedia. With each research project, they will develop even more complex and intricate presentations using basic programming in Hypertalk and HTML. By employing Pagemill, Netscape, and BBEdit, the students will create their own personal World Wide Web pages. They will conclude the year with a publication on the Internet, as part of the first City & Country School web site.

Teacher's & Technology Coordinator's Role in the Classroom

The key to success lies in finding the appropriate points for integrating technology into a new pedagogical practice, so that it supports the deeper, more reflective self-directed activity children must use if they are to be competent adults in the future (Strommen & Lincoln, 1992, p. 6).

The center of the progressive philosophy embodies, when properly executed, the commitment to student-centered education in which the child's individuality is a key determinant of the way in which the teacher executes the curriculum. Like other areas in school, the teacher provides the structure, but the execution comes from the child. In other words, the teacher serves as a moderator and facilitator.

The teacher's role is to empower children by helping them recognize their abilities in their own creative manner. A teacher guides the class through the content portion of the curriculum, helps them develop the research skills needed to locate information, and shows students how to make connections to understand history better. When it comes to presenting their information though, the children have the autonomy to make their own decisions while meeting the requirements of the assignment. The end result is not the mere regurgitation of facts, but a continuing acquisition of skills.

The role of the technology coordinator or computer teacher is also an important component in the education of the child. As educational institutions introduce computers, a technology coordinator becomes more valuable. She/he is no longer the person who sets up the film projector or makes sure the television is running, but the person who drives communication and information philosophy through the school. In that respect, technology is more than just teaching students the ins and outs of computer software, but it is educating them to obtain the information needed to engage in a multimedia society. A computer need not be a glorified typewriter, but is the vehicle with which the student organizes his/her learning. This requires that a student use the computer for filing information, communicating with others, developing projects, and publishing their work. We instill confidence in students in their ability to comprehend computers, so they can freely decide which technology best suits their needs.

For the students to be successful, the teacher must work closely with the technology coordinator This is a twofold activity: first, time needs to be allocated for the teacher and coordinator to develop and integrate the technology into the curriculum; and second, the teacher needs to be trained. Scheduling computer time for the students is also essential. This year, the XIII's (eighth graders) worked in the computer lab daily. The computer became a an invisible tool, much like a pencil or piece of paper, in every aspect of their work.

The teacher determines the material that will be covered in a given year, while the technology coordinator has the expertise and knowledge of the computer. Empowering the teacher is always the first step to enabling the students. Training the staff has now become the key role of the technology coordinator. It is imperative that teachers become technically literate and comfortable when using computers. Like teaching students, the technology coordinator needs to be sensitive to the individual. The coordinator needs to teach what is necessary, always making lessons appropriate. City & Country not only embodies progressive education for students but supports a long history of training teachers to become experts in "learning from children." Together, the teacher and technology coordinator create a program that is developmentally appropriate and academically challenging.

Conclusion

> How do we educate the "new child," raised in a world of instant information, where interactive technologies have led them to believe they can act on the world with the press of a button (Strommen & Lincoln, 1992, p. 2)?

The Middle School and Upper School curricula at City & Country School embody and trace the progression of communication and technology throughout history. We are, in essence, providing experiences for them to understand the process and the impact of these advancements in technology. The discovery of paper had enormous implications on the printing press and literacy, as did the Pony Express when post offices opened up across the country. Now, the proliferation of personal computers, electronic mail and the Internet is making today's world even more accessible. With the use of technology, we encourage independence and resourcefulness in our students. Nurturing that love of learning and the ability to be autonomous is at the heart of progressive education. It is our responsibility as teachers to provide the experiences that prepare our students for the 21st century.

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Seeing Is Believing: Computer Club Activities Inform Instructional Practices

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This is a tale of two schools, two teachers, and two groups of students. The schools are Texas Christian University's School of Education and the Alice Carlson Applied Learning Center, an elementary school in the Fort Worth Independent School District. The two teachers are myself, an Assistant Professor of Educational Technology at the university, and the elementary school's Multimedia Specialist, Charles Williams. The two groups of students are graduate students in my educational computing courses and children attending the elementary school. These entities became connected through a professional development school project and happened to be located on adjacent campuses.

The School

The Alice Carlson Applied Learning Center is a school of choice that is open to all students in the district and operates on year-round calendar. The school's central purpose is to encourage children to learn, both independently and as team members, in a stimulating environment with strong links to the community.

Applied Learning, the approach upon which instructional practices at the school are based, requires that students use what they learn in solving a problem or fulfilling some important need. Finding resources beyond textbooks or encyclopedias is an integral part of this process. Students are required to communicate in different circumstances, using visual, oral, or written means. Educational technology is intended to be a fundamental part of this process.

Children at the school are given the opportunity to join clubs during the regular school session. They may also attend workshops during the fall and spring intersessions. These clubs and workshops allow students to pursue interests in a variety of areas. They provide opportunities to work with local artists, talented parents, university interns, and staff members who sponsor workshops or clubs.

Club Benefits

As a result of the professional development school project, I became involved in co-sponsoring a computer club with the elementary school's Multimedia Specialist. The club serves as a laboratory for introducing and experimenting with new programs while providing a mechanism for professional development for both of us. I use the club to try out software that I'm teaching in my classes. I can then tell my students stories about what happened, show them examples of children's work, and provide them with opportunities to observe children using the software either during club time or at other times during the school day. The school benefits in several ways. The club members benefit by learning more about computers. In addition, the club has become a tool for encouraging the use of new software throughout the elementary school. After it is used in the club setting, the software may then be used in other contexts, either as part of formal lessons or on an ad hoc basis.

Club Operating Procedures

Computer club members are selected through an application process or by teacher nomination. The activities that the club work on are demonstrated and/or described. Interested students are then asked to submit a letter of application, telling why they want to be in the club and stating their qualifications for membership. Some letters are as simple as the one below:

> I would like to be in the computer club. I think you should let me in because my teacher thinks I am responsible and computers are something I should have a chance to do. It will also help me write better.

Other letters are a bit more complex:

> I think I could be in the computer club because I like computers and I like to learn. I think computers are cool. All I know now is how to play games and use it as a word processor, and I want to learn more about computers. I know that there is a lot more about computers that I would like to learn. We have a Macintosh at home. Through this club, I hope to make better use of the computer at home and school. Thank you for considering me for this club.

The primary qualifying criterion is the child's motivation to be in the club. Those who are motivated are more likely to be productive and stick with their projects. The club's size is typically limited to between six and twelve members, with at least two students from each fourth and fifth grade class and an even mix of boys and girls. Girls sometimes need a bit of extra encouragement to participate, as boys tend to apply for the membership more frequently than girls.

Club meetings are usually held in the school's media center, which is a hub of activity for the school. The lab houses about 20 Macintosh computers, and peripherals such as a scanner, digital camera, laserdisc player, modem, and an LCD panel. When access to the Internet is needed, we have held club meetings in the School of Education's computer lab, which is within walking distance of the elementary school. This lab also has about 20 Macintosh computers that are connected to the Internet via an Ethernet network.

Each semester at least one program is selected for club members to work on. In the past, the programs have included *HyperCard*, *MicroWorlds Project Builder*, *HyperStudio*, and the Internet. Students are given some general guidelines for the types of projects they can work on, but have a great deal of freedom to choose exactly what they will do. They are provided with demonstrations, instruction, and assistance, as needed.

Club Projects

Hyper-Adventures

Our exploration of using *HyperCard* provides a good example of the club's impact. I had read and heard about children creating hypermedia projects. However, I suspected that there might be logistical difficulties and did not know if elementary school children could handle such projects. I was uncomfortable advocating a hypermedia project to students in my computer courses when I had not tried implementing one myself.

Charles and I decided to try out *HyperCard* with small group of six fifth graders. Each week a new skill was introduced and students worked in pairs to practice and apply it to the projects they were working on. Once success was achieved with this small group, the size of the club was increased to 12 members. Those in the first group were encouraged to teach the new members how to use the software.

To learn more about *HyperCard*, Charles attended a summer workshop that I taught and an ongoing course that I teach about hypermedia. These learning opportunities were funded by our professional development school grant.

Our efforts have lead to other uses of *HyperCard* at Alice Carlson. Charles has taught fourth and fifth grade classes to use *HyperCard* and has held an intersession workshop on *HyperCard* for second and third graders. (I was surprised to find out that HyperCard was successful with children that young!) He has also found other opportunities for using the program. For example, he helped two fifth graders do a stack on Texas wildflowers in lieu of a written report.

My students have also seen children working with *HyperCard* when observing at the school. One student wrote in her journal:

> I began to watch two girls work with *HyperCard*. They were playing a game that they created. It was a game about finding your way out of a forest. I was in awe, literally, because I think this is all so great. This is what I want for my students.

This observation is typical when children are given freedom to choose a project involving HyperCard.

MicroWorlds

Club members have also worked with *MicroWorlds Project Builder*. These projects provided my students with an opportunity to see children using the program. Such observations are particularly important, because the way adults interact with the program can be much different from the way children respond to it. Adults sometimes become frustrated or anxious when attempting to understand and solve problems using *MicroWorlds*. By watching children work with the program, adults can see the children's level of engagement and the kinds of thinking that it fosters. One student observed:

> I was impressed with how creative the children were in using *MicroWorlds*. The importance of allowing free exploration, as opposed to the typical "drill and kill" was reflected through this experience. The children learned in an environment rich in mathematical, artistic, and technical operations. Their desire and motivation were cause for their intense involvement, so much so that they did not seem to want to leave.

Students also have a chance to observe appropriate teaching strategies while children are learning to use the program. One student observed me introduce the program to four boys in the computer club and wrote:

> They had obviously learned a little about *MicroWorlds* already, because when Dr. Anderson asked about certain details of the program, they knew. For example, she asked "Do you remember how to put the pen down?" A boy responded, "Yeah, uh, PD." Another question asked was, "What would make the turtle turn half the way around?" One boy answered, "Left 160." Instead of correcting them right away, Dr. Anderson submitted that command so that the kids could see that it wasn't quite right. After that demonstration, it was easier for the kids to figure out that they needed to turn the turtle just a few more degrees to get it to face the opposite direction.

I have also integrated my class work with the computer club activities by showing the club members some of the projects my students had worked on. The children could get ideas for their own projects by viewing club activities or they could learn more about the program by modifying or adding their own ideas to the existing projects. At the same time, my students had a chance to field test their projects with children. One student observed three boys working with a microworld about Hawaii and wrote:

The children did a great job in deciding who was going to control the mouse and what they were going to do. If someone did not know how to do something they would help them by telling them how to do it. They were trying to get the turtle to travel to different islands by using the button. They could not seem to get it to get off the first island. I guided them to use the right and left buttons to move the turtle a different angle and then click travel. They seemed to like to try to pronounce the names of the islands. They had the most fun on the next page, [which showed] the earth with a plane that would travel around it, some stars, and other planets. The boys pushed the button and it would play "It's a Small World After All." They would change the plane to into a spaceship then to a space man, then they would blow him up to be really big, then try to find out how small they could make it. One said, "Hey, the smaller it gets the faster it goes! Let's leave it here."

Art and the Internet

Another club project arose out of my curiosity about how teachers could make use of resources available on the Internet. The Dallas Museum of Art had made images from its collection available through a Gopher server. I wondered how this resource could be useful in an educational setting. This project provided me with a source of stories and sample projects to share with my students.

I started by downloading a sampling of images from the museum's Gopher site and bringing them to the school to show the computer club. The club members used image viewing software to look at and manipulate the pictures. They changed the dimensions so that the pictures were tall and skinny or short and fat.

The next week we took the club members on a field trip to the museum. The children were excited to find the items they had viewed the previous week. Some of the students decided to hunt for a gold cup that they had seen on the computer and remembered in great detail. They located a case of gold cups, but did not see the one that was on the computer! This lead them to discover that the museum does not display all the articles in their collection.

Students then selected one of their favorite works of art and incorporated it into a project they created using *HyperStudio*. Their projects included images from the museum's collection that were either downloaded from the Internet or digitized using a scanner. One of the most elaborate projects was an adventure story in which the user makes choices to find a "sacred blade" that they had seen at the museum.

Surfing the World Wide Web

Later students learned how to search the World Wide Web. The most intriguing aspect was to observe what sites the children were interested in and which held their attention the longest. I started out by providing a web page with links to sites I thought they might like. However, I found I wasn't a very good judge of that! What ignited the children's interest was a gaming magazine, brought by one of the students, that contained a web address for a game. Once this site was located, the word spread around the lab. Soon most of the children had learned how to type in an address to go to a specific site. Later they began using various search engines to find things that they were interested in, including. sites about books the liked to read, games they liked to play, movies they had seen, and favorite TV shows.

One of my students, attending a computer club meeting, was able to experience the phenomenon of adults and children learning from each other:

The club had been surfing the net during the school year. They were definitely ahead of me since this was my first real experience on the Internet. I had spent a few minutes with it when it was introduced in class, but I had trouble finding my way around in *Netscape Navigator*. The students did not seem to have this problem. I was looking over the shoulders of the two boys on either side of me quite often.... There were several times that they asked me questions, as if I should know simply because I am adult. Strangely enough I was able to help them some of the time. But they definitely helped me more.

Later this student, brought her Camp Fire Club to the university computer lab so that they could search for information on the Internet. Several students from my class were also there to observe. One noted the way the children learned from each other:

The boy next to me looked up Disney in order to find something on *James and the Giant Peach*. The boy who was sitting next to him was still working on information about Bluebirds, but was paying attention to us as well. After about ten minutes of searching, he was able to find *James and the Giant Peach*. The boy sitting next to him continually voiced ideas on how to find the intended page and what to do once he got there.... Once he had it on his screen, word quickly spread to other students and they quickly tried to find the same page on their own.

The club's use of the Internet has spawned several other applications at the school. For example, when Charles learned that a first grade class was doing a weather project, he suggested using the Internet as a resource for gathering information on weather patterns. The first graders checked weather in six cities and posted the information on a bulletin board in the hallway. My students have seen this in action when observing at the school:

The little girl wanted to get a weather report off [the Internet] to share with her class. She had been doing this on a regular basis, but had not done so in several weeks. Charles walked her through the steps, allowing her to perform the necessary steps if she remembered them and coaching her through the rest. She began by switching on the modem and going to the weather folder. When she had written down the codes of five cities, she was ready to obtain the weather reports of each. She obtained the weather reports for the individual cities, cutting and pasting each into her document. She then printed the weather reports to share with her class.... It reminded my of the teacher in *We Teach with Technology* (Kearsley, Hunter, & Furlong, 1992) who had his students download information to use in a class project directly from the weather satellite. The little girl's information was only a half an hour old!

Other Internet activities have included reading stories on a web site called "Kidpub" and exchanging e-mail with authors of the stories. One of the poems was published, with the author's permission, in the school's newspaper.

An On-line Art Gallery

This year the club is involved in the creation of an on-line art gallery for the school. I anticipate that this will be the most challenging project we have attempted thus far. We identified several tasks required to establish and maintain the art gallery. Students selected a task that they wanted to learn about and be responsible for. Some students worked on a process for soliciting artwork from each classroom, including a letter to teachers and a form to be filled out by the student artist and signed by a parent. Others have learned to use a digital camera or scanner for digitizing artwork. A third group designed and created the web pages that will display the artwork. Breaking the project into parts and allowing different students to gain expertise in just one part will hopefully make this complex task feasible. Later students will be able to teach their skills to others, so that the children will have a chance to learn other skills.

Summary and Recommendations

The computer club has provided a mechanism for informing teaching practices at the university and at the elementary school by serving as a laboratory for trying out various technologies with children. It has provided me with a source of "real life" stories to tell students in my classes, a collection of children's projects to show my students, and a setting for my students to observe and interact with children using computers. It also served as a source of professional development for the school's Multimedia Specialist and myself. Besides providing opportunities for a select group of children to learn more about computers, it has helped promote the use of different types of software and hardware throughout the elementary school.

If you would like to start a computer club, Charles and I offer the following suggestions for a successful experience:

1. Select children who are interested. Those who apply for membership in the club are likely to be motivated to participate.
2. Keep the group size small. This makes trying new things manageable and mistakes less disastrous. Once the "kinks" are worked out, the software can be tried with larger groups or whole classes. Students who already know the program can help by teaching their peers how to use it.
3. Encourage collaboration by having students work in pairs or groups. This allows students to learn from each other and to contribute their unique talents to the completion of a project. Children often learn computer skills by watching what their peers are doing and asking them to explain how it is done.
4. Allow students to choose what they will work on, within certain guidelines. For example, specify what program is to be used, but let them choose their own topic or role. Students are more likely to stay engaged in a project for long periods of time if they are working on something they are interested in.
5. Remember that children acquire skills by playing. Allow them to experiment and have fun! While they are doing this, you will learn a lot about what children naturally do with computers.

We hope that you will benefit from and enjoy doing this as much as we have!

Acknowledgments

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LEGO-Logic: A Computer Learning Environment for Technology Education

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LEGO-Logic is a learning environment that integrates creative construction of concrete machines and models with an introduction to computerized process c ontrol. LEGO-Logic was developed to facilitate the understanding of both scientific concepts and their technological applications and logical thinking of programming and control. The environment was designed to be suitable, attractive and effective in teaching even young beginners.

Tammy, Natalie and Judy are planning to build a car from LEGO bricks. Tammy and Natalie are building the base of the vehicle and its wheels, whereas Judy is building the vehicle body.

Tammy: I need four motors.
Teacher: What are you planning to build?
Tammy: Very simple, a car.
Teacher: And why do you need four motors?
Tammy: In order to turn the four wheels, of course.
Teacher: Do you know how many motors are in your family car?
Tammy: (hesitates): Maybe just two?

After a few moments of silence, during which Tammy manually moves the LEGO car back and forth:

Tammy (speaking loudly to herself): Actually, two motors will be enough for me. I'll attach them to the front wheels, and the back wheels will be towed along. (turns to the teacher) Okay, so now I need two motors.
Teacher: But now, I have a slight problem. All the motors are being used by other children, and there is only one left. So your task now is, to turn the two wheels using only one motor.

This conversation between twelve-year old Tammy and me took place at a lesson in the Computer Laboratory of *IDEA Center*, at the department of Education in Technology and Science at the Technion[1]. The lesson was part of an experiment aimed at examining the possibility of implementing an innovative project called *LEGO-Logic.* The research was carried out by *IDEA Center* directed by the author.

The above dialogue can on the one hand, hint at children's existing knowledge concerning technological concepts and phenomena, and on the other, demonstrate that exposing children to those concepts, in an appropriate learning environment could improve and enhance their knowledge in this domain.

Modern society is characterized by the rapid developments taking place especially in technology. The educational system that aims to prepare the student for life in such a society has to adapt its curriculum to include technology as a vital field of knowledge.

What do We Mean by Technology?

We propose to adopt the term "Technology" as human knowledge that is utilized to answer human needs both material and spiritual needs. This definition reflects the alternative approach to technology which considers technology as one of the components of the social-cultural medium (Hiedegger, 1969; Simon, 1990). Knowledge, skills and resources are combined to help solve various existential and practical problems. Alvin Toffler in his book *Future Shock* (1970) states that the metaphor that relates technology to machine, has always been unsuitable and even erroneous, since technology was always more than factory and machines. Technology can be seen as human competence and talent to overcome its human biological restrictions by extending its abilities.

The qualification of students to live in a technological world will be evident in their ability to efficiently utilize technology, use existing technology to plan and manufacture new products, and think of directions to develop new technologies. Thus, learning technology has to involve two main activities: using technology and developing new technologies. Understanding the nature of technology and its influence on human life is essential for the development of curriculum for Technology Education.

The Model Used for Curriculum Development

In order to study the interrelations between technology and the human beings and to realize its influence on the development of society, a theoretical model called "The Spiral Model of Technology Evolution", was used (Krumholtz, 1996; in press). The Spiral Model describes the interrelations among four factors: human needs, physical phenomena, technological constraints and technological solutions.

Based on the Spiral Model we suggest to distinguish five stages in developing of technological products:

1. Research - to identify human needs or problems that call for technological solutions.
2. Plan and design a solution - chosen out of different solutions that had been suggested.
3. Carry out the Plan - producing the product.
4. Market - the product.
5. Future developments - of improved product or of a new one as a subsequent of usage that triggers new needs.

We suggest an educational approach to teaching technology that allows the learner to experience technological activities and technological processes. A technological process includes the identification and separation of all four factors in the Spiral Model. The learning experience in a technological process starts with identifying a problem - an human need - and ends with raising and choosing a solution - the production of a practical product. Science and technology learning is inherent to the global learning process when the student tries to deal with technological problems and to overcome physical constraints.

The learning environment that allows such activities must fit the learner's ability level and to relate to individual fields of interest, so that the technology activity will be as real and as significant as possible.

Our Pedagogical Approach to Learning

Our pedagogical approach is based on the constructivism theory of development suggested by Piaget (1954; 1973), that learning is building knowledge structures, and on the educational philosophy developed by Seymour Papert and others - the social constructionism approach (1980; 1991; 1993). The pedagogical approach is built on independent inquiry and self-guided learning and it facilitates the personal construction of knowledge about the external world.

The Learning Environment

In order to give the learner the opportunity to go through a process similar to the process of developing a technological product in real life, we had to choose a simulation system to fit the learner. That is, it has to be easy to use, close to the content of the child's world of interest and suited to his or her level of development. Moreover, in order to teach scientific and technological concepts and principles in a way that will lead the student from intuitive understanding of the concepts to a more formal, scientific understanding, it is necessary to provide the student with a wide range of concrete experiences using simple models and familiar tools.

We have found that LEGO DACTA computer control systems: LEGO-Logo and the later development ControLab, meets these requirements. They can be used in classes as "Micro-Worlds" that the kids can operate in (Resnick, 1993). We have developed learning activities that allow the learners to experience technological processes. Through the activities students gain practical experience in planning, constructing and operating physical models that are computer controlled. The learners are building models from LEGO bricks, including motors, lights and sensors and using the computer to control the operation of the models. Such models are traffic-lights that simulate real operation, greenhouses that open and close doors according to the temperature, remote controlled wheelchairs, washing machines, conveyor belts that identify boxes with dissimilar size or color, elevators, and racing cars.

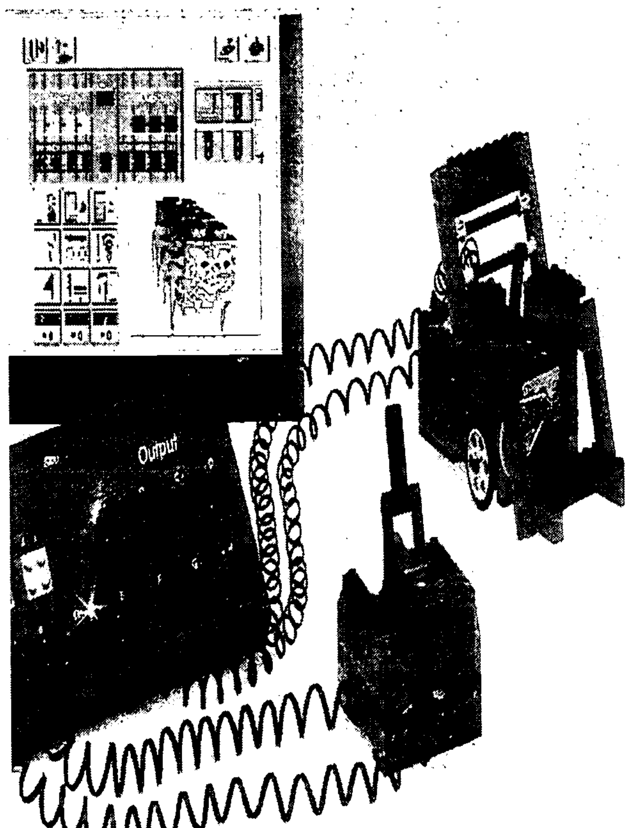

Figure 1. A LEGO Dacta computerized model.

The Learning Process

Following the five stages of development of technological products, we suggest that the children experience five stages in the learning process of becoming both users and developers of technology:

1. Learn about human needs - identify one need or demand.
2. Plan and design a solution - suggest a LEGO model that will give an answer to this need.
3. Carry out the plan - build the model from LEGO bricks and program the computer to control the model's operation.
4. Market the product - exhibit the product in the classroom.
5. Suggest future developments - for your LEGO model based on possible new demands it may triggers.

Advantages and Difficulties

Models

Based on our experience with students and with teachers we found that the LEGO DACTA computer controlled models answer our needs to a simulation system that helps deal with the technological world. We realized that the LEGO bricks and the variety of products allow us to choose different models for the different populations. The great variety of LEGO models and building elements made it possible to define an evolving line of models with increasing levels of complexity.

Software

Working with the programming software TC-Logo and later with the ControLab software, we identified some basic difficulties:

1. It takes time to learn a formal computer language properly, in this case the Logo language. This was very crucial considering the time limit of 30 hours we had.
2. For young and novice learners the programming language is too complex, even without considering time limits.
3. The English language is not the mother-tongue of Israeli children, and therefore is especially hard for young learners of grades 3 to 6.

We realized the need to have a programming software that: keeps the powerful ideas of Logo programming like structured programming, simple recursion, closed-loop and open-loop control; is easy-to-use in relation to the level of the user; is user friendly, for example, commands which are represented as icons and not as words; has an on line detailed help screens, to allow inquiry and self learning; and does not require any previous experience in computers;

We defined the concept for a programming software that, in cooperation with a software-house in Israel, was developed under the name of *TechnoLogica.*

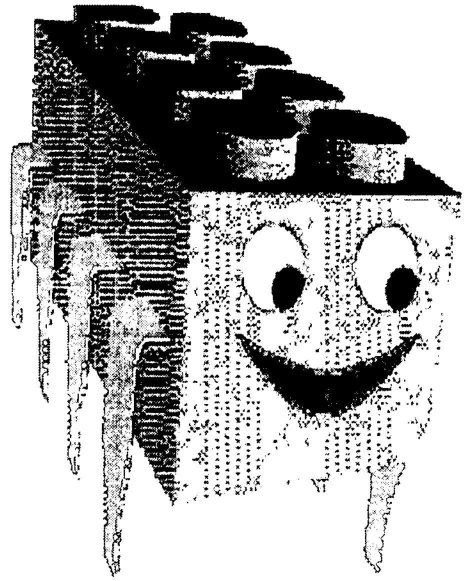

Figure 2. TechnoLogica Software Icon.

LEGO-Logic - The New Learning Environment

TechnoLogica software, the LEGO models and the learning activities and processes based on our educational approach, composed a new learning environment called "*LEGO-Logic*". For the teaching of Technology we chose to emphasize the role of the logic of control structures that are defined using *TechnoLogica,* rather than programming using formal computer language. In that sense, *TechnoLogica* was developed as an icon based software that allows the user to define various control structures (IF, IF-ELSE, WAITUNTIL, REPEAT) without the need to use any use any formal programming language.

TechnoLogica allows three modes of control:

1. Immediate mode of manual control .
2. Automatic Control: Open-loop control, executing a list of commands.
3. Feedback Control: Closed-loop control, using sensors for feedback.

To let students experience technology evolution, the models are first operated manually. Then, a motor and batteries are added to operate the model by electricity. At these stages the student operates the models in on/off operations, under manual control.

At a more advanced stage of control, the model is connected to a computer and is automatically operated, controlled by *TechnoLogica* procedures, programmed by the learner. In the final stage, sensors are used to enable feedback in the control loop.

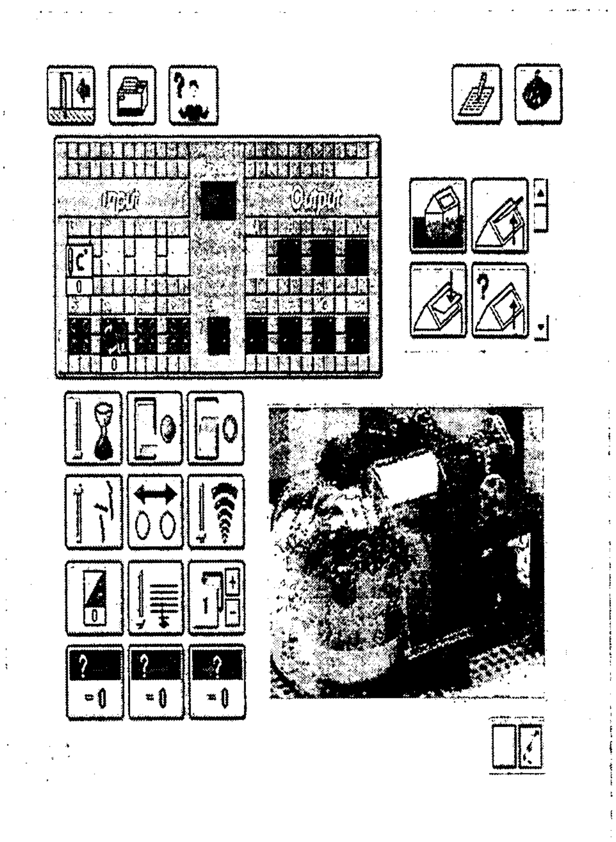

Figure 3. The Main Screen of *TechnoLogica* Software.

In a final exhibition, part of the marketing phase, each participant raises suggestions for further development of the product that may satisfy new advanced needs triggered by using their model. An example for such a model is an elevator. In the first stage the elevator is operated manually by the user who pulls a string connected to a pulley. In the second stage a motor is connected to the pulley via gears and is operated using batteries to supply electricity. The student decides when to stop the motor when it reaches each floor. The student uses his eyes to identify when the elevator reaches a certain floor.

The more advanced stage is when the motor is connected to an interface box that is connected to the computer. A procedure is programmed to operate the model to run a four times loop of 5 seconds ON and 3 seconds OFF, to allow people to get on and off the elevator. This operation is called an open-loop control or an automatic operation.

In the last stage a light sensor is attached to the elevator and to allow for feedback; when the light sensors "sees" each floor, the computer "tells" the motor to wait for 3 seconds, before going on to the next floor. The future developments for this elevator model suggested by the student are based on a safety need that will arise when the elevator is used. Another light sensor could be used to determine if people are standing in the ... revent the ... ment could ... p in each

... iels car ... between the concrete physical world and the abstract world of computer science. The models built from LEGO blocks represent the physical mechanical world, and the programming using *TechnoLogica* allows the construction of abstract logic thought structures.

Research Results

LEGO-Logic was tested with groups of pupils of different ages nd with different needs: average students aged 8 to 14 in a special research setting and in normal class settings, gifted kids aged 6-8 and 13-14; and students at the age of 12-14 with learning difficulties.

One of the studies that took place, involved a group of 6th grade students familiar with Logo programming. The experiment made it possible to expose the students prior technological knowledge and to identify their motivation factors.

Another study engage three groups of 7th and 8th grade students who went through the process of developing a technological product according to the learning process that was described above. The research concentrated on identifying the physical concepts and principles and the technology phenomena that could be experienced in the computerized LEGO learning environment. Moreover, the level of understanding of the students on those concepts and phenomena was tested. The analysis shows that physical concepts such as speed, acceleration, static and dynamic friction, gravity, force and balance were involved and that most students (87%) had reached intuitive understanding of the concepts. Some of the students (24%) expressed more formal scientific understanding of the concepts. The technology phenomena that were identified were mechanical advantage in tradeoff between speed and power in a combination of tooth wheels, the relation between the feedback from the sensors and the control of the machine's operation, and the distinction among manual control, automatic control and feedback control.

The group of students with learning difficulties had reached the intuitive understanding to some extent. What was most significant in their experience, as expressed by them at the end of the learning period, was the chance they had been given to create something of their own - a solution which they invented. Their expressions of creativity ranged from merely giving a name to a given model to suggesting new different operations to its function, and for some of them even building of a model out of their imagination.

Final Remarks

The modern age is characterized by the rapid developments taking place, especially in technology. Unfortunately, although major investments have been made in developing high technology, the guiding ideas and concepts are not always clear to the user, who them on a daily basis. In addition, school curriculum touches only a few aspects of these rapid developments, and thus is not properly addressing the need to prepare future citizens to work in today's technology environment. The LEGO-Logic learning environment is one of the answers to this educational situation, an environment that can help deal with the technological world of today. We believe that having go through such a learning process, students will be more ready to become both users of technology and developers of new ones.

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"The *IDEA Center*, once called the "Israeli Logo Center", is involved in the past eight years in research, development and implementation within the fields of Technology and Scientific education. The specialty of the center is the development and implementation of innovative learning environments which use computer technology to enhance learning and teaching. Such learning environments that has been developed are for example, Logo and LEGO-Logo. The learning environments developed in the *IDEA Center* are open environments, which can be implemented in various content areas and be activated with different learning and teaching styles.

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DISTANCE EDUCATION

Section Editor:
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The evolution of distance education in the US has generally paralleled the evolution of technology. In fact, over the past twenty-five years, it has been one of the few areas in education where technology has been central to the teaching task. However, familiar delivery systems such as telephone, radio, and television are rapidly changing with the addition of fiber optics, wide area networks, the World Wide Web, and a variety of other computer technologies. Distance learning students now can receive assignments, take tests, and interact electronically with their instructor and classmates. Distance educators can now deliver instruction through one-way and two-way satellite video conferencing and computer telecommunication tools such as electronic mail, electronic bulletin boards, chats, computer conferences, and mailing lists called Listservs. Courseware can also be delivered all over the world with hyperlinks to documents, graphics files, sound files, and digital movies through the World Wide Web (WWW).

While distance education is not a new form of educational delivery, distance education (as a topic) is a new section in the *Technology and Teacher Education Annual.* The authors represented in this section provide a wide variety of distance education applications and technologies. The programs and courses described are as varied in their content and sophistication as the technology used to deliver them. Grouping these articles proved to be a challenge. Should they be grouped by technology, or should they be grouped by project or purpose? I decided to take a middle-of-the-road approach. I started with a broad overview and moved to more specific topics and technologies.

The paper by Omoregie opens the section. It provides an overview to the various distance education technology tools. Omoregie points out the importance and need for planning, preparation, and organization of distance education efforts. McManus provides a discussion of distance education at the university level. This paper explores important issues and how universities are redefining themselves in light of advances in telecommunications and changing educational paradigms. Gannon and Blind design a distance education internship for graduate instructional technology students. Such an internship provides students with an overview of all components and activities involved in the distance education division of a major urban university. Hill addresses cost and quality issues of distance education in the college of education at a state university. Specifically, Hill asks: Is distance education as good in terms of quality as traditional learning, and are the benefits of educating teachers through distance learning worth the costs?

Several authors researched and evaluated distance education projects. Daulton, Barlow and Thomerson research student perception of distance learning experiences. McKenzie, Kirby, Davidson, & Clay evaluate the strengths and weaknesses of a state program from both faculty and student points-of-view. Riedling explores the social issues that can restrict or encourage doctoral students in a distance education program.

Using distance education technologies in teacher education programs is a popular and growing movement. Tucker describes an experimental floating lab used to teach hands-on activities to pre-service teachers. Stanbrough & Stinson; Lumpkins, Pippen & Parker; and Barron & Boulware discuss a variety of distance learning activities and technologies they are using in pre-service and in-service teacher education programs. Gere, Miller, Heller, & DeMonner discuss TATE (Teacher Assisted Teacher Education), a two-way video project, designed to provide pre-service teachers the opportunity to observe exemplary teaching practices. Common threads of discussion are: student and instructor needs, strengths and weaknesses of the various technologies, and the use of collaborative instructional strategies.

Paroiatnikova uses EdNet to teach beginning Russian to remote sites in Utah. Speziale talks about the Northern Tier Rural Distance Learning Consortium and how it partners with the State Museum, via compressed video, to provide alternative uses of technology. Mims, Newbill, & Schick propose the use of emerging technologies to enhance awareness of cultural diversity.

Several authors describe large projects that combine multiple technologies. Tiene's project describes interactive courses which have WWW access and two-way compressed video in networked classrooms. Nummi, RÖnkä, & Sariola's project uses a variety of technologies for linking the students to activities and events outside the classroom. Pohjolainen & Ruokamo-Saari describe the *Distance Learning in Multimedia-Networks,* a joint national Finnish project designed to develop technically and pedagogically useful methods for distance learning.

New developments in computer technology now make it possible to deliver distance learning completely online via a variety of synchronous and asynchronous communication channels. Allen, Hartman, & Truman; Pitt & Stuckman, and Rose discuss the pros and cons, techniques, and issues involved with this strategy. Gamas uses this approach for collaboration through classroom forums. Mackenzie, Kitto, Griffiths, Bauer, & Pesek describe how they have used online techniques for Problem-Based Learning (PBL) experiences. Leddo's *Virtual Schoolhouse* is a repository of electronic educational resources and includes a resource room with intelligent agents and intelligent simulations. Stockbrand & Althoff discuss online graduate programs for those unable to take advantage of traditional programs.

Educators and administrators are now beginning to recognize that distance education technologies offer a new way to realize basic missions and goals. What can be accomplished through distance education cannot always be accomplished through conventional classroom instruction. The decision to implement distance education technologies can be a powerful step toward achieving valuable benefits for academic institutions. The innovative capabilities of emerging technologies, combined with the talents and creative energies of faculty and participants, will fundamentally change what, when, where, and how people learn.

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Distance Learning: An Effective Educational Delivery System

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In recent years, researchers have studied the effectiveness of distance learning and its delivery methods. Willis (1994) contended that researchers have attempted to study distance learning effectiveness by exploring variables such as student demographics, motivation, attrition, cognitive style, gender, and achievement. Eiserman and Williams (1987) conducted a study exploring the comparative effectiveness of distance and traditionally delivered instruction which also agreed with Willis's variables. In the study, they concluded that distance-delivered instruction could be as effective as traditional instruction if the delivery methods were based on the background and experience level of the students. The content examples should be relevant to individual learners' experiential and cultural background. In a similar study by Omoregie & Jackson (1996), variables such as age, gender, environment, educational level, experience, computer usage, graphic presentations, and video presentations were used to determine the effectiveness of a distance learning course. The study revealed that learner environment and life-time experience have an important role in the planning and organization of an effective distance learning delivery system.

Garrison (1990) examined the impact to the learner in audio teleconferencing and found that dialogue, negotiation, and validation of knowledge must be used in order for this tool to be a successful educational delivery method. Willis (1994) claimed that the success of distance learning relies on the key players — students, faculty, facilitators, support staff, and administration.

Finally, research suggests that the effectiveness of distance learning is based on preparation, educators' understanding the needs of learners and instructors' understanding of the target population and their instructional needs rather than excessive attention to innovation and the delivery systems.

The Impact of Planning and Organizing Instructional Materials

The planning and organizing of instructional materials for distance education have increased the effectiveness of the delivery process. Instructors who are involved in distance education spend about a semester before the actual transmission to prepare instructional materials for their courses (Omoregie & Jackson, 1996). When an instructor spends this much time for researching, planning, and organizing, the instructional process becomes strengthened. Some distance learning instructors usef graphics, video tapes, and printed materials during their lecture to illustrate content area. Distance learning can also utilize face-to-face instruction with technological tools such as compressed video and computer desktop video conferencing.

While some critics argue that face-to-face instructional process has more credibility than distance education, due to time students spend with instructors after lecture, traditional classroom instructors sometimes deliver lectures without notes or instructional materials based strictly on the length of time allowed for teaching the course.

Impact of Technological Tools and Software Packages

The rapid growth of computer and fax machine usage in schools has increased long-distance communication between faculty and students (Mackwood, 1994). Students can now communicate with their instructors by the use of electronic mail and fax. New computers are manufactured to include audio/visual communication hardware and software packages. Mackwood also claimed that computers have become the preferred long-distance communication tool in distance education.

Audio/visual equipment and technology tools such as multimedia computer, television, VCR, laser disc player, telephone, digital camera, LCD panel, QuickCam, and PC/MAC TV Converter have changed the instructional process in classrooms across the nation. Instructors and students who use these tools have better chances of teaching and learning effectively than those with less technology (Morse, 1991).

Companies such as Microsoft, Corel, and Roger Wagner have revolutionized the software market by including incredible presentation packages with a variety of functions for classroom instruction. Packages such as *PowerPoint, Harvard Graphics,* and *Corel* applications are used for creating innovative presentations for classroom instruction. *HyperCard* and *HyperStudio* software packages allow the instructor to create their own multimedia projects and presentations which have added another dimension to the instructional process. Computer graphics, electronic print, multimedia software applications, presentation software applications, and electronic mail utilized in distance education make communications and learning easier (Verduin & Clark, 1991).

Finally, the declining cost of computing equipment, more available software applications, and telecommunications tools have allowed student access to college and university campuses for interactive conferences with their instructors. Computer networks on university campuses are making it possible for distance and traditional students to gain immediate access to the university's resource centers and the libraries. The overall result from the rapid growth of various modern technological tools is the increased effectiveness of education.

The Impact of Faculty Development

The learner and instructor are the most important factors in distance learning. As the needs of the learner are considered in the planning and organizing stages, faculty needs are also considered. Faculty development remains a critical issue for distance learning to be a successful delivery method. Willis (1994) suggested that for the success of distance education, "Teachers and administrators must work together on identifying and resolving the issues, policies, and biases that inhabit systematic use of distance education meeting academic goals" (p. 288).

Research suggests that distance education preparation should include faculty in-service training, staff support, and administration. Faculty in-service training should include hands-on experience for preparing tests, videos, and graphic instructional materials for the course. In-service training should include the use of technology in the classroom such as telecommunications, and computing equipment. Training should also include techniques for managing distance learning and understanding the unique need of learners. Support staff also plays an important role in the success of distance learning. An office should be created to support the instructor in preparing instructional materials for the learner. Support staff can also play the role of a facilitator or a technical person who makes sure that the equipment is in working order. Finally, the administrator and instructor must actively work to ensure a quality distance learning program. In doing this, they must identify and resolve faculty development issues that might affect the success of the distance learning delivery process.

Conclusion

In conclusion, the study revealed that distance learning can be an effective instructional academic delivery system for adult learners in schools and industries if all the key players are involved in the process. Researchers found improved modern technology tools and software application packages to have also played a significant role in the effectiveness of distance education. Research suggests that there are no significant differences between distance and traditionally delivered instruction. Research also suggests that variables such as student demographics, motivation, attrition, cognitive style, gender, and achievement play a significant role in distance learning. Finally, faculty development has an important role in the effectiveness of distance learning.

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Redefining the University: The Changing Role of Distance Education

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Traditionally a university has been bound by four walls. Only students who were willing and able to place themselves physically within those walls could pursue a degree. New technologies are pushing at the boundaries of that paradigm. Universities are having to reevaluate their mission and the definition of their constituency in light of advances in telecommunications and distance education. Distance education has the potential to change the basic nature of university education. This paper will explore the issues involved and how universities are redefining themselves in light of this new paradigm.

The Issue

Distance education has a long history world wide. The British Open University has been granting degrees for nearly twenty five years (Sopova, 1996). As new technologies have developed, new institutions have grown to take advantage of the desire for students to get away from the traditional higher educational paradigm. In recent years, these opportunities have led to the creation of several commercial educational brokerages (Denning, 1995) and virtual universities (McManus, 1995). In order to compete with these new institutions, traditional universities are considering the possibility of offering degree programs wholly through distance delivery. Advocates of distance-delivered degree programs argue that the changing technology opens needed new avenues for learners to access scarce university stores of knowledge and instruction. The same technology allows universities to leverage existing resources in to new educational markets and programs. But the effective use of distance education requires a shift in paradigms. Universities have to move away from a strict reliance on classroom delivery of instruction. This idea can be problematic (Jackson, 1996) but some argue the change is inevitable and that institutions need to prepare themselves for it (DISC Committee, 1996). The survival of many traditional institutions may depend on how they do so.

The Opposition

There is strong opposition to distance degree programs in some of the more traditional institutions of higher education. Universities who have prospered under the traditional paradigm of classroom instruction and residential degrees are often loath to risk their reputation on new and untried distance education initiatives. The prevailing attitude seems to be that change should be driven by need rather than by opportunity, or just because technology allows them to change does not mean they have to. Their arguments fall into four basic categories: distance degree programs do not offer the same intangible benefits as residential programs, distance degrees are perceived as inferior to traditional degrees and therefore risk the university's reputation, money that is spent on distance degree programs could be better spent on increasing the capacity of the campus, and distance education fosters unnecessary institutional competition.

Distance education undermines one of the foundations of a traditional university education. The argument is that much of what makes undergraduate education at a particular university unique to that institution are the non-academic experiences and the personal interactions which take place in the physical surroundings of the academy (Monti, 1996). These experiences include the intellectual discourse and social networking a student engages in with professors and peers, as well as participation in extracurricular organizations and activities which help promote a sense of institutional identity. According to this view, academic endeavors make up only a fraction of the entire traditional university experience. Some argue (Yudoff, 1996) that distance education cannot offer the students the same sort of interactions and intangible benefits. As David Upton, an associate professor at Harvard said, as a student you should "feel the hot breath of the instructor on your face" (Lublin, 1996).

Another common objection to distance degree programs is that they are of lesser quality than residential programs and therefore will degrade the reputation of the institution which grants them (DISC Committee, 1996). As local educational monopolies based on geographic access are challenged, students will have a greater choice of where to obtain their collegiate credentials and may opt for convenience over quality. In this way distance education may give rise to more diploma mills and marginal institutions (Stafford, 1996). There is a danger that any university which delves too deeply into the field may come to suffer through guilt by association. Only by maintaining strict quality controls, which are part of the traditional educational process, can such loss of stature be avoided (Monti, 1996).

The initial costs of creating a distance education infrastructure and of developing curriculum for distance delivery are high (Sopova, 1996). Given the tight budgetary confines in which most universities find themselves, this fact alone can keep an institution from trying new ideas. Large state institutions face pressures from their legislatures to serve, first and foremost, the people of their state. Distance education can be seen as spending state money to educate students in other parts of the world. Some argue that the money could be better spent on improving the faculty and facilities at the home institution (May, 1996). Even private universities face budgetary choices which may preclude large investments in distance education.

The last main argument against distance education programs is that they promote unnecessary competition between universities. If, for instance, a flagship state university offers degrees which can be obtained by students living in other cities or states, that university then places itself in direct competition with local branches of the state system, other universities, and community colleges for the students living in that location. This can create friction which may damage the relationships within a state system or between universities (Yudoff, 1996). Geographic separation is the basis for much of the higher education cooperation which goes on today. The removal of this distance could have catastrophic effects on such cooperative efforts.

The Supporters

Distance learning, once considered strictly a rural education strategy, is now recognized as having the potential to provide solutions to some of the problems that states face in delivering quality education to all students (Bell, 1991). Those who support the idea of distance delivered degree programs argue that there several important reasons for a university to make the effort to change. Distance education allows universities to reach a broader audience and provides educational opportunities to those who might otherwise not have them. Utilizing distance technologies enhances an institution's reputation by establishing them as a leader in the new educational frontier. Distance education is the future and those who do not keep up will be left behind. Others say technology-based education prepares students to function in the information age. There are even some who argue that distance education will prove cheaper and more efficient than classroom-based instruction in the long term.

Competition is a strong factor driving the move towards distance education. Distance education requires that universities revise their definition of competitor and of potential student. New technologies allow institutions to compete across the world. A school in Idaho can offer degrees to learners in Texas, New York, and Thailand without requiring the student to leave home. Colleges and universities that overlook the potential of new technology for development of distance-learning programs may find themselves losing students and revenue to other institutions and corporate competitors (Martin & Samels, 1995). Universities have a distinct advantage over commercial educational providers in that they often have a store of unique expertise which they can offer to a prospective student. But if universities don't make that expertise available and convenient to the students, they may choose to turn elsewhere (Stafford, 1996). Competition also drives universities to stay at the forefront of educational practices. Being known as a "technologically advanced school" may give a university the edge it needs to attract the best students and faculty (Lublin, 1996).

Many educational planners now believe that the demographics of the university student population is changing in such a way that traditional classroom-based instruction will no longer be able to serve them (OSSHE, 1996). But technology-based instruction allows for the displacement of instruction in time as well as distance. This allows students who are unable to attend classes when they are normally offered access to instruction at a convenient time. As this need becomes greater so will the need for degree programs that accommodate such students. Institutions which do not take seriously the changing nature of their constituents risk loosing them.

It is not only university demographics which are changing. The world outside the university has entered the Information Age and if universities are to prepare their students to function in this new world they need to adopt new methods and technologies. Policy makers are beginning to recognize that the strength and well-being of both their states and the nation depend heavily on a post-secondary education system that is visibly aligned with the needs of a transforming economy and society. At the same time, the states' capacity to respond to these challenges is severely constrained by limited resources and the inflexibility and high costs of traditional educational practices and by outdated institutional and public policies (Western Governors, 1996). Studies have confirmed that distance education appears to be effective and has been well-received by teachers and students (Bell, 1991). It is even argued that distance education may be less expensive that traditional instruction (Sopova, 1996). If distance education is cheaper, of equivalent quality, and better prepares students for the future, universities should adopt it and change with the times.

Personal Perspectives

I noticed two things in particular about the arguments I read and heard. Many of the arguments were couched in the vocabulary of business rather than academia (Denning, 1995; Twigg, 1995, Lublin, 1996), and there was very little written about people's fears and doubts about distance education.

I believe that distance education has become the rallying cry for many of the supporters of a business model of higher education. The idea is that universities are providers of a scarce commodity - instruction (Denning, 1995). Students are the consumers. The production and delivery methods may vary but each educational institution is trying to sell its product. Technology simply increases the number of customers you can reach. I think one reason for the link between business and distance education is that information technology is so prevalent in business and when people with a business perspective look at academia they see technology as a way to improve it. There are dangers in this. If higher education is different from business, applying the same philosophies may be inappropriate. On the other hand, technology is not exclusive to the business milieu. Distance education has a growing instructional research base. And it can help universities reach qualified learners who for whatever reason are not able to attend classes on campus. This helps schools fulfill their goal of providing the best education to the all qualified students.

The majority of the literature dealing with the issue of distance education policy in higher education seems to fall on the side of the supporters. Even the opponents have a tendency to urge caution rather than prohibition of distance degree offerings. One reason for this may be that distance education is a popular bandwagon and those with doubt or reservations voice them cautiously lest they be branded reactionary. Despite the fact that it is seldom stated openly, there is resistance. You can see it in the discussions of the University of Texas' distance education task force (Yudoff, 1996) and in MIT's Council on Educational Technology (MIT, 1996).

Conclusions

Any paradigm shift is accompanied by a period of resistance and instability. I do believe that the propagation of distance education degree programs is inevitable. I think there is a need for them. As the needs of learners change, the methods and policies of the universities have to change as well. But I don't think we have to change just because we can. I think that universities need to proceed with care and deliberation. The risk of producing bad instruction is high with a new medium. If great effort to ensure quality is not taken then the fears of the opponents may well come true.

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Designing An Internship to Go the Distance

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What began as an opportunity for a doctoral student in instructional technology to apprentice in the distance education department, turned into a vision of a departmental internship that could be generalized to other university departments. This student went on to develop a clear focus for a model of a distance education internship program. This program can introduce doctoral students to the various components of distance education and give them hands-on experience in the University of Houston's Division of Distance and Continuing Education. The model evolved to include possibilities that could bridge departmental gaps and involve students seeking exposure to distance education from other academic disciplines.

The decision to approach the distance education director came about because of the need for more understanding of how distance education works. While instruction delivered through distance education is a key component of instructional technology, there is little exposure to it in the instructional technology curriculum. Therefore, it could benefit instructional technology majors to have some familiarity with tele-transmitted and online classes. The director agreed to accept an intern into the department for a semester or two to see if it was mutually beneficial for both the student and the distance education department. If it worked out, the director could consider developing a plan to let more instructional technology majors become interns in the program.

From these informal proceedings, the project began. The project objective was to have the intern observe the program, then turn in a paper describing what distance education was at the University of Houston and what it could be in five years. The understanding was that the intern would observe, assist when possible, and do so without disrupting the employee's routines and/or deadlines. The intern's ideal scenario would be to learn about each employee's duties while working for that employee.

The first several weeks of the internship consisted of creating sign-up sheets for employees to utilize the intern resource, working out schedules for shadowing distance education employees, while accommodating a personal class schedule. As the weeks passed, it became more clear that because of the exigencies of this fast-paced program where each employee rushed to meet unique deadlines, there needed to be some kind of framework for intern activities.

As the first distance education intern, I was discovering that important aspects of the distance education program could easily be overlooked. It was hard to know what I was missing because each employee's job was so different. So, I decided that conducting a type of "action research" might provide a key to learning more about the big picture of the distance education program (Moore & Kearslely, 1996; Willis, S., 1995; Kinnaman, 1993). Action research is a term for "on-the-spot" observation, usually by teacher/researchers, through disciplined inquiry (Willis, S. 1995). Usually the teacher/researcher is not on the outside, but rather part of the process being observed. In this case, I was not a staff member, but was allowed full run of the division and included in all divisional undertakings. In action research, as the name implies, ultimately some type of action is recommended. It is based on the teacher/researcher's observations and examinations and may include additional relevant data. Since my action research was informal, it did not include the normal procedural data collection and analysis, instead leaving that portion of the research for future studies. I also realized decided that, due to the small numbers of interns accepted into the internship, it would prove difficult to conduct any formal quantitative- type studies.

This action research might also provide the foundation for the creation of a potential distance education internship program. "Research is the cornerstone of decision-making, but theory is the foundation" (Kinnaman, 1993). I decided the theoretical foundation of this fledgling program should be constructivist, primarily because of the nature of the qualitative research that was giving it shape (Willis, 1995). A constructivist theoretical base for the framework would provide the flexibility to design, observe, and reflect on my findings, then redesign a core program that could develop and evolve as new needs arose (Jonassen, 1994).

My plan was to observe the overall operation of the distance education by attending general departmental meetings, working under as many employees as possible, and by "hanging out" in the hallways asking questions about distance education. In the course of the remaining weeks in the semester, I was able to work under eight staff members, attended a number of departmental meetings, and managed to stop employees along the way to ask endless questions. I journalled overall observations at the end of each employee assignment and summarized each assignment's experiences.

However, I felt that I needed to construct a framework of these experiences. Since I am a curriculum and instruction major, I decided to design a boilerplate of what I thought should be covered in an internship. I then shared it with the distance education instructional technologist, my course instructor, and the distance education director to be sure I wasn't leaving anything out. This boilerplate quickly evolved from a theoretical framework of what might be included in a single semester internship activity to a potential distance education internship program. If the program design were flexible enough, it could provide vital hands-on experience for instructional technology students.

Such an internship program might also provide a solution to another emerging dilemma — how to help students in other academic disciplines acquire distance education experience. Many large universities do not have crossover relationships to permit students to take courses outside their departments. Often the communications, technology, business, and education departments may all have forms of distance education, but those forms may not parallel each other. For example, an online class in a business department may not be the same as a televised class in a communications department. A distance education class in the education department may not utilize some of the components of the Distance Education Division. The internship would give students in other departments the opportunity to literally see what they may be missing. Crossing into other academic disciplines provides an experience that transcends both academic and spatial boundaries.

This internship could be given some structure and serve as a benchmark for other interns, both in instructional technology and other academic disciplines.

A Distance Education Boilerplate

A distance education boilerplate could include the following components: a history of distance education, exposure to the various technologies used in distance education, ongoing system designs to accommodate new technological trends, management and administration of the program, and ongoing evaluation of the distance education internship. The distance education instructional technologist concurred with the initial boilerplate, but, after reviewing the boilerplate components, suggested we omit the detailed history of distance education. Instead, a brief explanation and history would suffice since there should already be some awareness of distance education by most instructional technology doctoral students. We would also briefly define distance education at the University of Houston and move on to address the remaining components of the boilerplate, namely the media and technological segments; the ongoing system design; and the evaluative role of distance education internships.

Distance Education Defined

The first component of the proposed distance education internship boilerplate is to define distance education at the University of Houston. The definition of distance education according to the Texas Higher Education Coordinating Board, and which has been adopted by the University of Houston, is "the delivery of courses at sites away from the main campus in either face-to-face (f2f) or instructional telecommunication formats" (University of Houston, Division of Distance and Continuing Education, 1996). Distance education at the University of Houston had its beginnings almost twenty years ago and has evolved into a division that offers both credit and non credit classes, undergraduate and graduate courses, and provides an array of delivery vehicles. There are live and taped cable-televised classes, live microwave local classes, and tape-purchase classes. The University of Houston initiated "tape purchase" classes in 1995 to meet the needs of students who could not, for various reasons, access and/or tape their classes. Computer online classes are also now being offered.

Distance Education Media and Technology

The second component of the distance education boilerplate would include media and technology. Since this might be the only opportunity for instructional technology students to get hands on experience, each segment of the technology should be noted. It might not be possible to actually go to the remote sites where the classes were transmitted, especially in the case where classes were transmitted via other school system's cable networks, but it would be possible to see how those classes were conceived, produced, and transmitted. The key types of media and technology are separated from each other because more and more of the classes are going away from televised media and toward online computer classes. But both methods of transmission are vital, and, while it seemed likely that a "marriage" of the two technologies would be inevitable, at least for now, they remained separate.

The first segment of media, consists of televised classes, microwave classes, and tape-purchase classes. In the instance of the televised and microwave classes the classes could be either live or prerecorded. Most credit classes were recorded and periodically recycled several semesters later.

What makes the University of Houston's distance education program unusual is that it does not purchase prerecorded tapes from outside sources. Rather, it produces all of its own tapes for various courses. That's what makes it well-suited for internships. Students not only get an idea of how distance education functions, but also can actually participate in the entire process, from the creation of the course to the airing of that course. Under the most optimal of circumstances, instructional technology students might have the opportunity to spend several semesters in the department working on one particular project, like a new course being introduced into the distance education repertoire.

Telecommunications is another technology segment of the internship which includes all aspects of satellite, microwave, and cable transmissions. Learning about these technicalities could be critical for a student who might need to build a start-up program in the future. Without exposure to the various types of telecommunications available, very costly mistakes could be made in the selection of the right program.

Another segment of this component could include some participation by interns in the preparation of on-line classes, multi-media classes, and emerging technologies. At present, the University of Houston might elect to "farm out" development of on-line classes to the respective departments delivering those classes. But the collaborative efforts are already underway in several departments, like Engineering and Education.

Administration of Distance Education

The third component of the distance education boilerplate would look at the administrative aspects of distance education. What might surprise most students is the scope of administration required to run this division. The director must not only prepare the courses for transmission and set those courses up in the appropriate telecommunications context, but must also make sure people, somehow, seek out those classes. .And that takes marketing. As recently as several years ago, students had little awareness that they could take televised college classes. Now entire degree plans are available to them in certain academic disciplines. The public has to be made aware of these offerings, and in a way, helped to understand what it means to them in their own daily lives. So that means developing brochures, fliers, television promotions, radio promotions, and delivering public relations efforts at junior colleges and trade shows, and even internal efforts to enlist other departments' awareness and participation in distance education. Plus, there are the ongoing accounting and administrative duties and responsibilities and the daily overseeing of operational telecommunications and technological functions. In addition, these duties must always consider the ongoing importance of grant writing to make sure the distance education division has enough money to continue its operations. All the daily administrative requirements seem to never end. The entire web of administration extends through all of these crucial functions and the intern will begin to get the big picture of what keeps a distance education program operational. In fact, even if the intern simply introduces one distance education course into his/her new job, chances are good that at least some of the administrative duties outlined above would still apply.

In a large university, like University of Houston, the director's job is Herculean. A skeleton staff works diligently to make sure everything runs smoothly. Funding is an ongoing challenge, so everything, including employees, must stretch to the maximum to get the job done. The hope would be that, while the first few interns might not be fully utilized until the department staff understood what extra pairs of hands means to them, the department would welcome the additional support. Ultimately, there could be interns assigned to each staff member for a period of time. This would give the intern a greater understanding of the staff member's administrative role, and it would provide that staff member with much needed, albeit brief, assistance.

A flexible internship program design would permit the intern to participate in the various arenas of distance education while performing a practical function for the distance education division. Then each intern could gravitate to the area of most career interest after the basic requirements were met. The success of the first interns could then precipitate a group of "master" interns who could, in turn, mentor and facilitate incoming interns and make sure the interns met certain prescribed performance standards for the distance education division. The interns would have opportunities to view, first hand, decisions made and implemented in the distance education division. This would help interns to integrate their academic theory with practical application. The participate process would bring home to them the relevance of their coursework while preparing them for real world experiences. At the end of their internships they could either move on to their respective fields or remain a little longer as master interns. Either way, they would have garnered a richer experience of distance education than before they entered the internship. They would emerge from the internship knowing that, while their experience may not have been as protracted as those interns in schools with huge media and distance education departments, they have, nonetheless, received a comprehensive experience of distance education.

Evaluation of the Internship

Last, the final component of the distance education boilerplate would include evaluation of the role of distance education internships. While my action research could not tell me the future, it provides me observations of the present. What I discovered in my internship could play a role in helping instructional technology and other interested students to learn more about the functions of distance education. Hopefully, interns would become an ongoing part of the Distance Education Division. The results were still out on how effective the internships would be for both the interns and the division, but feedback from many of the employees in the program rated it favorably. So evaluation will be ongoing. There will be more interns, perhaps just one or two in this initial phase, but, hopefully, there will be more in the future. The idea of the master or senior intern also has merit and should be considered since it would provide the interns with a mentor and the division with someone already familiar with the operations.

The truth of Heisenberg's Principle of Uncertainty sustains, that what is observed is changed by that observation. It seems appropriate in this case. Internships can be dynamic, and this internship certainly proved to be that, and more. Observation and participation prepared the way for the shift to a new level of student awareness, but also demonstrated a need for more of these types of internships. The "observed" distance education division was not dramatically changed by the internship process, but did remain open to the acceptance of new interns. That's a start.

Discussion

A hundred years ago a student carrying his books across the frontier and sending his papers back to his teacher would have been called a distance learner. Today a distance learner has a variety of ways to receive and transmit courseware. The bottom line is that distance education is a hot topic, and eventually almost every department in every university will either have, or recognize the need to have, some type of distance education. But five years from now distance education may look very different than it does today. What will remain current will be the need to expose more advanced graduate students to distance education (Loyola , 1994). The need is crucial for instructional technology students, but could also become compelling for administration majors, or majors from a broad spectrum of academic fields. Distance education internships can be a rich resource to both the students and the UH distance education division and can provide knowledgeable graduates that "go the distance" to the academic frontiers of educational technology.

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Teacher Education Through Distance Learning: Cost Effectiveness and Quality Analysis

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Distance learning is a technology that has been utilized by the College of Education at The State University of West Georgia for less than two years, yet it has reached more than 500 teachers at remote locations. The university receives inquiries daily from teachers throughout the state who would like for a site near them to receive education courses so that they may achieve certification or a higher degree. In spite of this demonstrated need and apparent success of teacher education through distance learning, concerns continue regarding quality and cost-effectiveness. There are significant costs associated with distance learning and although increased enrollments often offset these costs, the problem becomes one of quality. One common perception is that increased class sizes resulting from distance learning will result in greater benefits through increased revenues. However, quality may be reduced when small group discussion and teacher-student interaction become more difficult to achieve.

The purpose of this research was to analyze the true cost-benefit of distance learning in the College of Education, and to determine how to enable quality in distance learning without financial strain. Specifically, the research addressed the following:

- Is distance learning through GSAMS (Georgia Statewide Academic and Medical System) as good in terms of quality as traditional learning?
- Are the benefits of educating teachers through distance learning worth the costs?

Methodology

This research project was undertaken over a period of six months, beginning in March 1996. Project personnel consisted of the distance learning coordinator and student assistants employed as distance learning classroom facilitators. The student assistants administered surveys to all education faculty who have utilized distance learning and also to all education students enrolled in distance learning classes. The surveys measured attitudes towards distance learning, perceived class quality, student demographic information, and enrollment information. Of 198 possible student respondents, responses were received from 129 (65 percent). Twenty-one surveys were received from faculty (out of a possible 25), representing an 84 percent response rate.

Background

West Georgia's distance learning program is part of the Georgia Statewide Academic and Medical System (GSAMS). This is a two-way "live" video teleconferencing system which allows teachers and students to interact immediately, utilizing audio and video. GSAMS is the largest distance learning and healthcare network in the world. It has more than 370 sites in Georgia, including K-12 schools, colleges, universities, hospitals, prisons, and Zoo Atlanta. GSAMS has been in operation since 1993, and the State University of West Georgia began its involvement in January, 1995.

The primary goal of distance learning at the State University of West Georgia is to provide access to students who cannot take advantage of traditional instruction, and for whom convenience is a critical factor in achieving a degree.

Findings

Quality Issues

Through my research and discussions, it became apparent that a major issue in distance learning is whether or not the quality of a course taught via distance learning is as good as one taught in the traditional manner. Five specific issues regarding quality emerged.

1. Satisfaction: Do students perceive the distance learning experience as positive, and what factors affect distance learning satisfaction? Teachers who take courses via GSAMS from West Georgia's College of Education generally have a positive experience and say they would take another course through distance learning.

- 87 percent reported that their attitude toward distance learning was positive at the end of the term.

82

- 89 percent said they would take another course by distance learning.
- 89 percent said they were glad that they took the distance learning course.

The study also measured the correlation between student satisfaction and satisfaction with the instructor, age of the student, distance of the student from the home site, the number of total sites, and the total number of students enrolled in a course.

Satisfaction with distance learning appears to be highly correlated with satisfaction with the instructor. Students who were less satisfied with their instructor also tended to have a less positive attitude towards distance learning.

The farther away the student was from main campus, the more positive his or her attitude was toward distance learning. Using a Likert scale with '1' being the highest, students at the Carrollton site reported the least positive attitude (2.492), while students at locations at least two hours away reported the most positive attitudes (1.523).

Older students were generally more likely to report satisfaction with distance learning courses than were their younger counterparts. 86.6 percent of students over the age of 25 said they were glad they took the distance learning course, compared to 45.7 percent of those under the age of 25. However, older students were generally at sites away from campus. Therefore, the correlation may be due to distance rather than maturity.

Neither the number of sites nor the number of students in a course appeared to have an impact on student satisfaction. Even though it was anticipated that students would be more satisfied with smaller, more intimate classes, some larger classes received higher satisfaction ratings than did some of the smaller courses. (See Table 1)

2. Does student and faculty acceptance of distance learning increase with continued usage and exposure? Although both faculty and students are often apprehensive about distance learning at the beginning of a term, much of these fears appear to be relieved somewhat once they become in involved in distance learning. Ninety percent of faculty who have taught a distance learning course at The State University of West Georgia say they would use the delivery system again to teach. Among the reasons faculty cite for wanting to use the system again are: the ability to reach students who cannot commute to the main campus, the ability to utilize technologies not available in the traditional classroom, reduction of travel, and the need to keep up with emerging technologies.

Our survey results also show that student satisfaction increases with usage. Eighty-one percent of distance learning students enrolled in the College of Education reported a positive attitude toward distance learning at the beginning of the term, while 87 percent reported a positive attitude at the end of the term. Also, students who had previously taken a distance learning course reported a higher level of satisfaction that did those who were taking their first class via distance learning. (see Table 2)

Table 1.
Correlation between student satisfaction and class size (Spring Quarter 96)

Likert Scale (1 = strongly agree; 2 = agree; 3 = uncertain; 4= disagree; 5= strongly disagree)

Enrollment n = ( )	I am glad that I took this DL course	I believe I learned as much as I would have in a regular course	I would take another course by distance learning
42 (32)	1.625	1.781	1.688
48 (41)	1.951	2.224	1.805
50 (30)	1.833	1.333	1.833
50 (30)	1.231	1.115	1.038

Table 2.
Correlation between student satisfaction and familiarity with distance learning

Likert Scale (1 = strongly agree; 2 = agree; 3 = uncertain; 4= disagree; 5= strongly disagree)

	I am glad that I took this DL course	At the end of the term my attitude toward DL was positive	I would take another course by distance learning
Distance Learning First-Timers	1.951	2.224	1.805
Experienced Distance Learners	1.625	1.781	1.688

3. Do technological limitations present significant drawbacks to achieving quality in the distance learning classroom? While technological problems (failure to achieve connection, audio problems, video loss, etc.) were frequent (generally occurring in at least one-fourth of the sessions), most problems were solved during test-time and did not actually interrupt class time. Although there are instances of system-wide failures and single site failures causing an entire class period to be canceled, most College of Education faculty had prepared for technological problems by communicating back-up plans to each site on the first day of class.

The greatest technological challenge observed was the actual maximization of the technology. Many students report feeling intimidated by the cameras, the monitors, and having to use a microphone to speak. 35.6 percent reported that they were "more reluctant to ask questions and make comments" in their distance learning class than in a regular class.

4. Do logistical challenges present an undue burden to faculty? In contrast to the convenience afforded to students through distance learning, faculty find themselves burdened with the details of transporting materials between sites, scheduling courses, and helping students register. Formal and informal interviews with faculty suggest that some faculty believe that the quality of their instruction suffers because they must spend such a large amount of time preparing mailings, faxing materials to other sites, e-mailing students at remote sites, and assisting remote students with registration and the procurement of books. Some faculty have responded by adapting their courses in a manner that requires less logistics, such as having fewer written examinations and more class presentations or graded discussions. Others have relied upon the support of secretaries, the distance learning staff, or student assistants to relieve some of the burden. Presently, however, logistics still present a problem as there is no complete solution in place.

5. Do current policies conflict with the goals of distance learning? As the world's largest distance learning network continues to grow, concerns continue regarding established statewide policies regarding residence requirements, personnel matters, post-secondary options, and cost sharing.

The formal Georgia Board of Regents policy required that all graduate students take one half of their courses on the main campus of the college or university from which they earn a degree. For the majority of teachers who take courses via distance learning, commuting 50-200 miles each way is simply not an option. Although the policy has yet to be formally changed, many Georgia colleges and universities are attempting to address this issue in their own creative ways (such as considering all remote sections and the main campus section to be "one" classroom) until a new state policy is released.

Another problem is that current policies, either state or institution, do not formally address a reward structure for faculty who teach distance learning courses. Because the program depends upon the participation of excellent teachers who will have to work harder to meet the demands of distance learning, the long-range success of the distance learning program is directly related to the ability to find a reward system that pleases faculty without burdening the institution.

Cost Issues

In order to address the question of whether of not the benefits of teacher education through distance learning outweigh the costs, a cost-benefit analysis was performed. The benefit is determined by multiplying the number of students who said they would not have taken the course if they had to commute by the amount of tuition each of these students paid. This is compared to the overhead costs of the distance learning program and additional costs such as mailing, travel, remote site monitor fees, etc. Results for Spring and Summer 1996 showed that the program facilitated the needs of education students at the State University of West Georgia in a cost-efficient manner.

Overhead costs for one year of distance learning are currently $88,507 and include the salary and benefits of the distance learning coordinator, student facilitator wages, telecommunications charges, travel expenses, and supplies. The cost per course is determined by dividing the annual costs by four quarters, and then dividing by the number of courses offered in a quarter. For some classes, additional expenses are also included when fees must be paid to other sites which charge for use of their facilities. During spring quarter 1996, the cost per course was $2766, and during summer 1996, the cost per course was $3166.

Program benefits were calculated by multiplying course tuition by the number of students at remote sites by the percentage who reported they would have commuted to the main campus to take the course. Courses offered by the College of Education generally went to sites at such a far distance that a large percentage (70 - 90 percent) reported that they would not have been able to commute to the main campus. Based upon these calculations, tuition gained for the four College of Education courses offered during spring 1996 ranged from $3234 to $8764. Thus the economic benefits of these courses were greater than the costs.

During summer quarter, fewer classes were offered, each with fewer students enrolled, and the tuition gained per course ranged from $1309 to $2631, representing a financial loss for the quarter. However, fall and winter quarters are projected to reach enrollments similar to those of spring quarter.

It must be noted that the greatest benefits of the distance learning program, its far-reaching effects on teachers receiving higher education, the children they teach and the entire educational system, are simply not measurable. But in order to reach these potentials, the realities of academic budgets and the concerns of university administrators facing financial constraints must be continually addressed. At The State University of West Georgia, this cost-benefit analysis is now performed quarterly and is used in the process of selecting appropriate courses and sites for distance learning. As a result, the distance learning program is better able to meet the needs of its end users without placing a financial burden on the institution.

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Student Perceptions of Learning by Compressed Video

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The rapid increase in the number of college courses delivered by distance learning technologies such as compressed video, has seemingly occurred with little information from the students about their perceptions of the success and acceptance of this mode of instruction. University administrators and faculty seem to have had the most input into the selection and design of courses to be offered. In the early stages of development of distance learning courses, faculty may be concerned with the technological aspects of delivery and less concerned with the impact of delivery on students and students' expectations from such courses. However, if student needs are to be met and the learning effective, student perceptions of that delivery will be extremely important. Student input will be essential in determining the courses to be delivered, the number of courses to be delivered, and the appropriate style of delivery of such courses.

As distance learning faculty who teach by compressed video, we received training on the use of the equipment and a few tips on how students could work with the technology. However, as the teaching progressed we began to hear comments from our students which indicated they were extremely pleased or very uncomfortable taking a compressed video course. As teacher educators we are also concerned with the effectiveness of the teaching/learning environment, method of learning, and the impact on learners.

A review of the current literature related to distance learning revealed a great number of articles related to distance learning, but few articles related to student perceptions of such learning. The articles related to student perceptions of such learning were more frequently comparisons of distance learner achievement through test scores or grades with students who received instruction in more conventional environments. Hackman and Walker (1995) found no significant differences in the perceptions of students in distance learning classes and those in the traditional face-to-face setting. These findings were similar to the those of earlier studies by Whittington (1987) and McCleary and Eagan (1989) which focused on academic performance of students in distance learning and traditional classrooms. While the academic outcomes warrant the continued use of interactive television as an acceptable mode of instruction, the concept of what students' perceptions of effective instruction via compressed video are not addressed.

Methods and Procedures

To obtain information regarding student perceptions of distance learning three separate strategies were developed: (1) oral interview, (2) video tape, and (3) questionnaire. Questions used in both the oral interview and questionnaire encompassed areas of projection and reception, dialogue, clarity, voice, materials, comfort level, and satisfaction.

The questions were developed and field tested. The field testing was conducted with evaluation of the instruments by three graduate students and three professors. Questions were adjusted using the review team input and then resubmitted to the review panel for clarity and exactness. Final adjustments were made and a final product was printed. The questions were asked orally to a random sampling of twenty students from two graduate classes in two different graduate education departments offering distance learning courses. The questionnaire was distributed to two different graduate education classes. It should be noted that the data was collected over a two year period. The oral interviews were conducted with students the first year distance learning was offered. The questionnaire was given to students in the same courses taught by the same professors the second year of the distance education program. Each session was taped to determine interactivity. In addition, some of the interviews were taped to enable a "live capture" of comments during the oral interview. The tapes were reviewed and a narrative included in the result section. The data collection is still in progress, and results will be available in final form spring 1997.

Summary

Initial review of our data revealed that student perceptions of distance learning by compressed video are varied. Students have many reasons for taking courses by compressed video and have different expectations for the content and delivery of the courses. Students who had participated in other media delivery courses, which were not interactive in nature, expressed their surprise and delight in the interactive levels of compressed video. Most students were positive about the compressed video learning experience and said that they would repeat the experience. However, comments such as "I would not take another compressed video course" and "television is still television" warrant a closer look at the impact of compressed video learning experiences and the expectations of these students. Perhaps there are identifiable expectations that certain students have which could help determine student satisfaction with this mode of instruction. As teachers we need to be more than familiar with interactive video instruction to meet the needs of our students. We need to know more about our students' expectations and perceptions of learning and how to provide the connections to make this experience positive and effective.

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Student Perceptions of Courses Taught Using Two-Way Interactive Television

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Providing higher education to nontraditional students has become a point of interest for many colleges and universi ties (McMeen, 1984). In many rural areas, the only way to receive some type of post-secondary education is for learners to enroll in a specialized program or curriculum at an institution a considerable distance from home. Evening and weekend courses are also used, but this is often impractical for many teachers and students due to travel and expense involved (Beare, 1989). Delivery of instruction to learners at distant sites using teleconferencing equipment that permits two-way audio and visual interaction has been used recently to resolve many problems associated with geographic distance and isolation. Distance education can make virtually any subject available to an individual learner in the most solitary of geographic locations; to the elderly, unable to travel, to the house-bound parent of young children, to the poor, unable to relocate, to special needs populations, to the highly mobile service persons and other workers, and to all those who prefer to control the timing, location and pace of their study (Moore, 1989).

Basically, a two-way interactive television system provides an opportunity for an instructor at a "home site" to teach students geographically located at "remote sites." Students in each remote site can see, hear, and communicate live with the home site and other remote sites. This is accomplished by modifying the classroom to accommodate specially equipped cameras, microphones, and television monitors. The signal between home and remote sites are relayed via microwave, coaxial cable, telephone lines, or fiber optics (Kitchen, 1988).

Effectiveness of Prior Distance Education Efforts

At the post-secondary level, a number of studies have been conducted comparing the educational effectiveness of distance learning technologies (Barker & Platten, 1988; Beare, 1989; Kabat & Friedel, 1990; Ritchie & Newby, 1989). Many of these studies have compared the achievement of remote-site distance learning students with traditional classroom students. Almost without exception these studies have shown that distance learning students achieve as well as students taking courses via traditional methods (Kendall & Oaks, 1992).

Most prior research on distance education has dealt with technologies other than two-way audio and visual interaction. However, study after study has showed that comparable performance can be expected from students regardless of the medium (Ritchie & Newby, 1989). Anderson's (1978) study indicated that students do learn by televised instruction, that they prefer two-way audio interaction over videotaped instruction, and that students prefer live instruction to either kind of televised instruction.

The Need for Two-Way Interactive Television

Despite present and past research to support the efficacy of earlier modes of distance learning, it is well known that this approach is generally held with low regard (Barker & Platten, 1988). The major problem with earlier methods of distance education was a lack of student/teacher interaction. "Educators have repeatedly stressed the importance of instructional interaction within the learning process" (Ritchie & Newby, 1989, p. 36). The use of two-way interactive television in distance education fosters live, teacher-to-student and student-to-student interactivity and enables distance education to assume its rightful and respected role in the educational process (Barker & Platten, 1988).

Distance Learning at Valdosta State University

In an effort to provide access to educational programs and services that are responsive to personal and community needs, Valdosta State University in Valdosta, Georgia has initiated a new program of offering courses via live two-way interactive television. Previous research regarding this new type of distance learning has shown that no significant differences were found when comparing academic performance of remote- and host-site groups (Kabat & Friedel, 1990). Indeed, this new technology seems to be the next best thing to being there. However, the student is not "there," and this still creates concerns. Kabat & Friedel (1990) contended that for some students, learning via technology is awkward and is not conducive to their learning style. Not all students feel comfortable learning from a `distant' teacher, and many students feel cheated that they do not get to know classmates at other class sites.

Initial findings based on student evaluations of courses taken in the College of Education at Valdosta State University reveal several advantages and disadvantages of the distance learning system. Remote-site students have commented that distance learning courses saves driving time, makes it easier to take classes, improves the chance of getting a full-time faculty instructor instead of an adjunct instructor, saves money on baby-sitting, and gives peace of mind to be closer to home in case of emergencies. However, problems such as the lack of personal contact with professors and other students, the difficulty in getting assignments to campus, a hesitancy to ask questions, equipment problems, and distractions have also been noted.

The Purpose, Methods, and Findings of the Study

The purpose of this study was to compare the perceptions of remote-site distance learning students, host-site distance learning students, and traditional classroom students toward the affective experiences they encounter while taking courses from the College of Education at Valdosta State University. A review of literature revealed that cognitive outcomes are virtually the same between distance education students and traditional classroom students. However, these same studies mentioned that affective aspects such as student/teacher interaction, overall course enjoyment/satisfaction, course structure, and the physical learning environment were often lower for distance education students than traditional classroom students. This study focused on these affective experiences encountered by distance learning students.

The study used a causal-comparative design, and utilized a survey instrument to collect necessary data. The survey instrument contained 21 Likert-scale statements grouped into four clusters (student/teacher interaction, overall course enjoyment/satisfaction, course structure, and the physical learning environment), as well as demographic information and three open-ended questions. The instrument was mailed to an equal allocation sample of 165 remote-site students, 165 host-site students, and 165 traditional classroom students. Data analysis was conducted on a total of 346 returned surveys.

Means and standard deviations were calculated for each cluster area to describe the perceptions of the three groups. An analysis of covariance, using age as the covariate, was conducted to determine if significant differences existed among the three groups. If a significant difference was found for a particular cluster area, pairwise post hoc t-tests were conducted on that cluster to determine which specific groups contained the significant difference.

Results of the study indicated that there were no statistically significant differences between the three groups in regard to student/teacher interaction or course structure. Significant differences were found between the three groups when comparing the physical learning environment. Students in the remote- and host-site distance learning groups responded significantly lower to questions dealing with the physical learning environment than students in the traditional classroom group. Students in the host-site group also responded significantly lower to questions dealing with overall course enjoyment/satisfaction than students in the traditional classroom group.

Discussion

The findings of this study indicate that although the distance education groups had generally positive course experiences, they did encounter problems not found in a traditional classroom course. Equipment downtime was the biggest problem. Students at both the remote- and host-sites reported becoming frustrated due to lost class time spent making adjustments in the equipment to bring all sites on line properly. Audio problems and distractions caused by the various distance education equipment were also noted as problems. Host-site students were less understanding of these problems. Many host-site students did not feel they should have to endure these problems seeing no advantages for themselves. Remote-site students were much more understanding stating that they reduced driving time and other advantages more than made up for the few distractions caused by the equipment.

Distance education programs have been shown to be effective in meeting the educational needs of rural and non-traditional students geographically separated from a college or university (Barker & Platten, 1988; Beare, 1989; Kabat & Friedel, 1990; Ritchie & Newby, 1989). However, the majority of past distance education research has based "effectiveness" entirely on cognitive achievement. This study has indicated that the affective experiences encountered by distance learning students often differ from the experiences encountered by traditional classroom students and should be considered when evaluating a distance education program.

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COMBINING DISTANCE LEARNING & PROBLEM BASED LEARNING WITH MULTIMEDIA APPROACH

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By definition, distance learning substitutes communications technologies for personal contact between instructor and students. Problem-based learning (PBL) typically requires intensive instructor contact with students and may be difficult to implement in a distance learning context. However, our course demonstrates that multimedia technologies and extensive use of the World Wide Web can make PBL feasible for both traditional and distance students. We use a combination of videotaped lectures, e-mail, and a comprehensive web site to involve geographically dispersed students in group projects. Since the biotechnology issues we address are often controversial and commonly misunderstood by the American public, our course has a broad potential audience. Consequently, we have developed techniques for providing geographically remote students with on-line PBL experiences which are equivalent to those we provide to on-campus students.

Our interdisciplinary course, *Biotechnology: Science and Socio-Economic Issues*, has been taught in the College of Agricultural Sciences for eight years. During that time, we have adopted and refined PBL strategies which encourage students to focus on specific topics covered in the course. This unique course brings expert guest lecturers covering topics such as:

The history of genetic engineering
Plant and animal tissue culture
Food biotechnology
Plant and animal applications of biotechnology
Consumer acceptance of food products produced through biotechnology
Biotechnology and the media
Ethics

This wealth of expertise is not available in any other course in the country. However, students can take the course from virtually anywhere in the world, either through the University of Delaware's FOCUS/distance learning program or via satellite. Several of the lectures were made available for live broadcast throughout the United States by a grant from A*DEC, a consortium of universities that promotes distance education.

Problem-based learning has proven to be a valuable tool for integrating many perspectives on a given topic. Because they don't live near the university and may work full time, students require more flexibility in their learning experience. As a result, our goal is to provide the same rich learning experience by providing lectures for viewing via videotape or satellite downlink.

Our course demonstrates how network technologies can facilitate PBL in the context of mixed local and distance learning. Local and distance students learn how to collaborate with each other over the Internet. The experience of working in a group is even more valuable when combined with the challenge of working with remote group members. By publishing students' case studies on a publicly accessible web site, we are developing a public information resource to promote better understanding of some widely misunderstood biotechnology issues. Since we are a Land Grant University, this effort is entirely consistent with the broad public outreach mission of our institution.

Under a grant from the state's Department of Agriculture (FY 96 Cooperative State Research, Education, and Extension Service Higher Education Program) we are reaching distance students with a series of videotaped lectures. The University Focus/Distance Learning Program offers selected courses each semester. These courses are taught in specially equipped video classrooms to traditional students. Each lecture is videotaped in an unedited fashion. Student-faculty interaction is maintained through special telephone office hours in which faculty advise students and answer students' questions. Students may also schedule appointments to meet with faculty in person or communicate via email. The last unit of the course is a PBL exercise in which students in our local classroom are teamed with distance students to analyze and solve a particular problem related to biotechnology in agriculture.

The class web page is divided into public and private areas. The public areas are open to anyone and provide general information on the course and biotechnology as well as links to other biotechnology sites. Private areas are protected by passwords and are accessible only to registered students. The private areas contain class lecture notes and pages for each group's case studies. Within each group's case study page are sections for posting and reading messages.

Each instructor provides their lecture in a *Microsoft PowerPoint* file. The file has been converted to HTML with Microsoft's conversion utility. The web form of the lecture is identical to the lecture presented in class. On-line class notes are a supplement to both traditional and distance students.

Case Studies

Case studies present a biotechnology topic such as: the acceptance of gene-altered plants, animal versus human rights in a famine situation and the use of bovine somatotrophin to enhance milk production in cows. Throughout the case study, questions are presented. Students discuss the case, their opinions and how they would develop a research program to find answers to the questions. Each group has a web page for posting notes and messages. One member of the group takes notes during the discussion. Remote students use the same message page to submit their comments. These are often especially well received by the group because they are fresh ideas not influenced by the group discussion. The messages are not live. That is, the submission of a message is not immediately available to other group members. We hope to include this capability next year.

Presentations

After the groups have studied a case, they present their findings to the rest of the class. While distance students cannot currently participate in the actual presentation they can provide materials for the presentation. We hope to allow distance students to participate in presentations next year by asking groups to present their work on a web page. Students will be trained in basic hypertext markup language (HTML). They will then work together to create a public web page.

Problems

One of the major obstacles in teaching the course was the classroom itself. The studio is designed for the videotaping of lectures and is not at all suited for PBL group work. For instance, network connections were located at the front of the classroom away from student seating. Students were unable to move their chairs to work together. One solution would be to hold group work sessions in a different classroom, but we wanted to include the group discussions as well as lectures on videotape. Next year, the class will be taught in a traditional classroom. Special network connections will be added to allow groups to work together on-line.

The technical skills of groups differed. Those groups with a proficient computer user tended to make more information available to their distance group members. This magnified the variation of the experience of e distance students. Distance students required more computer and network expertise as they were required to connect to the web site and use the message center without any direct instruction. Of the four distance students taking the course in the first year, two dropped because they did not have ready access to the Internet. The other two had connections at their work place and, after some initial difficulties, were able to communicate with the other group members.

Passwords, implemented with Basic HTTP authentication, were used to protect class materials. For instance, some materials provided as background for case studies were copied from books or magazines. The material's use in the class is legal under the fair use act. But it is not legal and certainly not appropriate to make this information openly available on the web. Passwords were also used to keep each group's work separate. PBL experiences are created by the exchange of information in the group. Two groups studying the same case will take entirely different paths to their solution. Different passwords were used for each group and each case study. One drawback was that the passwords often proved difficult for students to remember.

Solutions for the Future

We found it was necessary to purchase a faster web server. A Sun Sparc Ultra I will replace the currently used Sun Sparc IPX. The new system, scheduled to go on-line Spring 1997, will speed up response time and provide more capacity for web material. Next year we will introduce an automated posting mechanism so messages, once submitted, will be immediately available to the group. We are experimenting with Common Gateway Interface (CGI) and Perl scripts as well as Java applications for implementation.

We plan to improve case study presentation by including links to other sources of information. Next year each group project will be presented on the web. Traditional students will work with distance students on an equal basis. Final projects will be accessible on the public pages of the class web site and will provide a forum for public education in biotechnology. As an added bonus, students aware that their work will be available on the web to the public will have more incentive to produce quality presentations.

Other innovations such as live "chat room" session will depend on the capabilities of the distance students. If the distance students are available to participate during classs hours and have access to high speed network connection, we may implement them. Otherwise, the current system should be adequate.

Conclusions

Problem based learning and distance learning can be combined. For the motivated student, the result is a rich and valuable learning experience. I encourage you to visit our web site at http://bluehen.ags.udel.edu/biotech

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Social Issues: Doctoral Students Studying Via Interactive Distance Education

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Often the turn of the century has psychologically sparked change. At the beginning of the twentieth century, Europe and the Americas abruptly shifted to a more mobile, industrial-based society. Americans in the late 20th century are in the midst of a revolution of similar magnitude. Grant (1994) stated that society is being transformed at a rapid rate by new technologies, especially communications technologies, into a culture where one no longer has to be present to be involved. Telecommunications inform, pervade, drive and increasingly shape our behaviors. Americans have come to rely on these technologies to entertain themselves, to communicate with others, and to assist them with a variety of tasks (Coldway, 1988). These changes are taking place rapidly not only in the business world but in the educational setting. According to Blumhart and Cross (1996), in the year 1995, more students enrolled in distance education courses than freshmen enrolling in all the colleges and universities in the United States.

Distance education has captured the attention of campus administrators, faculty unions, statewide coordinating boards and regional accrediting agencies. Schrum (1996) noted that, "Currently, much energy is being expended on distance education in every state and province in the United States and Canada, as well as in many other countries in the world" (p. 30). Yet the impact of distance education in the United States has been negligible when compared to its broader acceptance in other parts of the world. Given the demands for productivity improvements in colleges and universities, technology could remain the most powerful force for change in higher education well into the future.

Problem

According to Willis (1993), what we do not know about distance learning exceeds what we do know about it. To be effective, distance education requires the integrated efforts of several participants, principally the learners. Meeting the needs of students is the cornerstone of distance education and the test by which all efforts in this field should be judged (Willis, 1993). In a distance setting, the process of student learning may be even more complex than conventional education because of the perceived obstacles the students encounter. Sayers (1996) discussed both social and academic attitudes towards distance learning. He asserted that one of the most important issues in distance education was the way students reacted to learning in a class whose members are separated by time and space. Attitudes towards learning are an important factor in academic success.

Purpose of Study

The purpose of this research study was to discover and explore from a student perspective the social issues that restrict or encourage distance education, and to learn from distance students themselves what coping mechanisms were available or invented in the distance-learning environment. The following questions were developed to address these social issues: (1) Why do students choose the distance education approach to learning? (2) What are the perceived obstacles that distance education students encounter? and (3) What are the perceived coping and adapting processes that distance education students use? This study addressed the observational and empirical gap in the literature by focusing on the social issues of Kentucky doctoral distance students as expressed from their perspectives. In addition, the University of Kentucky (U. of K.) distance doctoral program, the only one of its kind in the United States, provided a special case, worthy of investigation in itself. The data collected during this in-depth exploratory study provided observation and interview-based insights which were contrasted and compared to the speculative literature.

Method

The questions proposed by this study are exploratory in nature because there is essentially no prior research to confirm. Exploratory studies tend not to be guided by hypotheses, because at the outset the researcher does not have sufficient understanding of the phenomena to form conjectures about relationships between constructs.

According to Eckstein (1975) theory-building studies are designed to "find out." This research was designed to examine the social issues related to doctoral distance education students. It was an observation-based examination of the social issues regarding distance education from the students' perspective. Focusing on student perceptions, the intention was to recreate for the reader some of the beliefs, practices, and behaviors of distance students.

The Milieu

The Department of Educational Administration began offering courses toward its Ed.D. specialization at U. of K. in the 1980s. In recent years, greater access to the program was desired; as a response, U. of K began using interactive distance education to remove the burden of travel for instructors and students.

Admission procedures for the distance students are the same as those for the on-campus students. Students are admitted on a "rolling admission" basis; new students may start any given semester. The average is four to five new admissions across two distance sites each year. The doctoral majors are required to take a minimum of 43 hours credit. The approximate time for completing the coursework is three years, including summer classes. The distance sites are staffed by a director and a technical coordinator. Support services are also provided such as technology maintenance, student registration, program planning and library support.

The Link

The Kentucky Telelinking Network (KTLN) was one of the first major users of the Commonwealth of Kentucky's Information Highway. The goal of KTLN is to design, install, and facilitate a fully integrated digital communications network supporting voice, video and data exchange. The core technology of KTLN is highly compressed digital video seen at approximately 30 frames per second.

The Participants

The participants were distance doctoral students studying at U. of K. They were selected because as doctoral students, they were among the most mature, and certainly among the best-educated distance learners in the country. The possible participants in this research consisted of ten students studying in a cohort in Paducah, Kentucky, twelve students studying in a cohort in Owensboro, Kentucky, and thirteen students who had completed their coursework. The participants in this study represented a variety of fields, ranging from nursing and biology to sociology and chiropractic. There were six final participants in this research—five females and one male. Their ages ranged from 31 to 48 years of age. The duration of time spent in this program ranged from four to five years.

Design

The research for this exploratory study was conducted using interviews, participant observations and documents. In order to gain a holistic perspective, interviews were used as the main tool. By interviewing, one is allowed to enter into another person's perspective (Patton, 1980). Because this was an exploratory study, this research was not driven by a predetermined agenda; patterns of information focused and drove the data collection. The technique of open, unstructured interviews was used; each participant was encouraged to share perspectives on the phenomena.

The study formally began with letters inviting the subjects to participate. Consent forms were mailed to all students in the distance program. The students who chose to participate responded by mail within approximately two weeks. The seventeen participants who decided to take part in the study began by participating in a screening interview. All but one subject was initially interviewed by telephone; the remaining participant was interviewed in person. These screening interviews individually lasted an average of two hours, and in many cases conveyed so much information that the participants felt that they had communicated their messages and did not participate further. All interviews and a group discussion (which provided another level of data gathering and perspective on the research problem) were audio tape-recorded to strengthen the reliability of the data. All of the audio tapes were transcribed and then destroyed. In the second round of interviews, six of the seventeen participants were asked to participate in a subsequent interview, which took approximately two hours each. In round three, three participants were interviewed in order to gain more in-depth, detailed and pertinent information regarding the emerging, unexpected social issues of these doctoral-distance education students. The fourth round consisted of the group interview of six participants which took place at one of the participant's homes. The fifth and final round was with two participants who agreed to review the final results. These results were mailed to the two participants and they returned the findings with suggestions and comments.

Site visits were then made at two sites, Owensboro and Paducah, Kentucky as well as the "host" site in Lexington, Kentucky. Field notes were taken; neither audio nor video tapes were allowed at the sites. Finally, to complete the triangulation process, documents were gathered. According to Merriam (1990), "One of the greatest advantages in using documentary material is its stability. Documentary data are 'objective' sources of data when compared to other forms"

(p. 108). The documents for this study included such items as placement procedures, program planning forms, job descriptions, and such.

Data Analysis

Based on the transcripts of the interviews and site visits, the first step of the analysis involved developing broad, preliminary categorization of data. The second step of the analysis process began the development of subcategories of data within each primary category. Step three involved preliminary understanding of the basic core themes of the experience. These themes were used in step four of the analysis process which included final identification of the themes. Step five completed the analysis—a composite representation of the essences of the experiences of the whole group. The overall objective was to develop an in-depth understanding of the structure of the experience; to condense the data and concentrate on the essence of the experience.

Findings of the Study

The participant interviews produced 61 hours of audiotaped, open-ended questions with expansive answers. When asked to give preliminary interviews, 48.5% of the distant doctoral learner population responded. After their unexpectedly generous and lengthy preliminary interviews, one-third of those who responded were asked to provide additional interviews. These final participants for this study were six students in various stages in the program at U. of K., currently studying or who had studied at two sites, Owensboro and Paducah, Kentucky. In-depth interviews of approximately one to two hours occurred. They were conducted until clear findings emerged concerning his or her experiences and perceptions of social issues surrounding the doctoral distance program. In addition, site visits were made at the two distant sites and the host site. Pertinent documents were gathered to complete the triangulation process.

Profile of Distance Students

All participants had differing personalities, backgrounds, and educational experiences. Yet common characteristics were apparent. These students fit into the non-traditional category. The average age of the students was approximately 35 and most were married and had children. Several of the students had received more than one Master's degree prior to beginning this program. Over 90% of the 35 students were female. These students held "noteworthy" positions in their communities. Few of the students were pursuing this degree for a career advancement or for financial reasons. In general, it was the intrinsic benefits (pride, accomplishment) rather than the extrinsic motivational factors (money, higher status) that prompted them to seek an advanced doctoral degree.

Findings of Question One

Question one addressed the reasons students had chosen the distance approach to learning. The response data revealed three major reasons: availability, convenience, and free tuition for those who were employed at a community college. During the interviews, each participant revealed or her personal situation, discussing how it impacted the choice of the distance education approach to learning. In addition, unexpected issues were voiced which related not only to choice but to group dynamics and individual circumstances as well. For instance, one student was pursuing a doctorate in order to continue in a currently held position. For most respondents, the choosing of a distance program appeared to stem from more than availability and convenience. Social issues also appeared to contribute to the decision once a student realized that further education was feasible. Observations and responses both showed that interaction with other students augmented the initial decision.

Findings of Question Two

As a part of the interviews for this study, each of the six final participants were asked to reflect on the obstacles they had encountered as students in the doctoral distance education program at of K. Approximately thirty obstacles were mentioned. Many of them were similar. Broadly, these obstacles can be divided into seven main categories:

- Problems caused by the lack of personal contact with the distant professors
- Obstacles caused by the slow turn-around time of papers and other materials
- The limited choice of classes provided each semester in the distance program
- Problems caused by having multiple sites
- Obstacles involving quick access to resources, which were needed for papers, presentations, etc.
- Problems concerning the proficiency of the professors at teaching via distance and their attitudes
- Obstacles regarding the distance site support personnel

These obstacles, for the most part, were not seen as critical, and each participant said they had, and appeared to have, individual coping processes which overcame the obstacles. No students remarked that any one of these obstacles or problems would cause them to drop their program of study via the mode of compressed video distance delivery.

Findings of Question Three

The numerous different coping and adapting processes were easily assigned to seven broad categories corresponding to the previously addressed seven obstacles encountered:

- Coping processes due to the lack of personal contact with the distance professors
- Coping strategies caused by slow turn-around time of materials
- Coping processes due to the limited choice of classes in the distance program

- Coping used due to multiple sites in distance teaching
- Coping processes regarding access to resources and materials (distance library)
- Coping with the variety of distance professors
- Coping with the differences in distance support personnel.

It was noteworthy that all of the distance doctoral students recognized the obstacles and had devised adequate, and at times creative, coping and adapting processes to overcome these obstacles. Overall, these distance students appeared to display contentedness and pleasure with the overall workings of the program.

Summary

The participants in this research study revealed a wide variety of experiences concerning social issues involved within the doctoral distance education program at the University of Kentucky. The students' perspectives on choice, obstacles, and coping processes regarding distance education were at times similar, yet may times they differed considerably.

Students chose this mode of educational delivery for the obvious reasons of availability and convenience; however, social, psychological and gender issues were also found to determine choice. It was discovered that no students felt they had made an incorrect choice concerning distance education once they developed an appropriate coping strategy.

Realizing that obstacles and problems existed within this distance program, the students devised creative and appropriate coping processes to address them. These students coped, in general, by using bonding with other students, and by being self-confident, self-motivated, self-disciplined, creative, and assertive. The interviews revealed that none of these distance students would drop the program due to any of these obstacles because they either cope adequately, or the problems were not critical enough to merit dropping the program. Observations showed that the students enjoyed their classmates and worked together to make this experience not only satisfying, but also enjoyable.

There were nonetheless serious issues revealed in this study that resourceful students might not have handled as adeptly. In addition, this research suggested major departures from the current literature.

It appears that the effectiveness of faculty and student contact time, whether in person or via telecommunications will be judged by the level of meaningful interaction. Eventually, "seat time" will become a less important measure of instructional progress, as more emphasis is placed on the possession of knowledge and skills. It is feasible that the proliferation of interactive media tailored to individual needs will help to push higher education toward a new model for instructional delivery. Possibly distance education and, indeed, distance higher education will no longer be a novelty. While it is true that distance education offers potential benefits, it is equally evident that insightful and substantive work in a number of related areas is required. Probably more than anything else, this study revealed that distance education is complex, multifaceted, and has many unknown aspects. There is an urgent need for further research.

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Teaching a Hands-on Technology Class in the Distance Education Environment

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In the fall of 1994, the Center for Excellence at Northern Arizona University began an experimental program of offering the complete course work required for elementary teacher certification via Interactive Instructional Television (IITV) on NAUnet. One course, ECI 447: Technology in the Classroom, remained problematic for this initiative because it was a hands-on computer competency course. NAU made an initial investment to create a "floating lab" of 20 laptop computers. Once that effort was accomplished, the ECI 447 was scheduled to be taught over IITV, during the fall semester, 1996. The course objectives were accomplished by using Timbuktu Pro™ 3.0 , FlashNotes™, Netscape Chat™ 2.0, and FreePPP™ 2.5v2 software.

The mission of the Center for Excellence in Education (CEE) at Northern Arizona University (NAU) is to prepare education professionals to create the schools of tomorrow. The State of Arizona has given the charge to NAU to address the pre-service teacher preparation needs of the state, especially those areas not serviced by metropolitan areas. To address these issues, NAU and the CEE have implemented a strong distance education program. In the fall of 1994, the CEE began an experimental program of offering the complete course work required for elementary teacher certification via Interactive Instructional Television (IITV) on NAUnet. One course, ECI 447: Technology in the Classroom, remained problematic for this initiative due to its nature. The objectives of ECI 447 are:

- to learn introductory level skills for using a computer as a personal and teaching tool,
- to learn introductory level skills necessary for integrating technology in the classroom,
- to examine issues surrounding integration of technology into existing curriculum,
- to examine assistive technology for special needs students,
- to explore specific ways for using technology in major subject areas,
- to acquire an understanding of the concerns related to software and hardware planning and evaluation,
- to examine the potential impact of technology on the curriculum of the future.

The course structure and approach determined that these objectives were to be accomplished through:

- Hands on computer competencies
- Small group activities
- Examination and evaluation of existing software
- Completion of individual and group projects
- Student presentations and demonstrations
- Visitation of the Instructional Human Development Laboratory

The only apparent solution to the offering of ECI 447 was to teach the course using facilities at the state-wide sites, local instructors, and not using the IITV environment. This was problematic due to lack of adequate facilities in some locations and no assurance of quality control. In the spring of 1996, a proposal was submitted for a possible way to teach ECI 447 via IITV. NAU would make a initial investment to create a "floating lab" of 20 laptop computers. This lab would be available on a rotating basis to facilitate the offering of ECI 447 state-wide. The computers would be checked out to each student for the duration of the class. This proposal was approved and the ECI 447 was scheduled to be taught over IITV Fall Semester 1996.

Course Design

To facilitate the instructional process, the IITV studios were networked so that the each student would be able to walk into the studio and plug their laptop into an Ethernet connection that provided access to the NAU intranet. NAU also provided local telephone numbers that allowed the students to connect to the NAU system from home using the 28.8 internal modem of the laptop. Each student had access to their e-mail accounts and access to the Internet using the NAU gateway both during class time and at home. A World Wide Web (WWW) Homepage for ECI 447 was developed to provide additional avenues of access.

To assist the students in accomplishing hands on computer competencies, Timbuktu Pro™ software was placed on each laptop and on the main computer of the IITV studio. This software allows the instructor to remotely control any student computer. With this captured desktop, the instructor can view any students computer screen no matter where they are located in order to work them through individual problems. If the instructor determines that all students would benefit by observing the process, the IITV studio operator can broadcast the captured desktop through the system and allow all students to observe the process.

Small group activities consist of students from different distant sites developing a class-time presentation on a controversial subject related to technology in the classroom. The students are required to conduct Internet searches and to utilize the products of these searches in their presentation. To facilitate this process, the students use a WWWBoard Version 2.0 ALPHA 1 located on the ECI 447 Homepage. The WWWBoard allows students to develop a dialogue and a set of URL's on the Homepage that can be accessed and utilized during the classroom presentation. To allow for interaction between students from different sites during class time, Netscape Chat™ 2.0 software is used. This allows students to be given a problem that allows for spontaneous discussions in a small group setting. Using Claris Homepage™ students learn to utilize Homepage development software as they create personal pages to be placed on the ECI 447 Homepage.

Preliminary Results

The use of Timbuktu Pro™ 3.0 was exceptionally successful. Timbuktu Pro™ for the Macintosh is a powerful remote control software. It provided a solution that allowed the instructor's Macintosh to connect to and remotely control the student's Macintoshes during hands-on computer competencies. Timbuktu Pro was also ideal for transferring files. Timbuktu Pro was promoted to provide simple connections whether modem-to-modem over regular phone or ISDN lines, ARA dial-up, over the Internet, LAN, or WAN to give total remote access on demand. Timbuktu Pro takes full advantage of System 7.5. Easy "drag-and-drop" file transfer made it simple for students to turn in large files. The FlashNotes™ instant messages provided a way to communicate with individual students during class without disturbing the other students.

Another success with the class was the use of the Netscape™ "chat" software. Discussion groups composed of students from different sites were established. A topic of discussion was given each group and during class time the group was to discuss the issue and then provide an informal presentation to the whole class over the IITV system. For example, when the Instructional Human Development Laboratory made their presentation on using technology for students with special needs the students were divided into discussion groups. Each group was given a part of the computer such as the keyboard or monitor and they were to discuss and then report how these pieces of hardware could present barriers to special needs students. The individuals used the software to discussed both "on task" and "off task" subjects. This technique provided avenues of collegialityís and served to breakdown barriers that exist because students are physically separated.

The area of greatest complication and least success was the use of FreePPP 2.5v2 software for at-home access. NAU had established local numbers at the remote sites for modem access. The laptops were programmed to complete the modem dial in using the FreePPP but because of the sensitivity of the system the students had almost no success and became exceptionally discouraged about attempting to use telecommunications at home. Several attempts were made to correct the problems, all with limited success. As a last resort, students were given a step-by-step manual login procedure that reduced the problem for the majority of the students. However, two students were never able to login from home. The failure of successful at home login restricted the success of Internet exploration planned for the class.

Recommendations for Future

The power and versatility of the Timbuktu Pro™ 3.0 for the Macintosh makes teaching introductory technology based upon hands-on computer competencies a reality. Scheduling for adequate in-class time for hands on problems solving is imperative. An area of future exploration is the use of modem-to-modem connections over regular phone lines that Timbuktu Pro™ 3.0 provides for helping students outside class time. Careful attention and extra support should be provided to novice users for modem access at home. The manual step-by-step login procedures for the FreePPP™ should be used from the beginning before anxieties develop to a point that successful login is difficult. The use of the Netscape "chat" software should be expanded so multiple groups can know one another as individuals.

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Utilizing Educational Technologies for Teacher Excellence

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Alternative teaching methods and delivery systems have become a focus of educational programs. Due to the recent development of a distance learning classroom at Emporia State University and the addition of a computer learning center in our division; the Division of Health, Physical Education and Recreation decided to investigate the potential of various educational technologies in order to better serve our mission as a teacher training institution. Our investigation centered on distance learning. What is distance learning? How can it enhance our mission of preparing students for the profession of teaching and providing inservice education for teachers in the field? What technologies would be most effective in accomplishing this mission?

Distance education is a formal, institution-based approach in which teacher and learner are usually separated by location but not by time. Two-way interactive telecommunications systems are used for lecture and visual presentations (Simons, 1995). The Association of Educational Communications and Technology (AECT) cites that many schools in the United States are applying distance learning in innovative and efficient pedagogical ways (Milet, 1996). These technologies provide equity in education (Rutherford & Grana, 1994). They allow opportunities for schools to reach a wider audience, meet the needs of students unable to attend on-campus classes, involve outside speakers, and link students from different socio-economic/experiential backgrounds (Willis, 1992).

Massy & Zemsky (1995) observed two trends emerging with distance learning. The first trend is the new demand for information technology-based teaching and learning, and its substantial growth in the next decade particularly as a economical means of providing more readily accessible post-secondary education and credentialing. The second trend is the profound change in teaching and learning. Institutions can reap the benefits of the great potential that distance learning offers if they transform themselves in fundamental ways.

Whether or not one agrees that today's colleges and universities have a worthwhile core of values that should be protected or that technology should be in part substitute for faculty labor, the potential for increased learning productivity through technology is too great for higher education to ignore. If colleges and universities fail to adapt effectively, other kinds of institutions will take up the challenge. (Massy and Zemsky, p. 11)

We need to not only make teachers aware of the latest technologies, but how we can learn through them and implement them into our classes (Milet, 1996). Viau (1994) stated that minds of tomorrow must be open and able to deal with information that is always changing and increasing. Educators must realize that tomorrow is here today with respect to developing innovative teaching techniques for keeping up with informational changes.

Willis (1990) emphasized that effective distance learning teachers realize preparation is more evident than innovation in the success of this approach. It should be emphasized that a number of strategies that focused on planning instruction, student understanding, and developing new interaction techniques, must be employed for effective teaching.

Course Development

Course Survey

With this information in hand, it was decided to develop a hard copy and online survey to assess the attitudes and opinions of teachers throughout the state of Kansas. In a survey of over 200 responding teachers, a significant number indicated a strong interest in internet courses — with and without limited time on campus. Distance from campus and hectic professional/personal schedules were the main reasons. Courses which helped them to become more knowledgeable and effective teachers were the most requested offerings. In addition, many indicated that their schools' trends were toward more technology-oriented procedures such as student and teacher evaluations plus more curricular emphasis on student proficiencies with computer technology.

Course Product

Recently, a new graduate level course, Analysis of Teaching and Coaching, was approved and placed into our curriculum. Since our investigation of distance learning suggested the demand for information technology-based teaching will grow in the next decade and this technology will change teaching and learning profoundly, the course delivery system should utilize a distance learning format. This format would insure that our graduate students would be utilizing the newest technologies available to them professionally. In planning and outlining our course structure, various technologies were implemented. These included interactive television with guest lecturers, internet interaction, electronic mail and bulletin board, video-taped analysis of teaching performances, and the use of various software to analyze teacher performance/student skill progressions.

Course Delivery

The Analysis of Teaching and Coaching class was offered for two or three hours credit in order to cater to the needs and preferences of teachers seeking graduate level offerings. The primary distinction between the two and three hour courses was on-campus class sessions. The two hour class had no on-campus class sessions and relied solely on internet and electronic bulletin board delivery. The three hour class was designed for the students to meet on campus the first and last meeting dates of class to ensure more in-depth instruction and personal interaction. A significant portion of the in-depth instruction involved the use of interactive television. An interactive television connection with Illinois State University faculty focused on the current trends in observational recording of physical education teaching behavior. The interactive television experience allowed our students to have personal dialogue with authorities on teacher performance.

Internet

Students were required to have access to the following equipment: internet and World Wide Web access, at least a 386 Windows capable PC or Macintosh computer, a video camera, and a VCR and monitor. A class home page was developed containing the course syllabus, assignments and directions for various technological procedures. A hard copy of this information was also produced in a course manual. Links to sources both on and off campus were established including library information that students could access on-line. A class profile was also developed to include pictures and personal information of both instructors and students to insure a more personalized learning environment.

Bulletin Board

The bulletin board system, *Worldgroup Manager* (1995) was the primary vehicle through which course information and class discussion was conveyed. *Worldgroup Manager* allows students and instructors to exchange messages in E-mail and forums, and participate in live debate in teleconference. *Worldgroup Manager* allows off-line work such as composing a message, before going on-line to deliver the message. Forums were established for long-term conversations between instructors, students and experts on a variety of pedagogical issues. A discussion question was posted every two weeks for these conversations and was perpetuated through a variety of threads between the instructors and students and also among the students themselves. Another benefit of this system was the privacy allowed for the class as opposed to a universal listserv.

Video Analysis

Due to the nature of the course, analyzing teaching and coaching performance to enhance one's professional skills was to be an obvious outcome. Videotapes were produced of selected master teachers at the elementary, middle and secondary school levels for promoting positive and effective teacher behaviors. Besides observing effective teacher behavior, the videotapes were designed to help the class analyze and evaluate teacher performance. In turn, each student was required to videotape themselves in a teaching situation and critique the situation. Initially, the instructors chose a variety of paper and pencil assessment instruments to use for analyzing and evaluating these master teaching videotapes and the personal videotaped teaching performances of the class. Since it was decided to share with the students a variety of educational technologies, the instructors pondered why not find an available software that facilitates the collection, analysis and reporting of the observable teaching behaviors and could be used with a PC or laptop computer?

Software

The advantage of a computer software program that utilizes objective criteria such as time and frequency enables a person with minimal training to conduct an evaluation of someone's performance. Also, a computerized screen presentation and/or printout with a graphical display of a performance can be an immediate and informative device to make one aware of their teaching behaviors. Simultaneous situations such as time on task, definitive portions of a lesson - introduction, and review, as well as, the duration of those situations can be tracked more easily through this software rather than manually through paper/ pencil and stop watch procedures.

After reviewing the current software available for analyzing teaching performance, the decision was made to develop our own software in a Windows environment. The Windows interface would make the computer program more user friendly than current MS-DOS based software available. Our goal was to develop teaching analysis software that would accurately measure and record various teaching behaviors and communicate useful results quickly to the observed teacher with the goal of improving teacher performance. Our objective was accomplished by developing a PC computer software program, *Evaluator* (Henry and Hubbard, 1996), that uses a Windows interface programmed in Visual Basic language. It was designed to effectively measure time on task behaviors as well as frequency of teacher related behaviors. The *Evaluator* allows collection of data for any observable behavior that can be timed, counted or commented on. Specific behaviors to be measured can be determined by the observer prior to actual observation. This software program can be used with a PC or laptop computer input directly in the classroom/ gymnasium or in conjunction with paper/pencil recording with later transfer to the software program. The program is designed to print reports, charts and graphs for immediate feedback. Information on the computer software program *Evaluator*, may be obtained by contacting Guerilla Software, 6826 East Odessa Ct., Wichita, KS 67226.

Future Implications

University teacher education programs must realize that technology-based education is here and is rapidly changing each day. Recent trends in education suggest the demand for information technology-based teaching will grow in the next decade and this technology will change teaching and learning profoundly. It is imperative that our teacher education programs incorporate technological strategies currently being endorsed in public and private schools. Utilizing educational technologies for teacher excellence will improve our teacher education systems so that they are more productive in serving a wider professional audience, and allowing teachers better access to new, innovative, teaching practices.

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Collaborative Distance Learning (CDL): An Instructional Model Designed to Enrich Teacher Education Courses

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The major purpose of the Collaborative Distance Learning (CDL) Model is to provide opportunities for undergraduate and graduate students to interact with teachers, administrators, and students in selected model schools using various telecommunications tools. The specific tools used are electronic mail, listserve, chats via internet using Cu-SeeMe software, video tapes, and telephone conference calls. The model described here is an extension of the Studio Classroom approach described by DeLoughry (1995) and used by Lumpkins (1995) in introductory courses to teach education. DeLoughry quoted Cutler as stating that the Studio Classroom approach is going to transform all of those courses that everybody suffered through in college. The trick, according to Cutler, is to get students involved in their education, and he is convinced that the studio approach works. By bringing students in teacher education classes into direct contact with K-12 schools using video conferencing tools, the study of teaching becomes real and viable. Perhaps the skeptics should consider the observation of Freedman (1995), editor of *Inc. Magazine*, who stated: "Companies (universities) that find ways to apply technology effectively stand a real chance of achieving a competitive edge. Those that don't, stand a real chance of being eaten alive" (p. 9).

Participants

Participants in the pilot program included students enrolled in selected undergraduate and graduate courses at Henderson State University during the 1996/1997 school year and selected teachers and administrators from two model public schools. A brief description of the tools and techniques employed in this project are presented in the following paragraphs. Two innovative model school sites in partnership with Henderson State University provided opportunities for participating students and teachers to dialogue about teaching and learning issues and concerns. A major belief guiding this inquiry was that this model would personalize inquiry and enhance student learning.

Distance Learning

Newer technologies are making it possible for universities like Henderson State University to enter into the heretofore restricted distance learning market. At Henderson State, the Studio Approach was used to implement distance learning during the Spring, 1996 semester. A graduate curriculum course used direct classroom instruction combined with electronic mail, use of the internet by the student to glean assignments, and the use of telephone conference calling. Though not true distance learning because most classes were taught within the classroom at the university, this was the first distance learning course offered by the elementary education department and will be expanded during the Spring semester of 1997. Distance learning comes to the student instead of the student coming to the classroom. Distance education is not simply the addition of technology to instruction; instead, it uses technology to make possible new approaches to the teaching-learning process. The distance learning courses may utilize several different formats and distance technologies. For example:

- Station to Station full-motion video
- Internet Relay Chat (IRC)
- Desktop video-conferencing (Quick Cam) The paradigm for desktop video conferencing is that participants sit at their own desks, in their own offices and call up other participants using their person computer in a manner much like a telephone.
- Telephone (computer and Internet lines)
- Video and Audio tapes (Email correspondence)

- Electronic mail and listserve
- World Wide Web

All of the above telecommunication technologies will be used in the Weekends@HSU Program (described later in this paper) in the spring of 1997, with the exception of station-to-station full motion video.

Enrollment in the pilot course in the Spring of 1997 will most likely be limited to students who are pursuing a graduate degree from Henderson State University. This will afford an opportunity to publicize the course in the summer and fall class schedules and to gather assessment feedback data from students. Students electing to enroll in the curriculum course will likely need some training in the technological tools they will be expected to use in the course. Six clock hours of hands-on training will be given to all students enrolling in the course. Participation will be required and certain competencies must be shown.

Many of the distance learning providers of the 1980's used a delivery model where the teacher lectured with occasional interaction with students at the various delivery sites. This model, even though it may be delivered via satellite, is just as ineffective as it is when used in the traditional classroom. In other words, the nineteenth century instructional model, with the "sage on stage" should be left in the nineteenth century.

CDL Plan

Laboratory schools, which were once considered to be an indispensable component of teacher education provided opportunities for future teachers to observe master teachers and to study the teaching-learning process. Cost and governance problems have caused many teacher education programs to close the laboratory schools doors and seek opportunities for their students to carry out observations and other practice activities in area schools. Considerable savings are being realized by this change, but not without sacrifice. It is very difficult for teacher education professors to secure placements for their students to observe, and even more difficult to have some degree of influence or control over the observations. Other difficulties revolve around time and distance. It is difficult for students and their professors to travel to off-campus sites for class observations and to carry out other assigned tasks such as interviews with teachers and students. The virtual laboratory school where connections with classrooms can be made via live video, taped lessons and conferences using a combination of distance technologies may be the answer to these problems.

The unique partnerships between K-12 schools and universities must be based on the premise that all participants will have something to gain from participating in the partnership. In other words, all are rewarded by one or more services provided by the other partners. The schools provide virtual laboratory school experiences for students in teacher education. University students may serve as mentors or pen pals for K-12 students and the university professors may provide compiled research summaries relevant to questions raised by teachers and also provide certain services within their area/s of expertise.

Experiences with other programs using distance technologies, and generalizations drawn from survey data gathered from both undergraduate and graduate students, and training specific to the technologies to be used in the collaborative distance learning model, must be included in the overall instructional plans. Certain prerequisites such as the student's basic computer literacy and word processing skill level along with availability of internet connectivity must be carefully adhered to if the student is to be successful in courses where information is exchanged using various telecommunication tools. Approximately twelve clock hours of class instruction will be allocated for training in the use of specific telecommunication tools such as video conferencing via internet, developing web pages for posting individual and group research and strategies for locating relevant information on the World Wide Web.

Weekend Seminars

Seminars and conferences are efficient vehicles for exploring issues and debating points-of-view. Each major set of topics studied by undergraduate and graduate students may be launched and/or concluded using these practices. While the students may meet on campus, the speakers may include teachers and administrators who present from their home station via telephone, Cu-SeeMe, or video tape. Students enrolled for three semester hours of graduate credit will be required to meet on campus one Saturday each month from 8:30 a.m. to 3:00 p.m. for lectures, seminars and training in the used of selected distance learning tools. A total of five full-day class sessions will be held during the semester, or the equivalent of 30 clock hours of on-campus instruction. The various cohort groups will be required to meet weekly at predetermined sites between the hours of 6:00 p.m. and 9:00 p.m. over a fifteen week period. During cohort meeting the students may work on group assignments and confer with their instructor/s via teleconferencing and electronic mail. In addition to the 75 clock hours each student will accrue by his/her participation in seminars and cohort class sessions, a great deal of time will be required to complete independent assignments. It is expected that the total time commitment of the students enrolled in a three semester hour Weekends@HSU course will equal or exceed the time committed by regular on-campus students enrolled in the same course.

Cooperative Learning Groups

Cooperative learning groups, consisting of three to seven students from the same geographic area, will be established for carrying out assigned tasks and to provide peer support and assistance. Cooperative learning groups and cohort groups are two terms used interchangeably in this particular project. These groups will be expected to meet one evening each week to discuss, to question, and to dialogue with their instructors and other classmates via distance using teleconferencing, electronic mail and net chat.

Collaborative and cooperative learning strategies are strongly supported in the literature as effective tools to use with all age groups. The cooperative inquiry model proposed herein depended heavily on using these learning strategies in a person-to-person format across distance. An example of a typical setting may be where two or more students may meet at a common location and cooperatively work on an assigned activity, conference with the instructor, school personnel at remote sites or other students via telephone, internet (Cu-SeeMe), Email or fax. Information exchanges and data transfers may occur from any combination of students, resource persons and/or the instructors during these sessions.

Specific Instructional Activities

Every university student involved in this project will have access to Email and to the internet. This access may be through the university or from other sources such as their place of employment, the regional teacher cooperative, or through a private vendor such as Prodigy or America On Line. Specific projects may be defined by the student while others may be assigned by the instructor. The independently directed activities will require the search retrieval and interpretation of information from a variety of sources and locations. Students may also transfer information to other students and his/her instructor using a variety of telecommunication tools. A great deal of flexibility will be given to the students in how they choose to schedule their time, and a great deal of independence will be given relative to the design of inquires and reports.

Cohort Discussion Activity

One cohort member should assume the responsibility for documenting the discussion by recording a complete set of written notes. The production of a written narrative giving an overview of the discussion will be a general expectation. This written document with a copy of the notes (in electronic format) will be submitted to the instructor no later than on week following the discussion activity. The discussion, if applicable, should be inclusive of both elementary and secondary school perspectives.

Individual Inquiry Activity

This type of inquiry is to look into the literature to determine the opinions of experts and to review the research findings relative to a specific topic. Documentation of this research is shown by the production of a short paper (one to three pages with references) which is shared with classmates by posting on the student's homepage. The inquiry should be approached from either an elementary or secondary perspective.

Internet Chat

One chat format will be "asynchronous" where the chat will take place over time with the participant deciding when he/she will login to listen and/or talk. A second chat format to be used will be "synchronous" with participants actively logged in during a set time frame.

Teleconferencing

Specific dates and times are established for cohort groups to chat with their instructors via distance using CU-SeeMe tools. Class members will be notified by Electronic Mail at least one day in advance detailing the particular discussion format to be used. One type is "Broadcast" where cohort groups are expected to log onto a specific reflector and join a designated conference during a specific time period.

Assessment/Evaluation

Mastery will be determined by written examinations plus the assessment of group and individual assignments and projects. Each student will be expected to develop an electronically filed portfolio of his/her work as the semester progresses which may be viewed by fellow classmates and the instructor. Each student will be expected to develop his/her personal homepage and systematically post the materials and completed projects on the web page.

Attendance Policy

Attendance and participation are believed to be key factors directly related to the development of skills and understandings described in the objectives for this course. Because of the uniqueness of the Saturday seminar, it is very difficult to replicate the information given, discussions, specific training in the information given, and specific training in the use of telecommunication tools. Cohort meetings are also unique in the sense that it is impossible to replicate the experience by doing a make-up assignment. Absences, regardless of the reason/s, will be carefully scrutinized and will result in additional assignments. The semester grade may be lowered if the instructor feels that the absences have been excessive and/or if it is not possible to replicate the lessons or experiences missed.

Conclusion

We believe the CDL model, along with university and K-12 partnerships using a variety of telecommunication tools, will personalize and enhance student learning. The effectiveness of the Collaborative Distance Learning (CDL) Model will be assessed as each phase of the program is implemented during the 1996-1997 school year. Specifically, data will be collected and analyzed relative to the following questions:

Question #1. Will there be a significant difference in student to student and student to teacher interaction between students participating in this project and students enrolled in traditionally delivered undergraduate/ graduate education courses?

Question #2. Will the Collaborative Distance Learning Model significantly affect student motivation and learning?

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Distance Learning and Teacher Education

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This paper outlines alternatives for distance learning applications in teacher education programs. Several technologies that focus on audio, video, and computer delivery are examined. In addition, case studies of distance learning programs being implemented at the University of South Florida and the University of North Florida are presented. There are many applications for distance learning in teacher education programs. Distance learning techniques can be used to deliver curriculum in the form of courses, mentoring, or team teaching; they can be used to support the learners via advising, access to resources, or student registration; and they can be used for assessment of students or programs. Delivery systems for distance learning can be roughly divided into audio, video, and computer. Each of these categories include a variety of technologies that can help to enhance instructional interactions between teachers and students who are separated by time or distance.

Audio Technologies

The primary audio technologies for distance learning include audio cassette tapes (one-way audio) and audio-conferencing (two-way audio). Audio cassettes provide an inexpensive way to distribute information. This method has been employed for years for audio books and other information that does not require interactivity. For example, lessons in a foreign language may be recorded and disseminated on audiotapes, allowing students to practice at home, in a car, or whenever and wherever it is convenient for them.

Audio-conferencing involves a real-time exchange of audio information that can take place through telephones or through the Internet. Telephone technologies that can be used to enhance distance learning include speaker-phones, telephone bridges, conference calls, voicemail, and fax machines. These techniques are inexpensive and easily accessible by the vast majority of people.

Audio-conferencing is also possible through the Internet. Recent software programs, such as CoolTalk, allow students with Internet access, an audio card, and a microphone, to talk to others throughout the world. Through Internet telephony, preservice teachers in the United States can communicate with peers or experts for little or no cost.

Video Technologies

Video technologies that can be used for distance learning include linear videotape, broadcast video, and satellite videoconferencing. A common method for distributing video and audio information is through linear videotape. With this approach, a series of tapes can be recorded and sent to students to watch whenever it is convenient. Interactions with the instructor can be conducted through e-mail, telephone, or traditional correspondence methods.

Broadcast video can consist of television broadcasts (usually on public TV), closed circuit TV, or ITFS (microwave) delivery. Broadcast video is generally one-way audio and one-way video. In other words, students may be advised to watch channel 32 at 8 pm for the Business Education course. If the video is broadcast to homes, students can watch it in the privacy of their homes, or they can tape the shows to watch at a later time. If it is sent (via microwave or fiber optic cable) to pre-selected sites, the students must congregate at the sites to receive the broadcast. In some cases, facilitators may be available, and telephone bridges can allow students to ask questions during the lesson.

Although more expensive, videoconferencing can also take place via satellites. With satellites, an uplink is required at the originating site to transmit the video and audio signals to a transponder. The transponder receives the signal and transmits it back to earth where it is received by downlinks and distributed to the classrooms. Satellite delivery is generally one-way audio and video, although two-way audio can be provided with a telephone bridge.

Computer Technologies

The Internet and the World Wide Web offer inexpensive means to conduct two-way interactions between teachers and learners. The possibilities range from a "correspondence-type" course conducted on E-mail to structured courseware delivered through the World Wide Web or CD-ROM. Desktop videoconferencing (with two-way audio and two-way video) is also available through the computers on the Internet or through high-speed lines, such as ISDN.

A determining factor with distance learning through the Internet is whether the course communications should be synchronous or asynchronous. If two-way interactions are required (either or audio or video), then the synchronous options of audioconferencing through a program such as CoolTalk or videoconferencing through CU-SeeMe or PictureTel are possibilities.

If, on the other hand, you want to deliver courseware independent of time, it is possible to develop Internet or Web-based courses wherein the students can read their assignments whenever it is convenient for them. They can also send e-mail messages to the instructor. Asynchronous courses require more time in the up-front planning, but are less restrictive and less expensive in the delivery.

Case Study: Desktop Videoconferencing Project at UNF

Desktop videoconferencing is the delivery medium for a joint project between the University of North Florida, Lone Star Elementary School, and Sandalwood High School. Business partners, the university, and the public schools are participating in a teleconferencing venture. The university is providing instructional and technical support. A cable television company is giving "in-kind" support to the schools for obtaining the necessary equipment for transmission, and computer and program development companies are providing "in-kind" contributions of hardware, distance learning courseware, and technical support.

Teaching and learning is the focus of this educational partnership between university faculty, preservice teachers in the UNF undergraduate program, and teachers and students at secondary and elementary schools. University personnel will facilitate the instruction for preservice teachers studying science education in the undergraduate teacher education program at UNF and will provide instructional technology support. A biology and a chemistry teacher at the high school and a science educator at the elementary school will assist students in their classes in preparing for and completing the project.

In developing content for the project, a number of sources were consulted: the National Science Standards, the Florida Sunshine State Standards, and the Duval County Public School District program called Academic Excellence and Achievement for All Students (AEAAS). The Florida Curriculum Framework for Science, a guide for teachers to help achieve the Sunshine State Standards, provides the foundation for the work of this project.

By focusing on the following standards, this project will provide participants with an understanding of the importance of science in society, truthful reporting of scientific findings, and the importance of sharing scientific findings with the public.

SC.H.1.4.4 The student knows that scientists in any one research group tend to see things alike and that therefore scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis.

SC.H.1.4.5 The student understands that new areas in science are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and usually grow slowly from many contributors.

SC.H.1.4.7 The student understands the importance of a sense of responsibility, a commitment to peer review, truthful reporting of the methods and outcomes of investigations, and making the public aware of the findings.

SC.H.3 The student understands that science, technology, and society are interwoven and interdependent.

SC.H.3.4.1 The student knows that performance testing is often conducted using small-scale models, computer simulations, or analogous systems to reduce the change of system failure.

Based on these standards, the project uses the "anchored" instruction model with distance learning to address the role of prior knowledge in the development of understanding, analysis of evidence and data, and include public discussions as a form or peer review. Elementary school students, high school students, and university preservice teachers will react to scenes in the hot air ballooning and scuba diving anchor as a preface to studying gases in their chemistry and biology classes. By explaining how these processes are possible students will share prior knowledge by remote links among the three sites. High schools students will collect and qualitatively evaluate data using the CBL-graphing calculator technology. Data will be shared and reviewed among the three sites.

Dissemination of the plans for this project and the findings will be available through postings to the Internet, videotapes of the teaching and learning episodes, and local media. Both university and public school educators and students will share the results of the project through their web pages using data from experiments, graphics, photos, and QuickTime movies.

Another project using teleconferencing technology as a delivery vehicle is part of the Jacksonville Urban Educational Partnership (JUEP). To prepare inservice teachers for using distance learning technologies, inquiry seminars are being developed by 9 inservice teachers and lead faculty from the university of North Florida. This collaborative partnership between the University of North Florida and the Duval County, Florida public schools seeks to better prepare teachers for urban schools and to enhance the achievement of urban students. Through the seminars school-based and classroom-based technology scholars will become "emerging experts" regarding teleconferencing technology.

Inservice and preservice teachers are learning how to use the Florida Information Resource Network (FIRN) as a means of communicating with other teachers and students at both elementary schools in Jacksonville, FL, and with teachers and students participating in the project in Houston. As soon as the infrastructure is completed, participants will use the teleconferencing technology to participate in the Texas STARBASE project. Teleconferencing groupware will be coupled with collaborative learning to assist students in working in small groups, focusing on problem-solving instructional units, and engaging in new ways of thinking.

Case Study: USF Learn From A Distance Program

The University of South Florida has offered courses through the Internet for the past four years. In the Spring of 1992, a graduate-level course was offered to a pilot group of four students. Based on the success of this and other courses, the USF Learn From A Distance (LFAD) program has expanded to fifteen courses with approximately 200 students enrolling each semester. The LFAD program offers courses in Instructional Technology, English as a Second Language, Elementary Education, and Psychological Foundations.

Most of the courses offered through distance learning focus on delivery of the course materials through the Internet or videotapes. These courses require two class meetings — an orientation meeting at the beginning of the semester and a final class meeting at the end of this semester (these meetings are waived for out-of-state students who meet specific criteria). Between the two meetings, students work through sets of well-designed assignments to meet the course objectives. Most of the course interactions with the instructor and other students take place through e-mail. In addition, several of the courses offer supplemental instruction through Web pages, videotapes, and computer software.

The Special Education program at USF also offers distance learning courses via videoconferencing (through the PictureTel system). There are currently three sites throughout the USF service district that receive courses in this manner. The PictureTel system was selected because of the high-quality video and audio that can be transmitted. Special high-speed telephone lines (ISDN) are required for delivery of the course.

A key component in the success of the distance learning courses at USF has been the establishment of the Learn From A Distance (LFAD) program. Teaching a distance learning course requires additional time and commitment on the part of faculty members. To assist faculty member and ensure a smooth operation of distance learning courses, the LFAD office performs the following service functions:

- Help to determine the best delivery system for a course
- Assist faculty with the technology necessary for distant delivery
- Assist in the development of instructional materials
- Duplicate course materials, such as videotapes
- Provide technical support to students enrolled LFAD courses
- Promote distance learning opportunities via mailouts, etc.
- Schedule distance learning classes, including rooms and equipment, if necessary
- Register students for LFAD courses

In the spring of 1997, a new College of Education building will open at USF with fiber optic cables throughout the building and direct links into a satellite uplink. As access to technologies increase, the USF faculty and LFAD office plan to work together to meet the needs of both traditional and non-traditional students.

Conclusion

Distance learning technologies are playing a major role in teacher education programs throughout the world. Integrating distance learning technologies into teacher education programs is not an easy task. There are many different technologies to choose from, each with its own advantages and disadvantages. In addition, the development of a distance learning course is extremely time-consuming and demanding for the instructor. Distance learning, however, holds a great deal of promise for meeting the needs of students throughout the world who strive to become teachers, but may not be able to attend traditional classes.

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Technology Assisted Teacher Education (TATE)

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In a recent article, Richardson (1996) succinctly describes the plight of pre-service teacher education. "It is sand wiched," she writes, "between two powerful forces — previous life history, particularly that related to being a student, and classroom experience as a student teacher and teacher"(p.113). While traditional pre-service programs may do a good job fostering knowledge of educational research and theory, and while this knowledge may have some eventual impact on practice, teachers' beliefs and actions tend to be influenced far more strongly by those other classroom experiences. The challenge for teacher education, Richardson suggests, is to find ways to support teachers' praxis, or what might be called their knowledge of practice. That is, what experiences can we provide that will lead pre- and in-service teachers to reflect critically on their long-standing beliefs about education? How might we help them to integrate educational theory and classroom experience? How might we encourage them to become life-long learners, engaged in a continual effort to improve their own teaching? In short, how might teacher education become a more powerful source of professional development, one that does not merely serve as an interlude between other, more formative experiences?

We believe that the emerging communication technologies point in promising directions for improvement. In particular, we are working to design interactive video exchanges between in-service and pre-service teachers. Two-way video-conferencing, linking the classroom of an experienced teacher with students in a university methods class, provides real-time observation of instruction, opportunities for subsequent discussion among participants, sustained involvement with a single classroom, and the ability to record observations for later analysis. What is more important, it provides in-service teachers with a means of continuing professional development and pre-service teachers with a common, and exemplary "text," one that will help to bridge the gap between educational theory and classroom experience.

To foster a knowledge of practice among pre-service teachers, most teacher education programs rely heavily on a period of observation in area schools, and this observation usually fulfills the teacher-certification requirements of the state. In Michigan, for example, pre-service teachers must spend a minimum of sixty hours observing in schools, prior to student-teaching. It is hoped that during this time, teaching candidates will begin to see how various educational theories are being implemented in classrooms. However, research has shown that very few observation sites exemplify the kind of instruction that teacher education programs typically promote. Furthermore, because teaching styles and teacher-student dynamics tend to differ so widely from one classroom to the next, from school to school, and from district to district, professors of teacher education cannot assume that teaching candidates have had comparable experiences in the field, much less assume that they share a common vocabulary for talking about classroom practices. As Carter (1990) explains, this can have a disastrous effect on pre-service learning. Teacher candidates learn best through reflective discussion about classroom practice, but such discussion becomes very difficult in the absence of a shared experience. One solution might be to send candidates to observe all in a single school, or in a single set of classrooms; but this is rarely feasible, given the intrusion and the logistics involved. Another solution, and one that many researchers have begun to explore, involves the use of videotape and hypermedia applications. We believe that these efforts are quite promising. However, they lack the immediacy of response afforded by the "real-time" connection of interactive video. One cannot ask questions of a video-tape, and the explanations offered on hypermedia applications may or may not address the spontaneous questions of individual students. In short, two-way video technology is likely to be the best means, in the long-term, for providing pre-service students with a common text for discussion of exemplary teaching practices.

While such exchanges are designed primarily to meet the needs of pre-service teacher education programs, the in-service teacher also stands to benefit. Teachers often lack opportunities for ongoing and serious discussion of practice. The daily pressures of work and the fragmented nature of many professional development efforts afford teachers little time to reflect on what they do in the classroom. Furthermore, as researchers have long observed, teaching is characterized by extreme professional isolation, such that many teachers have no idea what goes on in the classroom next door. However, involvement in a project such as a two-way video link with pre-service teachers can begin to break down that isolation, showing both the pre- and in-service teachers that there is much to be gained from professional exchange. The ensuing questions, discussions, and articulations of pedagogical choice-making, can strengthen an in-service teacher's knowledge of practice, particularly when that discussion is carried out over the course of an entire semester.

Although the remainder of this paper will focus of the technical aspects of our project it is important to keep in mind that the work did not evolve solely out of the desire to introduce elaborate new technologies into the classroom. Rather, it emerged out of our commitment to employ technology in the creation of a new form of learning community (Lytle & Cochran-Smith, 1993), one that unites pre- and in-service teachers around a common classroom text. All of our efforts at TATE's technical functioning have been geared towards fulfilling these pedagogical principles.

Technology Implementation of the TATE Project

Set and Setting

The Technology Assisted Teacher Education program links a university-based English methods class with a middle school language arts class, thereby placing pre-service teachers virtually in the classroom of an exemplary teacher, rather than positioning them as passive observers or recipients of instruction.

In the summer of 1996, Dr. Anne Ruggles Gere, of the University of Michigan School of Education, embarked on a pilot project to develop the use of videoconferencing tools in pre-service teacher education.

The groundwork had already been laid towards the creation of an observable field study. Dr. Gere had, for several years, worked closely with Laura Schiller, a sixth grade teacher at Birney Middle School in Southfield, Michigan, one of the first teachers certified by the National Board for Professional Teaching Standards, and she had determined that Ms. Schiller's class would serve well as the focus for the exemplary teaching model. A co-mentoring program was established to provide the undergraduates direct working experience with their sixth grade partners and the sixth graders with personalized instructional feedback. A variety of interactions between undergraduates and their partners were initiated. Dr. Gere's undergraduate class traveled to Southfield to observe the class first-hand. Phone calls between both groups of students and letter writing were other forms of shared communication. This set the stage for the introduction of the conferencing tools.

Working closely with Dr. Gere, the project team defined the instructional goals and set about the task of initial testing and design. The three primary instructional goals of the project are:

(1) Provide pre-service teachers with the opportunity to observe Ms. Schiller's instruction without unduly impacting the class.
(2) Provide pre-service teachers with the opportunity to discuss practice directly with an exemplar teacher.
(3) Provide Dr. Gere and her students with a common observational frame of reference upon which to base their discussions of teaching methodologies.

The University of Michigan's School of Education is fortunate enough to have a state of the art Multimedia Classroom, and we decided that the methods class would be best served by meeting there. This classroom had individual Macintosh workstations equipped with a number of video and audio input devices and the capability to project any station to the large screen.

The Southfield location was, of course, predetermined. We were lucky that Ms. Schiller was extremely adaptable, as standard K-12 classrooms provide some of the worst environments for effective conferencing. We were not without our difficulties, but Ms. Schiller's willingness to configure the classroom in a way to achieve optimum conferencing immensely aided the project.

Delivery System

Initially, the project team looked at low-end IP-based video conferencing applications. Under consideration were Cornell University's CUSeeMe, White Pine Communication's Enhanced CUSeeMe, and Apple's Quicktime Conferencing. All offered a number of pluses and they were relatively inexpensive to implement. However, they were determined to be inadequate to meet the specific demands of the pilot. Color was not of primary concern for our needs, though we quickly realized that students would immediately consider images other than color to be inferior. We needed to have good frame rates and quality video to provide the pre-service teachers with a good observational experience. In many ways the audio quality took on greater importance than the video quality. Packet-switched IP-based video conferencing applications cannot deliver both high quality video at 320 x 240 pixels along with telephone-grade audio, at least not at the time we were searching for solutions.

Budget constraints prevented our serious consideration of high-end land delivery systems or satellite links. We had to look at what was a fairly small number of mid-range price options. We determined that point-to-point Integrated Services Digital Network (ISDN) offered us the best option of delivering acceptable levels of video and audio over standard phone lines. After some investigation, the project team chose a product called ERIS, from RSI Systems, Inc. The system met the majority of our criteria, adhering to the current conferencing standards for audio G.711, G.728, and G.722 with full duplex capability and the common videoconferencing carrier standards. Also, ERIS was totally cross-platform compatible and promised future releases of a computer-free option. The ERIS System also allowed for a considerable amount of flexibility, with multiple video and audio inputs and outputs. RSI, Systems, Inc. indicated that the ERIS 1000 offered scalability, allowing the user to dynamically control the bandwidth dedicated to video or audio. A demonstration system was procured from a local reseller, and ISDN lines were installed at the School of Education and at Birney Middle School.

It is at this point that we must stop and reflect on the difficulties we encountered with our ISDN installation. This is not a trivial matter, and would advise anyone entering the ISDN abyss to understand some of the major pitfalls before proceeding with an installation. Though ISDN is not inherently difficult to install, the issues surrounding configuration and peripheral devices make the installation procedure much more complex. On January 23, 1996 AT&T Network Systems, 3Com Corp., Ascend Communications Inc., and U.S. Robotics Inc. announced the formation of an ISDN Forum to promote the use of ISDN. One of the stated goals of the group was to reduce the complexity of an ISDN installation by automating configuration. Currently an end user has to know their switch type and Service Profile Identifier (SPID). The Forum members plan to develop systems that will automate this process, making configuration much more transparent to the user. The problems we encountered were exacerbated by the fact that we were working with two different providers, our Regional Bell Operating Company (RBOC) and the University's own telecommunication specialists. It necessitated our knowing not only what questions to ask but how to communicate our particular concerns to two different groups. The user must be able to sort through a number of issues. One example would be whether or not a Network Terminator (NT1) is required along with a Terminal Adapter (TA). Basic Rate Interface (BRI) versus Primary Rate Interface (PRI) is another issue that has significant cost and quality implications. Missed communication and the lack of clearly defined responsibilities led to a number of false starts, many wasted hours, and a good deal of anxiety trying to meet deadlines. Our experience has not diminished our faith in ISDN technology, but it has led us to offer up the following bits of advice:

(1) Develop a strong relationship with a responsive person at the phone company who will follow through on your order.
(2) Be sure you order and receive an NT-1 with power supply (if needed).
(3) Be sure all necessary adapters associated with your particular device are purchased.
(4) Order the proper line configuration (e.g. 2B+D).
(5) Make sure you can be present during the line install and that you see the actual test of your line to confirm operation.
(6) Make sure installer does not leave before you receive your SPIDs (phone numbers), dialing prefix (if any), and your switch type (e.g.. Northern Telecom, AT&T, etc.).
(7) Know where your line enters your room.

Many of these points may seem obvious but should not be dismissed as they can have significant repercussions.

Room Configuration

After we determined that our connection was relatively stable, we were able to focus on room set-up, and camera and microphone placement. We used a number of different configurations dependent on the type of interactions we planned. The most common set-up is shown in Figure 1.

At the University of Michigan location we typically had the students sitting around the tables facing the large screen. There were two conference microphones in the ceiling and a headset microphone located at the instructor's station. All microphones were wired into a microphone mixer for manual level control. We had a camera mounted on a tripod in the front corner of the room that had a wide angle shot of the seminar area. At the instructor's station there was a Flexcam used for the one-on-one interactions at the workstation. The room has overhead speakers allowing the audio emanating from the Southfield location to be broadcast throughout the room. The overhead microphones allowed the students to converse with their Southfield counterparts.

The Southfield classroom, as I mentioned earlier, posed more problems. One whole side of the room was window, and this, mixed with the overhead fluorescent lighting, posed color temperature problems for the camera. With some use of the existing shades and putting the windows behind the camera placement helped to eliminate some of the registration problems. The remote image was broadcast over an existing TV monitor hung in the front of the class. The private face-to face conversations took place in the back of the room at the Macintosh computer we provided. Small group observations took place at designated tables and large group interaction usually occurred at the front of the room on the rug.

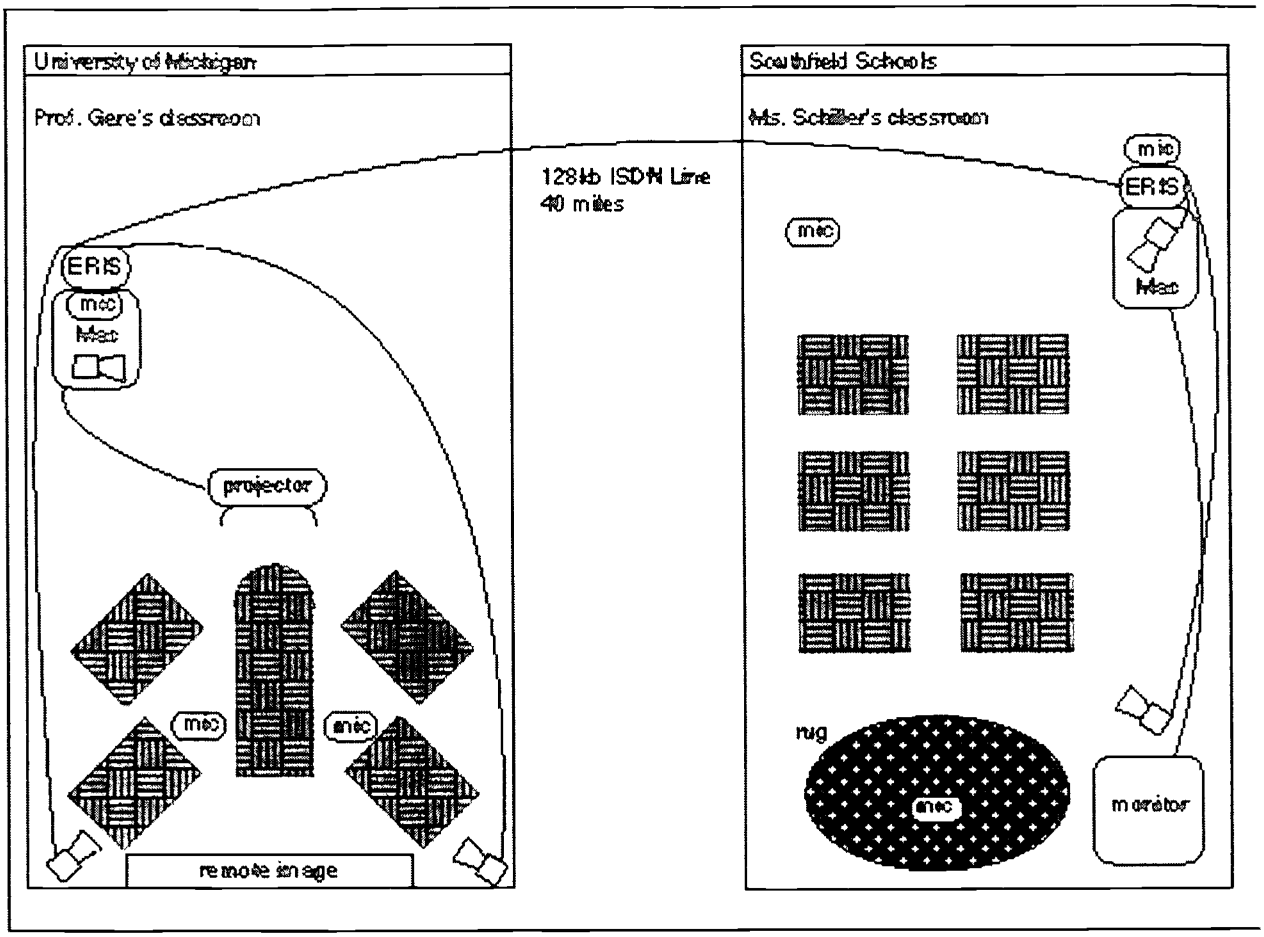

Figure 1. Multimedia classroom and Birney Middle School classroom configuration.

The pilot consisted of six sessions consisting of ten hours of synchronous conferencing. As indicated, a number of different interactions and observations were attempted. The first two sessions concentrated on face-to-face interaction between the Birney students and their mentors at the university (see Figure 2.). The benefit of this particular type of interaction was that it familiarized the students with the equipment and allowed them the opportunity to become comfortable with its operation.

Figure 2. Face-to-face interaction.

The small group observation gave the university students the chance to observe the outcomes of particular methods applications such as self-assessment by the Birney 6th grade students. It also allowed for the observation and discussion of peer interactions. Audio and video segments were selected and delivered to Dr. Gere's students and discussed at length.

Figure 3. Small Group Observation.

The large group to large group interaction was fairly dynamic as both groups could see and speak with each other. This was problematic for the Southfield students however, because their monitor was significantly smaller than the large screen projection the University students were receiving and consequently they had a difficult time resolving who the individual speakers were at the University sight. One attempt at solving this problem was the placement of a small monitor in the group circle at Birney. The University students were able to get a sense of the classroom dynamics, layout, and management issues but the graininess of the image was a disappointment to some.

Many of the sessions started off with individual to group interaction typified by the university students querying Ms. Schiller on various aspects of practice. We could say that this was our most successful connection as far as the audio and video quality were concerned.

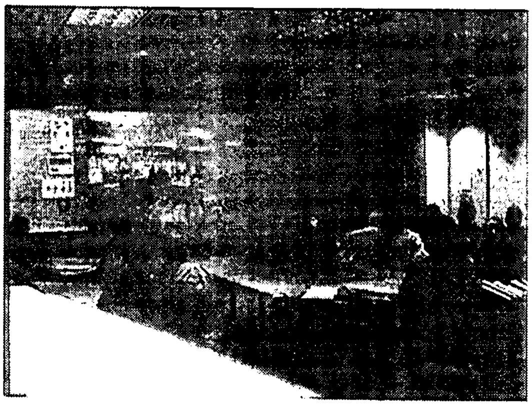

Figure 4. Large Group-to-large-group interaction.

Figure 5. Individual-to-group interaction.

This project is by no means completed, but we have already learned a great deal from it. In addition to what we know about how to work effectively with ISDN, we have also learned the importance of thinking of technology in broader terms rather than simply focusing on the two-way connection. We found, for example, that an occasional conversation via a speaker phone between the university methods class and Ms. Schiller enhanced the video experience. Similarly, video tapes were sometimes useful as the real time connection. After the initial semester of two-way connection, the project team initiated an analysis of the data collected, and that analysis is still in progress. What we can report at this time is that the technology of two-way video has real promise for enhancing the discussions of praxis among pre-service teachers.

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Beginning Russian Course for Distance Learning in Rural Areas of Utah

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This paper deals with the design, development, preparation, and delivery of Beginning Russian, a course taught via EdNet (Educational Network) simultaneously to a class of Southern Utah University students and a concurrent enrollment of high school students at five remote sites of Utah in the fall quarter of 1996. The EdNet and Telelearning Center located on the campus of Southern Utah University in Cedar City, through state appropriations, has been involved in distance education activities for more than 3 years now. It transmits classes to 10 sites in Utah, including both rural high schools and local colleges (Dixie College in St. George). Classes taught on EdNet, so far, include both General Education classes such as Intermediate Algebra, World Geography, and Business core curriculum classes such as Accounting or Marketing. Beginning Russian is the first attempt to teach a foreign language using this new and rapidly developing educational medium.

The reasons for choosing this particular non-traditional foreign language as the first one to experiment with are both objective and subjective. The first reason is that SUU is currently developing a brand new Russian minor program, and the University wanted to make it more visible for prospective students. The second reason is that the instructor of Russian is enthusiastic about new technologies and brave enough and willing to undertake the design and teaching of a telelearning course.

This paper deals with Stage 1 of the project which consisted of identifying the problems and finding appropriate solutions for effective instruction in the following areas:

- Organization
- Training
- Technology
- Methodology
- Psychology
- Teaching strategies
- Evaluation and assessment

Works by McKenzie and colleagues (McKenzie et al, 1996) and Beers (Beers & Orzech, 1996) provided valuable guidance and insight which helped us to avoid and minimize some pitfalls. However, other "gremlins" became evident even at the preliminary stage. The main reasons for this are as following:

1. This is a "mixed" course. There are on-campus students at SUU and high school students at five remote sites in different parts of Utah. This situation required adaptation of the regulrar course and integration of new learning designs and media into the course delivery in order to meet the needs of two student groups meeting in different learning environments.
2. Foreign language acquisition implies gaining both knowledge and skills a fact that makes distance learning more challenging than many other academic disciplines.
3. Russian has a different alphabet. This poses extra problems for computer communication, especially for the beginning class, which does not seem viable both logistically and methodologically.
4. This five-credit hour class is taught every day of the week — a situation that has its advantages and disadvantages.

Organization and Training

Southern Utah University is one of eight higher education "hubs" that connects high schools to universities in the state. SUU allows high school students in the rural areas of Utah to enroll in courses that allows them to earn high school and college credits simultaneously.

The organizational strategy developed and implemented by the SUU Telelearning staff included marketing of the class, selection of the most convenient time slot, and organizing training for all the participants. In addition, the staff worked with the university bookstore to provide textbooks, workbooks, tapes, and extended syllabi for the class.

Marketing was conducted in the spring of 1996, along with other telelearning classes. The result was that students in five rural schools of Utah expressed their intention to participate in the Russian language class with a total of about 25 students planning to enroll. The high number of schools was unexpected since it was not a traditional course taken by high school students. We faced a difficult dilemma, should we limit the class to two distant sites and the on-campus students as was originally planned? Or, should we go ahead and accommodate all the interested students for the sake of promoting the program and try our best to organize a quality instruction comparable to a traditional language class? We decided in favor of the latter alternative, keeping in mind that the class size would decrease during the first two weeks of instruction.

The next step was scheduling. The time slot for the class had to be negotiated so that it would fit into the schedule of the telelearning center, the instructor's schedule, and the five participating high schools. It seemed like an insurmountable difficulty, but thanks to the excellent working relationships between the Telelearning Center and the principles of the high schools, it was resolved.

During the mandatory training conducted by the Telelearning Center, both the site facilitators and the university distance education instructor received all the necessary information (there is a special package developed for this purpose) and had hands-on experience with the support of the Center's technical staff. The instructors had a choice of controlling all the technology in the telelearning class themselves or having a technician (usually a part-time student) do it for them. The Russian language instructor, for several reasons, decided to have a technician working for her — this proved to be very wise. She had her hands free to deal with more demanding problems during the class delivery. Out of five sites, just one (at Beaver) did not have a specially appointed facilitator. However, one of the students successfully performed this function.

The University bookstore ordered all the teaching materials for both on-campus students and distant education students and sent them over to the respective sites in time for classes. The bookstore also provided all the enrolled students with the extended syllabus which will be discussed later on.

Technology

The course was delivered on EDNET, a live interactive closed-circuit television system which connects all the public higher education institutions in the state to over 90 sites in Utah. The class was transmitted to all the participating sites from the specially equipped telelearning classes on the SUU campus. For this particular class we had to increase the number of microphones (one for two students) which was required by the specifics of the foreign language instruction. The facilitators at the sites were asked to pay particular attention to the quality of audio equipment and its proper adjustment to the needs of the class. The telelearning classroom is equipped with a computer, VCR, CD-player, cassette player, and ELMO, which certainly enhanced the presentation of material for on-campus students as compared to a regular class in an ordinary university auditorium. The room also had a telephone and a fax machine which facilitated the communication, especially during tests.

Methodology

Methods and techniques to be used in this course were determined by two major factors: goals and objectives, and the specific needs of the student body involved in the knowledge acquisition. Beginning Russian is defined in the extended syllabus as a "*communicative* introductory Russian language course that emphasizes language proficiency in all four skills of speaking, reading, listening, and writing." The focus on communication as a goal posed incredible difficulties for the instructor as well as the students at distant sites in view of apparent additional barriers for authentic communication inherent in this mode of instruction. However, the temptation to substitute it with a more easily achievable goal of teaching just reading and translation was rejected as doing a disservice to the students, lowering the plank of instruction, and limiting further progress of students' foreign language studies, since it is the initial stage of language acquisition that determines to a great extent the student's attitude towards it.

This goal determined the construction of learning environment as interactive, interpersonal, and communication-centered. The cognitive, constructivist learning theories of language acquisition , as well as the theory of Stage-by-Stage Development of Mental Actions (Galperin & Talyzina, 1976) proved to be very effective for this technologically enhanced medium of instruction just as they are for a more traditional one. It should be noted that it has been very successfully applied to Computer Based Instruction (CBI) and in mathematics as well (Bouniaev, 1996).

Another goal of Beginning Russian is stated as "Introduction to Russian Life and Culture, from history and traditions to geography, facts, and famous people." This goal is actually much more easily achieved in the well-equipped telelearning class where we can view videos, listen to the tapes and CD's, bring pictures from WWW, take a close look at maps and pictures than in a regular university auditorium. In this case, on-campus students can benefit from taking a class in a technologically enhanced learning environment. The goals of the course determined the method and type of instruction as traditional delivery of content with the instructor being not only an information provider but a facilitator of communications and interactions between students both on campus and at distant sites.

The mixed type of student body consisting of both "live' university and high school students, some of whom were more than 200 miles away, required development of methods that would make it into one big learning team where everybody is involved in the ongoing activities. The key methodological elements were teamwork, involvement, cooperation, and interaction in real-time with all students participating as members of *one class.*

Psychological Aspects

Psychological aspects of this telelearning class were considered of primary importance for its success. It is a highly challenging class for both the instructor and the students considering that communication is the goal of instruction and interaction is the mode of language acquisition. Two major psychological issues had to be addressed in designing and delivering this class: (1) developing camaraderie with and between students and minimizing the feeling of isolation at remote sites and (2) finding effective ways to deal with debilitating levels of anxiety which is particularly difficult to cope with in the situation of increased interpersonal distance and exposure to several different audiences.

The emphasis on cooperative learning and communication focus required that special attention be paid to coping with debilitating anxiety which motivates the learner to flee the new learning task thus stimulating avoidance behavior (Scovel, 1978, p. 139).

Camaraderie is an important factor in learning a foreign language since "familiarity, trust, and comfort with others act to boost students' certainty that their actions will be well received and their attempts at communication will be welcomed, or at least not ridiculed or scorned" (Pellegrino, 1996, p. 7). Several important elements helped to create this atmosphere of comfort:

- Every student in the class had to choose a Russian name for himself or herself, thus "hiding" their own personalities. This turned the class into a play, a stage, a different reality. It was interesting to observe that after some time the students started calling each other their Russian names even out of class.
- Before the beginning of each class, students from different sites could ask each other questions, find out some personal information such as likes and dislikes, sports, and hobbies, which also helped to create camaraderie.
- At each site students were encouraged to work as a team or in several groups and respond to instructor's questions together rather than individually. The initial stage helped timid and shy students to become involved in the active process of language acquisition in a "cushioned" environment.
- The class atmosphere was relaxed and humor played an important role in setting the mood of the class in order to establish a more personal relationship with students which made it seem less like "virtual" reality
- The instructor took trips to visit the three largest groups of students in Escalante, Orderville, and Bicknell. Meeting these students in isolated villages of Utah was one of the most gratifying experiences in the teaching career of the instructor and helped to establish a live bond with the students.

The developed psychological strategies included all the above mentioned elements of creating psychologically comfortable learning environment with the special emphasis on correction techniques. As Pellegrino states: "Aggressive correction, mocking, quick or elevated speech, and condescension are frequently cited examples of others' behavior that can cause students to feel more certain of negative results" (Pelegrino, 1966, p. 7). The students' corrections were in the form of either explanation of a particular grammar rule and then all the students were asked to repeat the correct version in chorus or just the latter. Therefore, correction of mistakes was a shared learning process. It was also a cognitive learning process since the student had a very clear idea of what mistakes were made and the correct way to do it.

It should be noted that all students were supposed to participate in this work, not only on-campus students or students at some particular site. Unfortunately, it did not work this way all the time because students got distracted. However, the instructor consistently tried to implement this strategy.

Another important component of the efforts to minimize the anxiety was the testing technique. Since it is the final result or outcome that is important in any foreign language acquisition, intermediate tests (five during the ten-week quarter) were not graded and students did not gain or loose any points for their final grade in these tests. The test was called "control work" which was undertaken to check their language progress and indicate both to them and the instructor what things should be reviewed again (memorized, practiced, etc.). The tests were thoroughly analyzed in class and distance students then mailed them to the instructor for the second review. This effort definitely helped to decrease anxiety and fear of failure, and helped to establish a healthy attitude to tests, correction of mistakes and learning progress in language studies. The students actually knew how they were doing but they did not get discouraged (which is a very common thing in foreign language studies) or felt that they had decreased or even ruined their chance for a good grade at the final exam.

This strategy was especially important for on-site students since they feel much more intimidated by tests than on-campus students due to the physical absence of the teacher. They could not ask her any questions without the whole class knowing about it, they could not get an encouraging smile or whisper like "you're doing great", etc. which provides psychological support in a stressful test situation.

Another way of dealing with debilitating anxiety, especially at the beginning level of language acquisition, is dispelling students' misconceptions about the Russian language. Students in the rural part of Utah, like many other Americans, possess a myriad of myths about the difficulty of Russian — especially its non-Latin alphabet, grammar, and vocabulary. One of the first things to do in the beginning Russian class is to dispel these misconceptions so that meaningful learning can begin. During the very first class students found out that they already knew about 120 Russian words -- "international" words like bank, telephone, business, doctor, actress.

In the second class, students learned half of the Russian alphabet (letters that are the same as in the English alphabet). Consequently, they learned the alphabet in less than a week and started to read after the third class. This helped to lower the level of anxiety and to implement a correct understanding instead of misconceptions. Dispelling the socio-linguistic and cultural misconceptions of language learning in the process of class instruction is especially important for distance education students. Very often it is their only accessible source of information. On-campus students can come to the instructor's office, ask numerous questions and get support, they also can interact (and they do) with Russian exchange students, none of which is available for students in far away rural areas of Utah.

Teaching Strategies

Enhanced multiple teaching strategies were designed from the psychological theories that would facilitate teaching both "live" students at SUU and distant learners. Some of them were already described in methodology and psychology parts of this paper. The basic concept is multifaceted interaction, group work, cooperative learning (different levels of cooperation) and active participation and communication of the whole class (both "live" and distant students). Feedback strategies were particularly important for this mode of instruction and were given special emphasis. These included encouragement, validation, assessment of students results, and active intervention to provide suggestions, comments, and clarifications. Back-up support included video-taped classes, audio tapes, and one hour a day "hotline" (dial up) for students' questions. Extended curriculum was prepared to serve as a guide for better organized learning. Teaching materials, which included a textbook, a workbook, recorded audio tapes, videotapes, and hand-outs, were carefully selected with the view of their appropriateness for both traditional and distance learners.

After two weeks of instruction it was clear that on-site students needed some extra time to ask their questions and to get some more practice on a one-on-one basis with the teacher. The unusually large size of the class (52 students) made it necessary to have at least one extra tutorial class for distance education students. These students, unlike on-campus students, did not have access to a Russian tutor four times a week and the instructor's help during office hours. Every Tuesday for the next eight weeks, on-site students could talk to the instructor and get the necessary help. The high school students seemed to enjoy and appreciate this tutorial class that was held just for them.

Assessment and Evaluation

Special questionnaires were developed to assess and evaluate the course. They were distributed among distant learners and on-campus students. Because the class is still in progress at this time, the results of this effort will be known later on in the year.

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New Found Resources in Distance Education: Museums Create Rich Environments

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The Pennsylvania State Museum has been conducting educational workshops and seminars for K-12 schools for years. To access these programs however, teachers have had to physically take their classes to the museum in Harrisburg, Pennsylvania. The limitation of distance has significantly decreased the number of schools that have been able to take advantage of the resources available at the State Museum. The Northern Tier Rural Distance Learning Consortium, initially composed of six rural school districts and three colleges from rural northeastern Pennsylvania, is predicated on sharing educational resources over vast distances. The combination of distance education technology and the resources of the State Museum has made the collection at the museum available to a much larger audience. This paper outlines the background of the Northern Tier and the subsequent inclusion of the State Museum as a partner. It also addresses some of the logistical problems faced by museum staff in preparing for presentations.

Background

In 1994 the Northern Tier Rural Distance Learning Consortium began a seamless exchange of resources using video-conferencing (Freeman, 1996). The original consortium was composed of six rural school districts and three colleges located in northeastern Pennsylvania. Lackawanna Junior College, Scranton, PA serviced the consortium as the original two-year higher education institution. College Misericordia, Dallas, PA and Penn State Wilkes-Barre, PA campus were the original four-year higher education partners. Both Misericordia and Penn State have offered undergraduate courses to advanced placement students in participating districts. In addition, the school districts in the consortium have utilized their distance education equipment to share unique and typically underpopulated high school classes such as Japanese and Aviation.

The consortium uses a compressed-video infrastructure to conduct interactive video-conferencing. All participating institutions have installed a Picture*Tel video-conferencing classroom system which is the focal point for transmission and reception of information. A typical system includes several devices for transmitting educational information such as a document camera which can be used to view overheads or three dimensional objects; a computer which can be used to project anything that appears on the computer screen; VCRs for broadcast of videotape; and two cameras which are used for face-to-face contact. These devices have forced distance educators to format their classes for presentation using the technology. Although this may seem to be a barrier, teachers have embraced the opportunity to enliven their presentations utilizing the new technology. The success of the distance education consortium has provided a foundation for additional funding received through a federal challenge grant. As a result, "the consortium will establish links with 60 video-conferencing sites in New Jersey, New York and other parts of Pennsylvania, greatly broadening its potential" (Freeman, 1996, p. 30).

The State Museum as an Outside Resource

Although the primary goal of the consortium is the exchange of classes to strengthen the curriculum, participants have continuously sought alternative uses for the technology. One such alternative has been to access the educational programs provided by the Pennsylvania State Museum. Although the museum's educational programs have serviced many schools over the years, teachers and students have typically had to rely on field trips to access the programs. Distance education technology has the potential to remove these barriers.

Through funding provided by the Northern Tier and a grant from Bell Atlantic, a system was placed at the State Museum. Grant funding provided initial training for museum staff, follow-up support from College Misericordia personnel, and a salary for an on-site technical support staff person who is responsible for the museum's Picture*Tel system.

The planning committee for the museum project decided that the first offering by the museum would be a workshop on archeology. Since the system that is located at the museum is a classroom system which limits its portability, the museum's staff was faced with the daunting task of converting their teaching materials to a format suitable for transmission via compressed video format.

College Misericordia personnel used a Sony Hi8 camera to record artifacts, dioramas, and displays, that are the focus of the archeology workshop. The college staff then used a Targa 2000 video capture board to digitize the video tape. Frames of the video were exported as graphic files for use in Power Point. In addition to presentation graphics, the museum staff uses hands-on kits containing simulated artifacts which are mailed to the participating classroom prior to the presentation. During the presentation, museum staff use the document camera to show three-dimensional artifacts and computer graphics to show digitized images from the museum's displays and dioramas. When the presenter makes a reference to a specific artifact, he/she asks the students to refer to their collection of simulated artifacts. This technique offers a hands-on approach even at a distance.

Summary

As a follow-up activity, College Misericordia's Education Department will be sponsoring a collaborative project in the spring of 1997. Faculty members from the college will work with K-12 teachers and students to build upon the archeology workshops offered by the State Museum. Suggestions such as creating cross level teams who will work at actual archeological dig sites are currently being considered. The follow-up project will help pre-service teachers to identify ways to incorporate outside resources in their classrooms.

Teachers in the distance education consortium are eager to participate, and view the opportunity as a chance to enliven their curricula. The inclusion of outside resources, such as the State Museum's collection provide ideal opportunities for creativity to soar and for students to experience a fascinating world of applied knowledge.

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You Can Get There from Here

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There is a lack of cultural appreciation and knowledge of diversity among faculty, students, community, and the service area of the State University of West Georgia (SUWG). In this immediate geographic area, migration has typically been outward. However, during the next 30 years, immigration from Latin America, Southeast Asia, Eastern Europe, and Africa into Georgia is expected to triple. Studies show that during 1993-1994, 7,520 foreign graduate students studied in Georgia. 1,466 jobs were created as a result of foreign students, and 28,105 language minority children were enrolled in Georgia public schools. Therefore, Georgia's current and future educators need to have hands-on experience, skills, and tools to promote curriculum and learning environments in which awareness, legitimacy, and significance of diversity within cultures are celebrated. Changes and additions to the teacher preparation program, as well as preparation for successful communication in all areas that deal with human relations, will be a major focus of the future at SUWG.

In order to meet these needs, SUWG, with a service area of 44 counties and a student population of 9,000, has instituted a three-course ESOL (English to Speakers of Other Languages) sequence to assist those teachers directly involved with the education of language-minority children. These classes are transmitted via GSAMS (Georgia Statewide Academic and Medical System) to the various school districts. Teachers who typically do not enroll in the three-course ESOL endorsement sequence, require exposure to and information on the nature of culture/acculturation, language acquisition, and the methods appropriate for use in the classrooms.

Language programs typically impact only students attending school. However, they do not represent the actual number of families living in the area or the gaps in cultural differences felt in many communities — especially those communities where few families have the opportunity to visit other cultures. Although many travel videos and textbooks relate topography and some local traditions, they do not take the place of actual experiences. Furthermore, students and educators visiting foreign countries often have superficial experiences because they stay in hotel and visit sites from a tourist bus with barely enough time to explore the real setting.

Technology and Teacher Education

In order to bring about substantive change in communities, curriculum reform must involve changes in the teaching of cultural diversity. The anticipated project will send six university instructors from several departments within the university on a three week cross-cultural experience to towns and cities in Mexico. Mexico was chosen as the first country or residence because 61% of students in the university's service area are Spanish speaking. The SUWG instructors will immerse themselves in the local culture by living with a Mexican family and becoming participant- observers in school and community activities. Before the field experience begins, a preparatory in-service session will focus on awareness, legitimacy and significance of different ethnic and cultural identities, as well as tools and skills for data collection.

In following years, the project will expand to include undergraduate and graduate students at SUWG who are or will be practicing teachers, counselors, and administrators. In order to give more depth to this project and to provide faculty and students with more knowledge of various cultures, other regions and countries within North America will be included. SUWG ranks 7th in the nation with the number of students completing undergraduate teacher preparation programs and 14th for graduate students. Therefore, this proposed reform has the potential to become far-reaching, and it is possible that other institutions will replicate the program.

This program takes a quantum leap from existing programs and impacts the whole service area of the university. It gives the participants action-oriented hands-on experiences to deal with and understand the diversities within cultures. The learners will share their first-hand experiences through several modes. For example, a professor can be linked with the university closest to their location and can conduct classes using a software program such as CUSeeMe, or satellite transmission, or e-mail. Students and community members can ask questions and discuss concerns, myths, and stereotypes with the professor.

Immediate feedback to such questions could provide a real break from preconceived ideas, and students in teacher preparation programs and graduate programs could gain a more realistic picture of other cultures. School children, relating to their peers and parents what they have learned in school about diversities in cultures, can assist in ending prejudices and/or allow for a better understanding of differences. An enhanced curriculum can provide a means of drawing people together into a more humanistic and caring environment, responsive to the diversity within a community.

Other universities could easily replicate this program. Furthermore, other colleges within a university or departments within a college could also have a stake in the program. The benefits of this program are more far-reaching than just universities, because present educators, future educators, and communities would benefit; affecting, in the long term, thousands of individuals.

Improvement Through Technology and Travel

In the past, pre-service and in-service educators have had limited multi-cultural education courses. With an increasing need to infuse multi-culturalism into the curriculum, instructors in all areas of education need knowledge of language and culture to incorporate into content specific courses. The willingness of teachers to change their teaching and to incorporate diversity into their lessons is a stepping stone to success. In the first year of the project, those university instructors who took part in the three-week cross-cultural residency would upon returning, revise existing course curriculum and incorporate this information into their courses. The faculty, would then become a model for curricular change. This first year would produce major reforms in curriculum and pedagogy. In the second year of the program, selected in-service teachers would revise and improve the existing curriculum with their experiences. An introduction to diversity may be more important for those children who live in predominantly mono-cultural settings because these children will be ill-prepared to function in a society that is becoming increasingly culturally diverse.

The SUWG is committed to its revised university mission statement of September, 1996 — "affirmation of the equal dignity of each person by valuing cultural, ethic, racial, and gender diversity ..." and endeavors to "provide significant opportunities for student involvement and field-based experiences." The primary objective of this project, which is to produce curriculum reform in the area of cultural relevance, reflects the focus and mission of our university. Through the evaluation process below, we will validate the effectiveness of the project.

Evaluation

The researchers are examining diversity within cultures and participants response to the diversity. Qualitative techniques are useful for capturing the richness of experience and are highly appropriate to this study, and since experiences will differ from individual to individual, evaluation will require detailed descriptions. Assessment the first year will be a goal-free, process evaluation using qualitative techniques of inquiry (Patton, 1990). Goal-free evaluation allows researchers to gather data on a broad array of actual experiences without narrowing the study to preconceived outcomes. Outcomes will naturally emerge and will eliminate the possibility of missing important unanticipated events. Goal-free evaluation relies heavily on description and direct experience with the program, and most critically, on suspension of judgment about the program. It concentrates on discovering what is actually happening in the field. Process evaluation is dynamic, emergent, and fluid and focuses on experience and feelings of the participants. Such evaluations are useful in programs in which dissemination and replication at other sites are desired. Second and third year evaluations will be formative and summative, respectively. The formative evaluation will focus on program improvement; summative evaluation will focus on program effectiveness.

Data will be collected on participants' experiences and on their three week residency. Participant data will include (1) Pre/post trip feeling's about diversity . The Expressive Autobiographic Interview (EAI) technique will be used to gather this data. The EAI technique permits the interview to selectively evoke feelings with a flexible and chronological self-centered framework. (2) A reflexive journal kept by each participant. (3) Observations of participant classrooms to evaluate the impact of cross-cultural experiences. Cultural data will include participant field notes, a video, or videos, of community and school activities recorded by participants, and nominal group session of students at the SUWG who view the films of the field experiences.

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Digitized Multimedia and Distance Learning: Do They Mix?

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As a state university with a mandate to provide opportunities in higher education throughout the northeast corner of Ohio, the Kent State University system includes seven campuses. Some of the six branch campuses are well over an hour's drive from the main campus, and a few are almost two hours away. This part of the country also experiences severe winter weather for several months, making driving conditions rather hazardous at times. Travel between the regional campuses and the main campus, where most of the coursework is offered, can be inconvenient and time-consuming. Providing more coursework at regional campuses via a distance education system makes a great deal of sense.

The "LearnLink" Project

Two years ago, the university established a distance education project to connect all seven of its campuses. After considering the use of full screen two-way television, it was decided instead that the system would be computer-based, with a compressed video component. Partners in this project were IBM and a software company named ILink that had developed computer software for transmitting data across networks. Kent State became a beta test site for this "LearnLink" software, and several courses have been taught at multiple sites using this approach. The term "Distributive Learning" distinguishes this computerized approach from television-based systems which are generally referred to as "Distance Learning."

Each campus will have its own Distributive Learning Classroom. This special classroom is essentially a networked computer laboratory with compressed video capability. Beside each computer is a small color camera with microphone. A part of the computer screen is used for low quality television transmission between participants. The instructor can control who appears onscreen in the video box and what computer screen will appear on all of the students' computers. Students can signal the instructor via the network that they would like "the floor," as it is termed, and they can appear in the video box on everyone's computer. In addition to communicating on Kent's own network, there is access to the World Wide Web through Netscape.

LearnLink supports the Toolbook authoring language, so lessons for this system need to be developed in advance, using Toolbook. The faculty who have offered to teach as part of the pilot phase of the project, including the presenter, have each been assigned a programmer to help them develop lessons. In this way, multimedia lessons have been developed to use for distance education, which include sound, still pictures, and video footage. Kent State's system can provide extremely dynamic forms of lively, interactive instruction that students at remote sites can use, at their own pace, each sitting at their own computer. This "Distributive Learning" system has tremendous instructional potential.

The Potential of "Distributive Learning"

What is the potential of such a system? First of all, the system is computer-based, so it can deliver instruction that takes advantage of the computer's considerable capabilities. One of these advantages is that instruction can be systematically planned in advance and developed carefully, following principles of good instructional design. The lessons, once developed, can be used repeatedly by students in subsequent classes. These lessons can be revised and improved, based upon instructor and student reactions to working with them. They can be made highly interactive. Students can answer questions and receive feedback regarding their responses. The computer can also encourage them, when they are doing well. When they are not, the computer can provide hints and remediation. It can also branch to other parts of the unit, if the material is either too difficult or too easy for the student. Students can move at their own pace through the unit. Instruction can, in this fashion, be highly individualized (Hannifin & Peck, 1988).

Today's powerful computers have the ability to provide a wide variety of different types of materials. In addition to text, pictures, sounds, and video materials can be incorporated into the lessons. These digitized multimedia materials can enliven a lesson. The visual material can help clarify key points. Audio can also be very helpful, especially for topics like music and language instruction.

In addition to being able to present video segments, the LearnLink system provides a window on the computer screen where a compressed video signal is shown. This signal comes from a small camera, with a microphone, placed next to each computer. This way students can see and hear the instructor, or any student who takes control of the system. This feature allows for face-to-face interaction between participants. Discussions can be held, and participants can get to know one another. It can significantly enhance the social dimension of this type of class and provide a more personalized experience than some other forms of distance learning.

Delivering this instruction via telecommunications lines to students at remote sites has several potential advantages. For the students at remote sites, they need not travel long distances. Because it is more convenient, other students in these locations may decide to enroll. Students who otherwise might not consider pursuing studies at the college level might take advantage of these opportunities (Willis,1993).

Hopefully, this experience will also benefit the instructor. If the equipment is user-friendly, the teaching experience could be similar to working in a self-contained classroom. Some might find it interesting to teach across multiple sites and meet the challenges associated with this experience.

Overall, the system has obvious potential benefits for students from the regional campus sites. It also may contribute to faculty development. The university itself might benefit considerably. Kent State may be able to augment its offerings at regional campuses and expand enrollment. Higher enrollment would increase income and would also help the institution fulfill its mission to bring higher education to the entire northeastern corner of the state. If LearnLink is ultimately used by other universities, Kent State might be able to market the courses it has developed for use on the system.

The Challenges Faced by "Distributive Learning"

The considerable potential of "Distributive Learning" is matched only by the magnitude of the challenges it faces. The more technically sophisticated a system is, the more prone to glitches it is. Providing computer-based instruction for entire college level courses is a ambitious venture to begin with, even without the additional challenge of trying to send it across telecommunications lines.

To begin with, the project is based upon the assumption that a significant percentage of the average college course should be delivered using computer-based instruction. Most university courses, based upon lecture or discussion, are essentially an exchange of ideas between participants. Whether this exchange can be replaced by computerized activities is debatable. Artificial intelligence is not developed to degree where a computer can effectively replace an instructor as discussion leader. Much of the material described in lectures could be provided as computer text, but reading lecture notes hardly seems like something worth the trouble it takes to create them.

Today's computers are capable of providing more than just text, however. The LearnLink project plans to develop exciting lessons that use the full capabilities of the computer. Instructors are being encouraged to digitize pictures, sounds, and video, as well as text. But multimedia lesson development demands creativity on the part of the instructor. Many college instructors are not used to using non-text materials in their classes and they may be unsure how to effectively do so. Furthermore, very few college instructors will have the computer programming (or "authoring") skills necessary to computerize their class materials. Programmers need to be employed for course development. The process is time-consuming. It can all get quite expensive.

Furthermore, to use commercially available materials, copyright permission must be obtained. This requires further time and effort. At Kent State, librarians are being asked to assist in this process. Publishers can be very concerned about the dissemination of their materials on-line. Apparently, some have claimed that even printed material in textbooks already purchased by students for the class is subject to copyright clearance.

Multimedia files also require considerable computer memory and processing power. Used to any great extent, they may tax the capabilities of the equipment in the laboratory. In demonstrations of the LearnLink system that have used extremely large video files, there have been problems with machines crashing.

Another problem associated with the amount of processing required by large lesson files is sending them across a network. A considerable degree of bandwidth is necessary. The Kent State system local area network has its limitations, in this regard, as do the T-1 telecommunications lines used to send signals between campuses.

Distance education poses its own set of challenges. Students at remote sites typically find it more difficult to pay attention, ask questions, contribute to discussions, get assistance, and get to know the teacher (Tiene,1997). Working with students at remote sites is problematic in the Distributive Learning system, for several reasons. In attempting to overcome these disadvantages, a system should provide as realistic a set of signals as possible from the teacher's classroom. However, in the Distributive Learning system, the compressed video signal is jerky and lips do not synchronize with sound when people talk. The audio part of the video signal is also on a delay. Students must wear headsets to hear it clearly. (In the teacher's classroom this becomes somewhat distracting, since the instructor's voice comes back in the headsets several seconds after the students actually hear it).

There is another problem associated with assisting students at remote sites linked to Kent's Distributed Learning system. The LearnLink software does not yet enable the instructor to see student computer screens, except in "snapshot" still-frame form. This still frame can only be initiated by the student, using a different piece of software expressly for this purpose. In addition, the instructor cannot demonstrate educational software on the system, other than Toolbook files, since it cannot be processed by the LearnLink software that transmits data throughout the system. These capabilities are promised by ILink software developers in the near future. But, for now, these limitations have affected the way in which instruction can be delivered.

It is hoped that many faculty members will enthusiastically participate in the Distributed Learning project at Kent State University. So far, participants in the Pilot Project have been selected from applicants who are given a stipend to cover the extra preparatory time and effort associated with preparing course materials for the system. Whether future faculty will volunteer and whether monetary incentives will be necessary, remains to be seen.

It will be interesting to see if this project allows the university to expand its course offerings and increase enrollment. The cost-effectiveness of the project will depend largely on its doing so. If the LearnLink-based system for Distributed Learning is successful and is adopted by other universities, Kent may eventually be able to sell some of the courseware it has developed, as a pilot test site for the system. Hopefully, the system will live up to its potential and can provide a highly dynamic form of college level instruction across an entire section of the state of Ohio.

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LIVE Project - Learning In Virtual School Environment

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The LIVE (Learning In Virtual school Environment project) means research and development of pedagogical models for distance teaching practice in school classrooms. These models help a learner improve information processing and cooperative learning in an open, virtual school-like learning environment. The LIVE project expands a multiple media learning environment and makes it possible for learners to document events and processes outside school. The equipment used enables the flexible, mobile use of audio conferencing, fax, and Internet services. As a result, the distance education network becomes an open virtual-learning environment — independent of time and space.

This article describes a research and development project carried out in a distance education classroom at the Media Education Centre of the Department of Teacher Education, University of Helsinki. The pedagogical decisions are based on the constructivist learning concept in an open and flexible learning environment. Special attention has been paid to the possibilities of using interactive telecommunications in learning situations, especially in videoconferencing. In teacher training, student teachers can include distance teaching practice in their studies which acquaints them with pedagogical decisions regarding distance teaching.

As the result of distance education development at the University of Helsinki, there is an ISDN-based school network consisting of the University, teacher training schools, and small rural schools. The schools in the networks are connected by three ISDN lines which enable the participants to communicate by video conferencing and/or audiographics. Instruction is further supported by telefax and electronic mail.

Theoretical Framework

The theoretical framework of the LIVE project consists of three concepts: (1) virtual school, (2) constructivism, and (3) cooperative learning. A virtual school can be seen as:

> ...an information system based on new information and communication technologies, which is able to deal with all the tasks of school without the need for a physical school building. Ordinary physical school and virtual school may also complement each other, i.e. exist in a symbiosis... part of the activities of physical school may be moved to virtual school and carried out there with the aid of information and communication technologies. (Tella, 1995, pp. 14-15)

The concept of virtual school can be linked with the idea of a flexible and open learning environment. Flexibility means independence of time and space, while openness can be seen as the learner's ability to make decisions in a learning situation. A learner can choose the learning materials, the topic, the learning group, or set his/her own learning goals. Such a learner-centered model is based on the constructivist learning concept, which stresses the learner's responsibility and activity in the construction of his/her own knowledge.

Keegan (1996) and Tiffin & Rajasingham (1995) point out that in virtual classrooms, face-to-face interaction at a distance is electronically re-created. Therefore, a learner must reflects on his/her actions with regard to the surrounding electronic reality and especially to the group he/she belongs to. Through reflection which takes place in social interaction, a learner can expand his/her knowledge about the foundations of his/her own actions. In telematic networking this can mean common problem solving in a computer conference or interactive video conferencing between two groups of learners.

While it emphasizes the role of the learner, the constructivist learning concept also changes the pedagogical decisions of the teacher. According to Rauste-von Wright (1995, p. 121) the constructivist learning concept inevitably leads to the emphasis of flexible teaching which pays attention to learners' skills and abilities. From the teacher's point of view, this means a new kind of media planning, where situation-based interaction and flexibility in terms of time and space are central factors in pedagogical decisions. In the LIVE project, the students and the teacher together plan a learning unit, where common and individual learning goals and contents are defined. Special focus is directed toward student interaction and how it can be improved by portable telecommunications.

Modern information and communication technologies (MICT) make it possible to interact in an open and flexible learning network. In turn, this helps students grow into independent learners, because they take responsibility for their own choices and decisions in a cooperative learning environment (Sariola, 1995). Cooperative learning differs from the conventional pedagogical approach which stresses cognitive goals and the role of the teacher and puts a strong emphasis on social aspects and common goals in learning. In cooperative working, interaction takes place mainly between learners and depends on the nature of the task.

Some cooperative learning methods call for more teacher direction than others, but all of them enable students to interact in varying degrees and talk about what they think, know, and feel about what they are learning. In addition, when students study together in small groups, they help each other and, at the same time, develop self-direction and responsibility for their learning. (Sharan & Sharan, 1994, p. 97)

The use of new technologies increases the learner's ability to move about in real life situations without losing the connection to his his/her cooperative group. When it comes to the whole school, it would be more meaningful if the working models of teachers and the whole organization were cooperatively-oriented. Such an organization could be called a cooperative school (Johnson & Johnson 1994, pp. 59-62). When this model is combined with MICT, it is possible to talk about a cooperative virtual school.

What is LIVE?

LIVE is a three-year action research and development project. The aims of the project are to research and develop: (1) pedagogical networking models in virtual school environment for teacher education and, (2) working methods and practices for cooperative learning in an open learning environment supported by modern information and communication technologies.

Research data will be obtained by participatory and other observation methods, by video recording learning situations, and by analyzing the contents of audio conferences and e-mail communication between learners.

The developmental perspective comes from the fact that the school has been criticized for its slow adjustment to the changing needs of society. On the other hand, Finland has introduced a plan entitled "Education, Training and Research in the Information Society: A National Strategy." One of the main objectives of the strategy is that "The whole education system will be brought within the reach of information network services, ensuring that educational establishments can use these services. Open and distance learning will be promoted at all levels of education and training" (The Finnish Ministry of Education, 1995). Similar reports have been published in other European countries and in the United States.

The LIVE project expands the MICT-based learning environment and makes it possible for learners to document events and processes outside school with portable communications equipment. This equipment enables the flexible, mobile use of audio conferencing, fax, and Internet services. The use of MICT can support and link several groups of learners together in a synchronous telecommunications network. As a result, the distance education network becomes an open virtual learning environment, independent of time and space.

With the development of MICT, it is possible to create so called LIVE groups. These groups, equipped with integrated mobile communications equipment, can move around in real-world surroundings and transmit real-time two-way messages. A similar idea, studying real-life situations and problems in distance learning, is taken by the Impact North Carolina Project at the Appalachian State University where "Students learn to plan, cooperate, present and deal with real-world processes, and problems that are models of the kind they'll find outside the classroom"(Strom, 1994, p. 13).

This expansion of the virtual learning environment enables fast synchronous interaction between school and surrounding reality. In the development of a virtual school, this means an improvement for the learners. They can follow changing processes in the world on location, transmit information quickly from place to place, process the information in real-time communication, and store the data for later investigation. All of this can lead to better understanding of the course content, which in this case, comes from the world outside school. Through cooperative working, an individual learner can create his/her own learning space for developing his/her information processing skills, problem solving, and understanding. Cooperative virtual school expands classroom-focused videoconference lessons and creates a more flexible learning environment (Husu, 1994; Meisalo, 1996).

Technological Environment

The use of the latest telecommunications equipment in the LIVE project means that learners should have the basic skills in MICT. Mastering different levels of usage in computer-mediated communication and telematics management can be described in Figure 1.

In the LIVE project, the technological environment is built on the use of several simultaneous telecommunications systems. The schools in the distance teaching network have been connected to each other by three ISDN lines which enable the participants to communicate by video conferencing or/and audiographics. For sending material, the instruction is supported by telefax and electronic mail. Learners are connected to each other in real-time interaction by mobile phones and lap-top computers or by integrated mobile communicators (Nokia Communicator 9000). Learning resources are supported by WWW tools available in the same virtual network.

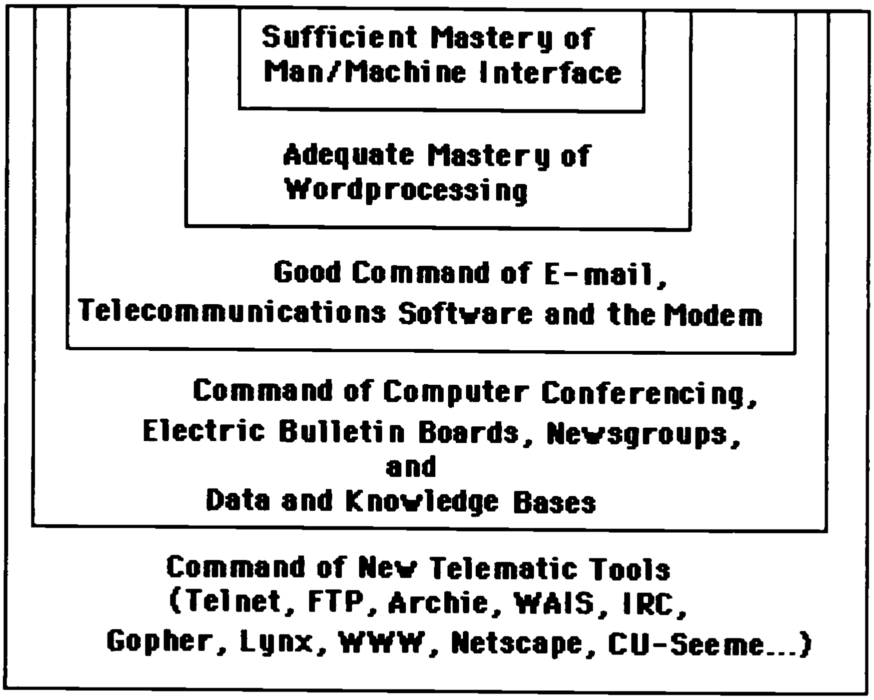

Figure 1. Levels of usage in computer-mediated communication and telematics management (Tella, 1995, p. 22).

The Nokia 9000 Communicator combines digital voice and data services and personal organizer functions into a single, small-sized and unit. In addition to voice calls, the Nokia 9000 Communicator enables users to send and receive faxes, e-mail and short messages as well as access Internet services and corporate and public databases. It also provides users with organizational functions such as an electronic calendar, address book, notepad, and calculator.

All the applications in the Nokia 9000 Communicator - phone, fax, address book, e-mail, Internet - have the same user interface. For example, to send a fax, the user presses the fax application button, writes a note and selects a recipient from the address book. The user can readily confirm a phone call by fax or a follow up a fax by phone call. When the keyboard is closed, the communicator can be used as a GSM phone. When the device is opened for using the keyboard, the speakerphone is activated, allowing the user to view documents from the LCD screen while speaking (Nokia Cullular Data Customer Support).

At the moment, the development of MICT is directed towards advances in mobile communication technologies. In the near future, this development will lead to a situation where communicators can be connected to each other from and to anywhere. Telephone and computer will integrate into one MICT tool. Businesses, homes, and schools can use cordless local area networks called DECT (Digital Enhanced Cordless Telecommunications). The DCS 1800 phone (Digital Cellular System for 1800 MHz), with multiple data transfer capacity (even 100 Kb/s), will be on the market in European cities in 1997. This makes it possible to transfer full-motion video to mobile phones.

As GSM phones have had audibility problems outside cities, satellite GSM phones will be tested in the next few years. The new telecommunications system will use so called dual-mode telephones, which can connect to twisted-pair telephone networks or satellite links (Yrityspuhelin, 1996, pp. 28-30).

Pedagogical Applications of the LIVE Project

The development of pedagogical applications in the LIVE project is part of distance teaching practice at the University of Helsinki. Students in both class teacher and subject teacher education become familiar with pedagogical media planning and cooperative learning methods during the teacher training period. At the beginning of each training period, students are divided into working pairs who then create their own telecommunications networks called teleteams. The members of a teleteam plan a teaching unit and evaluate their own work with help of e-mail and other telecommunications tools and at the end of the course, collect a team portfolio. As a result, teacher training takes place partly in a telecommunications network formed by the students and the teacher trainer.

The working methods and practices during the project are called LIVE working. Working consists of three levels:

LIVE Level I

At the beginning of work, learners plan together the contents and goals on the basis of the chosen topic. Next, they form cooperative groups with tasks focused on the same goal. Learners are divided into a local group at school and into a LIVE group. The local group searches for background information from the Internet and other sources while the LIVE group collects real-time information outside school. The first level work can, for example, deal with news. The groups communicate via audioconferencing or e-mail. Finally, the groups evaluate the learning process together. Learning experiences are written down in learner portfolios.

LIVE Level II

A distance learning situation is built between two schools and the LIVE groups at LIVE Level II. Work starts with joint planning during a videoconference. The learners in each school are divided into the groups, like Level I, and start to collect and process information.

Both LIVE groups communicate via audioconferencing, collect the information into e-mail messages to all the members of the network, and give audio information to both schools. The role of the LIVE groups is to act as telematic expert groups in their own learner networks. The role of the local groups is to collect further information about the topic from sources at school or from the Internet and ask the LIVE groups for reality-based corrections and explanations about the topic. Level II work could deal with regional geography, for example, and the final product could be a joint report on the topic. Figure 2 shows activities in LIVE Level II.

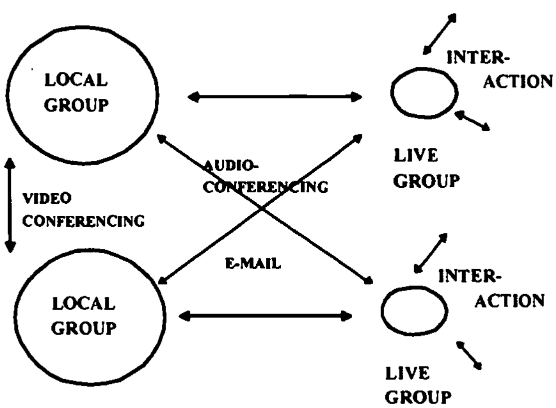

Figure 2. LIVE Level II.

LIVE Level III

At Level III, the nature of telecommunications changes into interactive multimedia. With integrated communications equipment, it is possible to transfer text, pictures, sound and full-motion video effectively. With LIVE working, this means getting real-world situation on video and transmission directly to other learner groups.

A learner can combine audio or video conferencing and audiovisual materials from the information network. The possibility of visualization is a major advantages of videoconferencing. Using a camera, both written and living learning materials as well as techniques in arts and crafts can be transmitted effectively. Compared with audiographics, videoconference gives both the teacher and the learner a better chance to follow events dealing with organizing learning situations. However, with regard to the quality of teaching, the way how the teacher and the learners construct knowledge in the learning situation is even more important (Sariola 1995, p. 12).

Learning in Virtual School Environment

As described above, student teachers work in cooperative projects with learners in LIVE projects. LIVE working can change the teacher's way to work, especially in planning. "In a telematic learning environment the teacher has to consider more carefully than before what kind of communication serves the teaching-learning process best both from his own and the student's or a student group's standpoint" (Tella, 1995, pp. 31-32).

In LIVE working, learning goals are based on the learner's knowledge. The teacher's role is to show different kinds of models and how goals are set and evaluated. In this situation, the learner's role is active information searching and responsible working towards his/her own goals and those of the cooperative group.

Since learning in cooperative LIVE working is regarded as a process, the activity during the whole process should be evaluated by both the individual learner (self-evaluation) and the whole group. Through different opinions from the group, a learner can expand his/her own knowledge about learning.

Learning in virtual school environment gives a learner a chance to work on many different levels of telecommunications. The advances of MICT make it possible for school to change into a flexible virtual learning environment and for the learner to build his/her own learning space. Live working expands the activities of learning networks into closer interaction with reality, which leads to a better understanding of the processes of life.

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Distance Learning in Multimedia-Networks: A Finnish National Multimedia Project

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The Finnish National Multimedia Programme (FNMP) supports the Finnish communication, media and telecommunication industry and improves that field's international competitiveness. The *Distance Learning in Multimedia-Networks* project is part of the Finnish Multimedia Programme and partners with technical and pedagogical research centres, institutions, and enterprises in a major joint project. The aim of the project is to develop technically and pedagogically useful methods for distance learning through the modern use of telecommunications (hardware) and multimedia (courseware). For example, development of broadband networks (e.g. ATM) makes it possible to carry out real-time and interactive distance learning. Tele-teaching can involve teachers and students using personal computers or workstations to communicate across networks.

Research Partners and their Roles

The *Distance Learning in Multimedia-Networks* project is formed with both research and enterprise partners. Universities form the project's research units. The Digital Media Institute (DMI) of Tampere University of Technology (TUT) functions as the project's coordinator and other units are its subcontractors. DMI has put much effort to developing broadband ATM-based networks. A media server that is suitable for distance learning will be used to provide video-on-demand-software via the network. A Hypermedia laboratory functioning as a part of the DMI of TUT has produced a hypermedia learning environment for the mathematical sciences (Pohjolainen, Multisilta, & Antchev,1996). During 1996, TUT and DMI produced WWW courseware for mathematics, telecommunications, and computer science. The participants of these courses are university students of the open university, employees of enterprises, and senior high school students.

The Institute for Extension Studies and the Hypermedia Laboratory of the University of Tampere are two project partners. The Institute for Extension Studies has developed and utilized modern methods of distance learning (TV, radio, audio and video, hypermedia, multimedia) in the fields of adult education, nursery, and municipal studies. The Institute for Extension Studies will produce contents for economics, administration, communication and learning. Participants are mainly adult students from the university, the open university, occupational extension studies and from other cooperation partners.

In the Hypermedia Laboratory of the University of Tampere, necessary tools are being prepared to produce hypermedia and to research modern learning environments. The purpose is to develop hypermedia for distance learning and private study material for professionals who are not educators.

The Information Technology Research Institute of the University of Jyväskylä coordinates the project's research in the city of Jyväskylä. The Department of Data Processing Sciences, University of Jyväskylä, has been directed towards developing interactive distance learning software with special emphasis on properties of group working, interface design and various forms of learning materials. The Department has interests in both producing learning material and developing tools for analyzing distance learning systems.

The University of Helsinki, Lahti Research and Training Centre, has notable experience in arranging distance learning and producing materials. They are testing group learning concepts in distance classes and integration of different media. They also have suitable material for distance learning in the areas of communication, Finnish art history, and environmental protection. The participants of the Research and Education Center of Lahti are adult learners, teachers, enterprise and academic job-seekers.

Enterprise Partners

The enterprise partners of the project are functioning in the fields of telecommunication, media production, hardware design for distance learning purposes, learning material publishing and application. The enterprise partners of the project are: Nokia Telecommunications (NTC), Finnet/TPO Ltd., Telecom Finland Ltd, Helsinki Media Company Ltd., Fujitsu ICL Computers Ltd., Yle (Finnish Broadcasting Company), Xenex Ltd., Otava Ltd., KTOL (Union of High Folk Schools), KVS-institute, Jarmo Siivari Ltd., JKO-Action Ltd., Teleste Educational Ltd., STAKES (National Research and Development Centre for Welfare and Health) and the subregion of South-East-Central Finland (the municipalities of Hankasalmi, Toivakka, Joutsa, Leivonmäki and Luhanka).

Project's Development and Research Work

The *Distance Learning in Multimedia-Networks* project will research and develop modern learning environments from a telecommunications (hardware), hypermedia (courseware) and pedagogical point of view. Distance learning via multimedia-networks will be tested through pilots, and the feedback received from both technical and pedagogical solutions will be used by the research groups to improve the existing solutions.

The functioning of the project is divided into two parts: (1) research work of the joint research teams and (2) research work on the pilots. The three research groups will focus on telecommunications, hypermedia, and methods of distance learning. The aim of the research is to:

- produce information for the project's functioning
- support pilots
- arrange necessary training
- analyze experiences received from pilots

Telecommunications

When designing a learning environment, different kinds of learning materials, media, and technological solutions must be taken into account. The quality of video and audio and the use of multiple channels are important factors. When using available network connections and real-time video links (Internet, ISDN, Ethernet, ATM), transmission is considered from various spaces, such as teacher's workstation, traditional seminar rooms, distance learning studios, and other various reception spaces.

The aim of the project's telecommunication research group is to produce information that is needed in the areas of network, hardware and software, video conferencing and multipoint connections, distance learning equipment, and the increased use of fast networks and video servers. Tentatively they will also assess the possibilities of digital TV/radio, media server, and cable network in distance learning. The research group is also mapping fiber connections, cable connections of homes, and possibly the use of cable modems. Different kinds of accounting arrangements and protection of copyrights in networks must also be considered.

Hypermedia-based Learning Material

Computers can be used in many ways to support learning in multimedia-based learning environments. An interactive environment, which contains the material to be studied and is able to immediately assess the user's actions and give him/her feedback, can be constructed on a computer.

The project's hypermedia team supports the pilots by clarifying, testing, and developing tools for producing hypermedia-based learning materials. There are several programs available to convert word processing, mathematical and office software documents to a WWW-format. In the future, conversion programs will integrate tools which can be used produce other learning materials for the network. The team also examines the conversion of sound, picture, video and animation to the WWW and accessing learning documents in a technologically easy and pedagogically appropriate way.

Parts of hypertext are created with hypertext links. The amount of links in a normal courseware material can become so large that manual linking is no longer reasonable. A task of the team for hypermedia material is to develop automatic link tools to support the work of learning material producers. A link tool should be able to create so called "context-sensitive" links e.g. analyzing in addition to one word/phrase whole sentences and paragraphs to improve the quality of automatic linking.

The users' knowledge level should be considered when creating learning environments. Different kinds of navigation should be created for different levels of users. In traditional WWW-environments this is not directly possible. WWW learning environments can be developed by maintaining the knowledge base of a user and on the basis of documents and links generated in real-time. The question of presenting learning material structurally with the aid of SGML-data bases is also connected to this matter

The technical production of materials does not necessarily produce pedagogically meaningful learning documents. In cooperation with the groupworking and pedagogic groups, this team pays special attention to the definition of the structure of pedagogically appropriate learning documents and experiments within the limits of pilot projects.

The hypermedia material team works in cooperation with the telecommunications group in the using of new technologies like VRML, Java, and JavaScript. Adaptivity of learning environment to available network capacity will be ascertained. The pilots will be supported by offering them technical support and training in producing the courseware materials.

Methods of Distance Learning

A pedagogically meaningful learning environment should include cognitive tools which support, guide and extend the learning process, and communication tools, which make communication and collaboration between student - teacher and student - student possible. Administrative measures associated with studying (entering for an examination, reading a study guide, studying a course, passing an examination, receiving feedback, criticizing, registration) should also be possible via the network.

The benefits of WWW in education are connected to the interactivity of the material. A good WWW course offers students enough feedback on advancement of learning. Interactivity is supported by direct e-mail connection to the teacher via the WWW-pages and a bulletin board connected to the course for students' discussions.

The activities of the project's methods of distance learning team are divided into the following fields:

1. *Interactivity between learning environment and content*. New and existing learning environments and those quality standards are examined from pedagogical points of view. The team maps appropriate views of learning and learning strategies for network environments. In pilot projects usability of learning material in networks is clarified. Research methods for evaluation of the pilot projects are considered, too.
2. *Tutoring of the students and technical support*. In interface design one should take into account the needs of different kinds of learners. Interfaces for studying languages in adult education and studying information technology at the university level can be very different.
3. *Groupworking techniques in network*. The team considers and develops groupworking in learning via network, groupworking techniques and also software. They cooperate with the network team that clarifies alternative equipment for groupworking technologies.

Distance Learning Experiments

The purpose of the distance learning experiments is to test both the technical and pedagogical functionality of the distance learning solutions developed.

The Digital Media Institute at Tampere University of Technology has a broadband network connection (ATM) to Kaukajärvi and to some other schools and to the student dormitory of Student Housing Foundation in Tampere. This environment is used for ATM-based distance learning via multimedia networks. In Kaukajärvi school the first teaching experiments using ATM-connections during spring 1996 have already been made and in this autumn a teaching experiment in Russian language has started. Experimental university level teaching between Tampere University of Technology and University of Jyväskylä using broadband ATM-based network will begin in the spring 1997.

Adult education will be arranged via open universities that already are familiar with it. The contents of adult education are: mathematics, communications, education, languages. Network solutions are based on the Internet, for which student services and counselling that supports interactive private study, is being designed as a part of the project.

Adult education is also arranged as internal education of enterprises. In this project an experiment is carried out with NOKIA/NTC. The purpose is to provide hypermedia-based study material for company's new employees.

The pilots are grouped basically according to contents. In addition, the project includes one technical pilot. The research teams described above support pilots by: producing knowledge, offering technical support, providing necessary training, and participating in pilots' activities in practice.

Pilots

Each pilot also has members from interested enterprises and the pilot's subjects. Pilots activities are presented as follows.

Broadband Networks and Technical Experiments

This pilot includes the following projects:

"School on the information super highway" (KOUTIVA) project: ATM-based network solution between Kaukajärvi school and the Tampere Teacher Training School, video server and experiments.

Experiments with Project's distance learning equipment in projects for constructing ATM-based network university that have been started by Finnish universities. Student dormitories (ATM/ISDN) are also connected to experiments.

Paying attention to projects using ISDN and modem connections, like "Inforengas" (Network provided by the local telephone company).

Receiving Academic Training Program transmitted from CERN to Finland via ATM connections.

Tests using DMI's media server with digital TV that uses set-top-boxes as soon as the necessary technologies are available.

Natural Sciences

The aim of the pilot is to advance natural science teaching in schools beginning with the learning of math. The first experiments using ATM-connections in Kaukajärvi school were realized in Spring, 1996. The pilot cooperates with the Tampere Teacher Training School beginning with university-level distance learning of Matrix Algebra for senior high school students using ATM connections. The pilot extends to The Finnish Ministry of Education's natural sciences and mathematics development project of comprehensive and secondary level pilot schools. The pilot offers learning material for mathematically gifted students' special education in the Päivölä High Folk School via the network. The pilot also cooperates with Ylöjärvi high school by offering them an Introduction to University

Mathematics course via the network. The pilot is also planning to develop an Extensive Mathematics 1 university-level distance learning course for mathematically gifted college students. The pilot is described as follows:

- Participants - are students from comprehensive and secondary level schools
- Partners - are Kaukajärvi school, Tampere Teacher Training School, Päivölä High Folk School, and Ylöjärvi high school
- Subject taught - Mathematics
- Technologies used - ATM/ISDN/Internet
- Materials - Solver (Ruokamo-Saari, 1996a; 1996b) network courses of TUT: Introduction to University Mathematics, Matrix Algebra, distance learning course of Extensive Mathematics (under development)

Languages

The pilot of languages is going to research computer-based language learning and its suitability to support traditional language teaching. In the pilot, language learning techniques are being developed along with learning materials and pedagogical methods appropriate to network environment. Students' learning strategies and styles are also studied. The subjects of the study are both private study materials and the use of network in the studies. Functioning is divided into observing and technical support. The pilot is described as follows:

- Participants - staff of TELE, KVS-Institute and students of high folk schools and residents of central Finland local authority area (KTOL)
- Partners - KVS-institute, KTOL, TELE, Teleste and JKO-Action Ltd.
- Subjects taught - languages, research of computer-based language learning
- Materials - TELE; Teleste, KVS-Institute, KTOL, JKO-Action Oy
- Technology - ISDN and modem connections

Education

The aim of the cooperation project of the subregion of South-East-Central Finland and the Institute for Extension Studies of the University of Tampere is to develop distance learning and support know-how in sparsely populated regions via education. The Institute for Extension Studies already has a test version of "Network tutor." The subject is to develop the preparedness of student and tutor. Among the inhabitants of the subregion of South-East-Central Finland, a pilot group will be selected that begins to study the Learning to learn course with the aid of new technology. After the orientation period students and teachers of the area will be motivated to continue studies in educational science and adult education. The pilot is described as follows:

- Participants - sparsely populated regions of the subregion of South-East-Central Finland
- Partners - South-East-Central Finland Learning Center
- Subject and materials - Network tutor, Learning to learn -course from Institute for Extension Studies and after that possibly educational science
- Technology - ISDN

Communication

The pilot in communication is divided into three items: 1) basics of communication, 2) preparing spoken and written text, 3) technological breakthroughs of audio-visual culture. The basics of the communication include the study section's Introduction to Communications (5 credits) lectures.

- Participants - are students of communication in high folk schools and institutes
- Partners - high folk schools and institutes
- Subject and materials - Basics of communication by University of Helsinki, A course in audio-visual culture by the Institute for Extension Studies.

In-house and Customer Education of Enterprises

NOKIA/NTC continues development of hypermedia-based internal education in cooperation with the Hypermedia Laboratory of the University of Tampere. The aim of the project is to develop hypermedia-based learning environments which Nokia's own teachers produce. Special attention will be made to pedagogical design and testing of the quality of learning. The pilot is described as follows:

- Participants - in-house education of enterprises
- Partners - NOKIA/NTC
- Subject and materials - educational material of NOKIA
- Technology - internal network of the enterprise

Many enterprise participants have been widely interested in different kinds of educational activities that are directed to personnel and customers (network mediated support for products, selling/dispersed education of servicing personnel). More detailed project plans for these will be completed during autumn 1996 and realization of these will begin in spring 1997.

Notification

Notification of the project is taken care of via WWW and the project's homepage, whose address is: *http://matwww.ee.tut.fi/kamu/*. The homepage is divided into public and non-public parts, the latter is open for all project participants. The public part includes general information and introduction to the project. The non-public part includes:

- Work plans
- Minutes of the management group's meetings
- Minutes of the supporting group's meetings
- Reports

- Plans of the working teams
- Information of contact persons in charge.

Each research team and pilot group also update their information on the network during the whole period of the project.

Major Achievements of the Project

In the beginning of the project in autumn, 1996, the following adjustments and mappings have been made:

- Preliminary selections of learning materials and contents have been done and have taken into account the available teaching experiments in the near future.
- The general structure of hypermedia learning materials has been outlined as well as the possible problems in its production. The media and video servers' potential utilisation has been considered.
- Technical mapping of distance learning has been done.
- Mapping of the interests of the enterprises has been done.
- The essential results during the project's first nine months have been reached in following areas:
- Organization is built and personnel elected
- Working plan has been dealt with
- Seminars have been arranged
- Research teams have been formed
- Pilots have started
- WWW-pages have been created
- Educational seminar "Pedagogical methods and technological solutions in distance learning" has been arranged.

Conclusions

The beginning stage of the project *Distance Learning in Multimedia-Networks* is over and research and development work have started. The aim of this project is to construct real-time operational distance learning systems and to produce hypermedia-based learning environments that are both pedagogically and technologically appropriate. This project collects data and evaluates experiences of pilot projects and develops pedagogical methods and technologies on the basis of these. In the near future the project can be extended within the limits of working plan and budget.

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Universal Reference Locators

Finnish National Multimedia Programme
http://matwww.ee.tut.fi/kamu

The Digital Media Institute (DMI) of Tampere University of Technology (TUT): *http://dmiwww.cs.tut.fi/)*

University of Tampere: *http://www.uta.fi/*

Pohjolainen, Multisilta, & Antchev: *http://matwww.ee.tut.fi*

The Information Technology Research Institute of the University of Jyväskylä: *http://www.juy.fi*

The University of Helsinki, Lahti Research and Training Centre: *http.//frodo.helsinki.fi/english*

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LEARNINGS FROM A DISTANCE EDUCATION EXPERIENCE

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The 20th century has been an era of accelerating change and will undoubtedly continue as the new millennium ap proaches. The institution of higher education is just one of the many institutions which has been tremendously impacted by change — especially in the field of technology. As a result, we are experiencing the lifting of the bonds of time and space that have been a part of the educational agenda. While there are many forces affecting education, two powerful forces are at work and are demanding that educational institutions make significant changes related to the delivery of instruction. These two forces are (1) the demand for new technology, and (2) the increasing need for significant and continued learning.

The delivery of instruction has been forever altered by new developments in technology. The changes in society have mandated continual learning if we are to function effectively in the future. Although not a new concept, distance education was in the past less flexible and designed to address the needs of remote learners and considered second-rate at best. However, distance education today is emerging as a mainstream delivery system by providing flexibility and responding to a wide variety of learners.

The University of Central Florida's Mission and Distance Education

The University of Central Florida (UCF) is a metropolitan institution in a region experiencing rapid growth and has a student population that is the fastest growing in the nation. Numbering more than 27,500 students, we project a student body of 34,000 by the end of the decade and over 40,000 by the year 2010. Tthe average student age is now approximately 26. Many of these students are adults who may be part-time or are seeking additional education in order to gain or remain employed in central Florida's expanding high-tech work force. Space exists to house only 2,000 students on the UCF campus, resulting in a 90% non-resident student population. For non-resident students, the time and expense of commuting must be added to the effort required to attend classes or to obtain academic support services.

The University of Central Florida has been struggling with many issues related to providing distance education courses and programs. Dynamic growth, changing student demographics, increasing need for lifelong learning, the change in our nation from an industrial base to an information base, and advances in information technology are all forces re-shaping the educational landscape in central Florida. At the same time, the state's public institutions of higher education seek to provide increased access and improved quality and reduced costs, while meeting the educational needs of a growing and increasingly non-traditional student population.

The University of Central Florida has recognized and is responding to these challenges —distance education is just one of the ways. The university has formally recognized that distance education is a strategic method for increasing educational access and opportunities for students within and beyond an eleven county region. We also see that technology can assist in addressing the challenges of a rapidly growing student population and the shortage of classroom space and still maintain the quality with available resources.

Distance Education - Modes of Delivery

Recent developments in information technology make it possible to create a new model of course delivery. This model is called an Asynchronous Learning Network, or ALN. Through an ALN, course material, pointers to information; communication channels such as electronic mail, discussion groups, and channels for live chatting. Interactive quizzes or laboratory simulations are integrated into learning activities. The term "asynchronous" refers to the ability of students to participate at any time and from any place it is possible or convenient to connect into the UCF campus computer network. With asynchronous learning, students become more active and participative than in large lecture classes. Students are responsible for dynamically locating, accessing, and acting upon course-related information. Interactive reviews, quizzes, and exercises can be structured into the asynchronous learning environment to facilitate self-assessment. Students must be challenged to use their higher cognitive skills to research, problem solve, and inquire about their own answers (Mizell, 1994). Tools such as electronic mail, discussion groups, and computer conferencing facilitate interactivity. Effective course design should make interaction an integral element of the class and also provide for the use of assistants who help the instructor for the duration of the course.

Faculty and Faculty Support

There is no substitute for a systematic plan for faculty development and the quality of on-line courses is directly related to the effectiveness of the instructor. Although not a necessity, choosing faculty with certain prerequisite skills creates a better transition for teaching at a distance. More important than technical experience is a faculty member's willingness to learn, try new approaches, and scrutinize their instruction as they adapt to a new instructional format. Faculty must be master teachers and be able to translate their style into an effective distance education format (Barker & Baker, 1995).

Faculty, like students, have varying learning needs. Their teaching styles must be accommodated with either systematic training or one-on-one consultation. Scholar and Anderson (1994) include the following teaching skills that instructors should acquire for distance education teaching:

1. Understanding the philosophy of distance learning
2. Dealing with copyright issues
3. Adapting teaching strategies
4. Designing interactive courseware
5. Identifying learner characteristics
6. Organizing instructional resources for independent study
7. Using telecommunications systems
8. Collaborative planning and decision making
9. Evaluating student achievement and perceptions

Faculty Support

System-wide support is critical for effective distance education — from commitment of the individual faculty member to the department (including colleagues and chair) and including the college and the university wide-system. The outcome has to be a team effort. Support from central administration is crucial for the adoption of a systems-approach, especially from academic and technological departments. Putting courses on-line is a change process that requires time for campus personnel and departments to accept and adopt. Expecting computer services to respond immediately to distance learning needs, among other campus needs, is unrealistic. Creating on-line courses requires teamwork among subject-matter experts, designers, programmers, graphic artists and administrators. Furthermore, communication and camaraderie must exist between departments such as instructional resources, computer services and academic affairs and is best established by leadership from top administrators. Without administrative support, development becomes problematic. With administrative support, development can also become problematic when communication breaks down and a "tennis doubles" syndrome occurs. "Tennis doubles" syndrome is when two departments receive a request and each department thinks the other will handle the request (play the ball). But then neither does and the result is a mishandled request and embarrassed team players.

Distance education courses are supported in a number of ways. For example, the UCF has established a formal training program for faculty who will be delivering courses in on-line degree programs. In addition, faculty who are not comfortable with the mechanics of creating web pages can turn to the Faculty Multimedia Center (FMC) in the Office of Instructional Resources. This facility, which is part of UCF's new media center, exists to provide training and one-on-one support for faculty efforts and includes support for the development of web-based courses and course materials. The FMC also provides graphics, audio, video and multimedia production services for both on- and off-campus instruction. The FMC facility includes both Macintosh and Windows PC workstations with a wide variety of software and a Sun server for the on-line development environment of web-based courses. When course development is completed, the finished files are migrated to the university's main web server where they become publicly-available.

With the dramatic increase of web site development, the FC needed to develop a less labor-intensive tool for the faculty. Two solutions were found. The first was creation of an automated web page development tool named *UCF WebWeaver*. This tool provides faculty with a structured environment for the creation of a course web site. The user simply selects the applicable sections and fills in (or copy-paste) various text blocks or graphics. Using *UCF WebWeaver*, a completed course website can be generated in as little as half an hour. Faculty can use other tools such as *Aldus' PageMill* or *Microsoft's Front Page* in combination with course template files. Both solutions allow the creation of high quality course websites without requiring the faculty to use HTML. Courses requiring more sophisticated resources, such as custom CGI or Java scripts, can be enhanced by skilled programmers once the basic pages are created. Another solution from the professional staff in the Faculty Multimedia Center is the recruiting and training of undergraduate and graduate students to help faculty in website creation and maintenance.

Designing Quality Courses

Designing on-line courses requires thorough research. Some critics within the field believe that successful distance education must try to replicate face to face classroom interaction. This is evident in state-wide initiatives to build two-way video and two-way audio networks. To attain the highest quality teaching and learning at a distance, consideration must be made equally to the theoretical perspectives of learning, subject content, learning context, delivery mode, and learner characteristics.

Distance learning can exaggerate poor instruction. Just as faculty must prepare themselves for a change in roles as distance educators, they must scrutinize their course content with a systematic instructional design process. The Internet combines the advantages of multiple media, is more interactive than videotapes and, unlike CD-ROM delivery, can connect people cheaply from all over the world (McManus, 1995). The use of such varied media requires instructional design.

On-line tools for instruction and the use of e-mail provides opportunities to create learning environments and communities of scholars. However, these tools are not without their drawbacks. E-mail can quickly overload a mailbox and overwhelm the instructor. Furthermore, sufficient server storage space must be planned and provided for. The ability to autosort messages is needed and students need to be instructed on Netiquette. While many students feel that they should get a response within 24 hours, a more realistic time frame is 48 hours. Backing up files and checking for viruses are other activities that must be constantly performed.

There is a delicate push-pull relationship in interactions between faculty - student and student - student. For on-line courses this can be the push of e-mail and the pull of computer conferencing. Unlike the traditional classroom, on-line students are expected to construct their own knowledge, see many perspectives, be more autonomous, be self-motivated and independent, and work collaboratively in groups. Furthermore, students' access to study resources is greatly enhanced with links to computer resources and other experts (Collins & Berge, 1995; Zack, 1996).

Student Support Services

Learner support is an inextricable part of both the on-line course delivery process and overall quality of the program.. Well-designed courses will not be well received if the campus appears unresponsive to the needs of distance learners. However, the perception of learner support is sometimes more important than actual need. UCF has only begun to address the need of distant students to access academic support services. To date, distance education students have used services available at one of UCF's attendance centers. To more fully meet the needs of a distributed student population, a central support center for distance education students is being established within the Division of Enrollment and Academic Services. This office will become a single-point-of-contact facility that will serve the needs of non-resident students. It will provide access to a variety of campus-based support services and distribute required course information and materials. The WWW is also being used as a way to provide student services ringing from course registration and financial aid to library information. This makes services accessible to distant learners seven days a week, 24 hours a day.

Strategies for Future Courses

The problem commonly associated with traditional distance education is the lack of opportunities for collaborative work, debate, dialogue, and conversational learning (Kaye, 1989). E-mail creates some of the push, but yet not enough pull. The limitations of e-mail were clearly shown in a recent web-based course. However, the use of asynchronous computer conferencing through a web browser holds much promise.

Computer conferencing, while still limited, can create learning environments where learners are actively engaged (Collins & Berge, 1995). The technological ability of the software program, combined with the facilitation of the faculty member, allows for the creation of learning environments that foster trust, collaboration, and cooperation (Collins & Berge, 1996). Higher level learning and integration is most effectively achieved through dialogue, which occurs in computer conferencing (Lauzon, 1992). Users liked the fact that anonymity helps facilitate their use of computer conferencing. They felt more empowered, yet daring and confrontational about expressing ideas (Lauzon, 1992). Learners are no longer on the spot and can reflect on the content (McMahen & Dawson, 1995). Guest lecturers may also participate in computer conferencing which allows experts to enrich the learning experience (Collins & Berge, 1996). International borders are diminished within the networked access of the Internet and the WWW.

Some of the drawbacks of computer conferencing for students and teachers are the technical requirements of the software and hardware. Gaining reliable access and overcoming the time-consuming learning curve are obstacles that need to be overcome early on to ensure quality experiences (Collins & Berge, 1996). Lack of visual cues is another limitation to computer conferencing. This includes gestures, body movements, eye contact, and voice inflection. Lack of visual cues may lead to greater misunderstandings and may even escalate into "flame" wars. The anonymity associated with conferencing can possibly create a depersonalized environment leading to abusive behavior (Kahle, 1996).

"Netiquette" training is essential for avoiding unnecessary conflicts. Zack (1995) found that while his business administration students did not want to get into conflicts using e-mail, they enjoyed controversy on the computer conferencing system. Since the actual sequence of talk is rearranged as communication occurs over time, following threads of posted messages can be difficult. This can lead to a disjointed flow of information. Many topics can also be active at the same — a situation that requires time and the ability to sort through various topics (Ocker, Hiltz, Turoff & Fjermestad, 1995). Other difficulties are inability of groups to work easily, difficulty in group decision making and problem solving, and lack of quality scholarly opinion (McMahen & Dawson, 1995).

In the traditional classroom, the teacher contributes up to 80% of the discussion, but in some studies cited by Jonassen, Davidson, Collins, Campbell, & Haag (1995) teachers contribute only 10-15% of the discussion when using computer conferencing. "The role of the teacher changes in that he or she is no longer the source of curriculum or the expert on a subject matter; therefore, students must engage in inquiry that goes beyond the walls of the classroom" (McMahen & Dawson, 1995).

The most important role of the on-line instructor is to accept responsibility to keep discussion on track.and involve learners to act independently, interactively, and interdependently. This accounts for the time spent by teachers up front in designing an on-line course. Collins & Berge (1995) go on to describe the responsibility of the on-line instructor, "Scaffolding for students interaction and meaning-making activities must be provided by the on-line instructor by modeling appropriate interaction and facilitation techniques on screen, and by providing metaphors and analogies to personalize and humanize the transactional space."

Future Directions

Many modern universities still utilize the same resources to deliver academic programs as institutions did a century ago. Classrooms, laboratories, books and faculty scheduled in 15-week terms are still the rule. These technologies can be used in only one place at a time and by a limited number of learners. The mode of delivery is primarily lecture-based, and in most growing state institutions, large lecture sections are common. However, the effectiveness of such courses is limited. The scene in the typical classroom is one of the faculty member actively working and the students passively listening and taking notes.

In the near-term, we see asynchronous learning techniques used for both distant courses and campus-based courses. Perhaps the most significant change will be in the exploration of possibilities for re-structuring the traditional class delivery model by combining live class meetings with Asynchronous Learning Network activity. It is our intent to pursue all available avenues of distance education that adapts well to the lifestyles of today's metropolitan student. This requires flexibility, adaptability, and openness on the part of all stakeholders involved.

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The Transfer of Traditional Curriculum To Online Learning Opportunities

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Currently, the push is to integrate computers and the Internet into traditional classroom curriculum. Not only are we bringing the Internet into the classroom, but we are also replacing the traditional classroom with a virtual one. There are many reasons for this push which is not within the scope of this paper. We are more concerned with the issues that accompany this computer and Internet push. The World Wide Web (WWW) contains many opportunities and tools for educational activities. According to Ellsworth (1994), there are an abundance of resources as well as methods for teaching more than just facts. Ellsworth feels the opportunity to contact people from around the globe, can "make any project more dynamic" (p. 5). Another asset is the ability to access the "most current information available" (p. 5). She goes on to say, "it is "fast becoming the largest reservoir of knowledge ever known to this planet" (p. 6). With the growing popularity of the WWW, students no longer need to travel to libraries for information. The information can come to them in their classrooms or at home.

According to Azarmsa (1993), computers can bring the "world into the classroom and make a student's desk a delta for information flow" (p. 13). Azarmsa goes on to say,

> Properly structured and facilitated within the existing curriculum, instructional telecommunications can be a powerful tool in the instructional arsenal. It can improve critical thinking skills and help us reevaluate concepts that may ultimately lead to true global education. (p. 13)

The availability of the Internet and easier access to information as well as to educational activities provides educators and learners with new options and choices. Learners attending traditional institutions of education are now provided with new ways of enhancing their education. Global availability to experts in the field and access to the latest research are just two examples of the importance and impact of the Internet.

Technology has exploded into education. As educators we must be prepared to work with these new technological innovations. There are many new educational technologies available on the Internet. With an understanding of technology, educators can integrate it into the traditional classroom and possibly lead to richer learning experiences for learners. Educators need easy access to information which enables them to keep up with the development of new educational technologies as well as understand techniques and methods to best use them.

Computers, The Internet, Support Systems and Our Educational Institutions

Baker and O'Neil feel traditional educational institutes are burdened by "legal constraints, high teacher - student ratios, administrative timidity...and even the physical arrangement of classrooms" (1994, p. 2) which have created "barriers to technology that have yet to be overcome" (p. 2). They go on to say, "technologies have not been embraced and pulled by real needs of the system because institutional focus has been on maintenance of existing goals" (p. 2). In other words "A real market for technology—in the sense of demand for innovative applications by teachers, administrators, and curriculum developers—has not developed" (p. 2). What has happened is technology has been forced to fit into "existing niches, where it cannot seriously threaten existing organizations and staffing structures" (p. 2). Baker and O'Neil state "Technology is acceptable if it does not upset or supplant functions served by people in the system" (p. 2). Therefore, in order to support educators in providing these technological skills to our future workers, the goals of educational institutions need to change.

In order to show just how powerful a tool computers can be, Azarmsa (1993) points to a three month pilot online course offered by The Center for Distance Learning at Empire State College in New York. The course was presented totally online and utilized discussion lists and e-mail. At the end of the study, the work submitted by the students in the pilot study "was found to be superior, both as to breadth of research and quality of analysis, to work submitted by a previous non-computer class" (p. 138). Azarmsa makes an important point here. Utilizing the Internet and computers can enhance the quality of work submitted by learners. This may be due to the increased access to more resources and information, but this access must be properly structured and facilitated by educators.

Another example of the power of computers in the classroom is provided by Kinner and Coombs (1995) who found that utilizing computers in the classroom setting "can drastically reduce barriers for persons with various physical and learning disabilities, and it can also facilitate interaction among those who are, for whatever reasons, inhibited in face-to-face settings" (p. 53). Professor Norman Coombs from the Rochester Institute of Technology taught an African-American history class that met both in the physical classroom and through a computer conferencing system. Kinner and Coombs feel that utilizing the computer conferencing system reduced such differences as "being hearing impaired, being Black, White, or Green, being shy or not a good speaker" (p. 53). Students who participated in the class were of various ethnic backgrounds and included both hearing and hearing-impaired students.

Students who are hearing-impaired require either that their instructors be proficient in sign language or that an interpreter accompany them to the class (Kinner & Coombs, 1995). When a class discussion is held via computer conferencing, the hearing-impaired student does not require any special assistance "to become part of a mainstream educational setting" (p. 54). One deaf student commented that she really enjoyed taking a class via the computer because it enabled her to "participate in a hearing class" (p. 54). She explained that she was able to get the other student's views without an interpreter "in the middle of the communication" (p. 54). The student also commented that she felt left out in other more traditional classes.

According to Kinner and Coombs (1995), software and hardware adaptations enable other students with physical disabilities to participate in educational activities via the computer. Kinner and Coombs feel that "Once appropriate access has been provided to the computer, these students function as equals in the computer classroom, and their disability vanishes" (p. 54). They go on to say, rather than the interaction being based on stereotypes such as a person's appearance, students can interact on the basis of their ideas. Kinner and Coombs also found that students developed a "strong sense of self-discipline" (p. 65) and assumed "more responsibility for their own learning" (p. 65). These are just representative of the many important advantages to utilizing computer technologies in the classroom.

Ellsworth (1994) feels the Internet is becoming "an integral part of life" (p. 5). She goes on to say, "It is used in education, business, and in leisure, and students will need to become familiar with the Internet to become prepared citizens" (p. 5). Educators will bear the brunt of responsibility in providing Internet skills to students and therefore will need programs and resources that will support them in acquiring these skills.

An important support system in our educational institutions consist of the programmers and computer professionals who are there to assist the institution as a whole in its computer related endeavors. These professionals can be an important resource when deciding to utilize computers in the classroom. They can provide seminars to help educators and students learn how to use the technology as well as provide ongoing support throughout the semester.

Professional Development and Computers

It is obvious that educators must first obtain computer skills so that they can in turn provide learners with the skills needed to use computers inside and outside of the classroom. Bork (1993) points out a major problem for providing our students with computer skills.

> Almost no teachers currently in the schools have had any acquaintance with computers. Indeed, the teachers now coming out of schools of education have almost zero acquaintance with computers because very few schools of education anywhere in the world are in a position to deal with this question adequately. (p. 77)

Not only are new educators unprepared, support for professional development in many educational institutions is often considered a low priority or nonexistent (Goeghegan, 1994). How can we expect educators to effectively utilize these new learning environments when institutions are not providing for teacher training and faculty development. Bork points out that there is "no coherent use of the computer in education" (1993, p. 77). Therefore, how do we prepare teachers/faculty to use computers effectively within the curriculum? Teachers/faculty can be taught to use the computer, but along with this training, they must also be taught how the computer is integrated within their area of expertise as well as how the computer can be used most effectively in delivery of the course content.

Providing Computer Skills To Learners

Ellsworth (1995) feels computer skills should be introduced at the first week of the course by demonstrating how the computer tools fit into the curriculum and then moving on to actually mastering those skills. Manrique and Gardiner (1995) recommend waiting a few weeks so students can first begin to work with the actual curriculum of the course before acquiring the computer skills needed within the course. Although they both differ on implementation, their goals are the same. Both models encourage the students' understanding of how the tools fit into the curriculum rather than fitting the curriculum to the computer tools.

Manrique and Gardiner (1995) found that many students were "turned off by the mere thought of facing a computer" (p. 126). They felt it would help a great deal if the instructor of the course approached the use of e-mail in a relaxed and confident manner. Manrique and Gardiner state "Thus, the instructor should make an effort to thoroughly learn how to use the e-mail system and not just send the students to the computer center for help when they have problems" (p. 126). Manrique and Gardiner's point here once again brings up the importance of providing programs and resources for educators to acquire these technological skills.

Online Resources

Many resources currently exist on the Internet for educators. One online educational resource is Diversity University (DU) which exists in the Multi-user Object Oriented (MOO) environment on the Internet (Burke, Clapham & Wee, 1994). The DU is a member of Globewide Network Academy (GNA) which is a non-profit virtual organization utilizing the WWW to provide educational resources (Burke et al). Diversity University provides virtual space for educators who wish to use the MOO environment for educational activities. According to Burke et al, examples of these activities have consisted of non-accredited course offerings, global collaborative learning projects, office hours for faculty and teachers, faculty/teacher development seminars, conferences and guest lecturers.

According to Evard (1993) the MOO is software that has been programmed to represent a particular environment. It is a place where people can socialize, participate in educational activities and "meet and collaborate on various projects" (p. 1). Bonefas (1996) describes the MOO as a "virtual 'space' where multiple users from anywhere in the world can log on simultaneously and interact"(online, 2nd paragaraph). In general, a MOO permits synchronous communication with other users who are connected at the same time. It's a virtual meeting place where your imagination can create exciting learning environments for students to experience.

Real Education

Going a step further, Real Education is a company which has not only developed online classrooms but has created a virtual college campus to house those classrooms as well. Every service that is provided at a traditional campus can also be obtained at the online campus. These online universities contain online catalogues, registration, academic counseling, career counseling, financial aid, bursar services and technical support. The online university structure also provides for an online library, student union, bookstore and of course online classes.

The mission of Real Education is to create and manage online university campuses and continuing education centers for their clients. Their belief is that online students are entitled to have access to the same services as face-to-face students who receive their services from the more traditional campuses.

Search engines have made online educational resources that are located on the World Wide Web easy to find. There are literally thousands of web pages on the Internet which can point the self-directed educator in the right direction. We are certainly not suggesting that these Internet resources replace teacher education programs or faculty development, but they can be excellent sources of information.

The Learners

"The central concern of all education is the learner" (Houle, 1974, p.166). Cross states "The emphasis is on learning rather than teaching" (1976, p.52). Manning feels "it is comparatively easy for us to repress or avoid the existence of individual differences whenever it is convenient or economical or comfortable for us to do so" (1976, p. 295). According to Cross (1976), "It takes no special knowledge of research to recognize that we all have characteristic 'styles' for collecting and organizing information into useful knowledge" (p. 112). Witkin (1976) states,

> it is easy to see that a teacher's cognitive style may influence his [sic] way of teaching, that a student's cognitive style may influence his [sic] way of learning, and that a match or mismatch in cognitive style between teacher and student may determine how well they get along, with important consequences for the learning process. (p. 57)

McKeachie (1991) feels educators need to think about how students learn the material. In McKeachie's research, he has found that educators really don't think about the instructional strategies they use. He reports educators tell him "it was just the way it had always been done" (p. 8). It appears that taking into consideration different learning styles is an important step when developing traditional or online course curriculum. When deciding upon one instructional strategy or another to use in an educational activity, these individual differences should be taken into consideration.

According to Kemp, Morrison and Ross (1994), "When an instructor lectures...the assumption is made that all learners are acquiring the same understanding, with the same level of comprehension, at the same time" (p. 139). In this case the learners are forced to learn at a pace which is set by the instructor and is not "adaptive to individual differences" (p. 139). In other words, utilizing only one instructional strategy will not include other diverse learning styles of many of the students participating in the class.

According to Tyler (1949), "learning takes place through the experiences which the learner has" (p. 63). Two students can be in the same class, but have different learning experiences. Tyler feels this requires the teacher to organize situations that have

> so many facets that they are likely to evoke the desired experience from all the students or else the teacher will vary the experiences so as to provide some that are likely to be significant to each of the students in the class. (p. 65)

In other words, educators need to include various instructional strategies in their curriculum. Rather than depending on one or two instructional strategies the educator can take into account diverse learning styles as well as create learning experiences that are meaningful to each student in the class. We believe it is the responsibility of an educator when planning and delivering educational activities to utilize the instructional strategies that most effectively produce the interactions and experiences in which learners can learn.

Instructional Strategies and Online Educational Activities

Knupfer (1993) feels "Many programs currently used in educational computing do not fully utilize instructional strategies to best facilitate learning" (p. 171). She goes on to say,

> If this technology is to be truly beneficial and remain a valuable part of our educational system, we must use what history tells us about good teaching techniques and sound innovational strategies and then apply critical planning and evaluation throughout implementation. (p. 171)

According to Knupfer, we must not let the computers dictate the curriculum. Schools must first formulate their curriculum and then consider how "computers can best serve the instructional objectives and activities of that curriculum" (p. 171). Rather than the "technology driving the curriculum" (p. 171), computers need to be implemented in a meaningful manner.

Effective use of the computer as a resource in education will "necessitate changes in pedagogy" (Knupfer, 1993, p. 171). The teacher once thought of as the source of knowledge, now becomes the "facilitator of information" (p. 173). According to Knupfer, the teacher guides the student toward the solution. In order for teachers/faculty to be successful in facilitating information, they must "be willing to release the control of learning to the students and feel secure in a different role" (p. 173). Within this new role, Knupfer feels the student and teacher learn together. Knupfer states, "Technology demands that teachers change their pedagogy to accommodate a different delivery system, and a different approach to teaching and learning that utilizes higher cognitive strategies" (p. 175). These new approaches to teaching will not only change the role of the educator, but the role of the learner as well.

According to Berge and Collins (1995), Computer-mediated communication (CMC) provides "electronic mail and real-time chat capabilities, delivers instruction, and facilitates student-to-student and student-to-teacher interactions across a desk or across the world" (p. 2). They feel these uses are

> enabling and promoting several paradigmatic shifts in teaching and learning, including the shift from instructor-centered distance education to student-centered distance learning and the merging of informal dialogues, invisible colleges, oral presentations, and scholarly publications into a kind of dialogic virtual university. (p. 2)

This reinforces the concept of the learners new role. In a shift from a teacher-centered to learner-centered environment, the change in the role of the educator will necessitate a change in the role of the learner.

There are many benefits to using CMC, but as in any other instructional activity, there are limitations as well. One of the "greatest benefits of CMC is its ability to liberate instruction from the constraints of time and distance" (p. 3). According to Berge and Collins, CMC also promotes self-discipline and requires the student to become a more independent learner by taking responsibility for his/her own learning. A drawback to this is the student who may require more structured learning.

Another advantage to using CMC is the "empowerment of persons with disabilities, physical impairment, disfigurement, or speech impediments, which hinder their equal participation in face-to-face encounters" (Berge & Collins, 1995, p. 4) and "promotes an equalization of users" (p. 4). Although this may be an advantage to some, it is a disadvantage to those that prefer "the social aspects of the classroom and are unsettled by the lack of face-to-face interaction" (pp. 4-5). For those that are hindered by face-to-face learning situations, CMC can be an advantageous environment for learning.

Berge and Collins (1995) list several uses for computer-mediated communication which cover a wide variety of online instructional strategies. They are:

- mentoring, such as advising and guiding students
- project-based instruction, either within the classroom or in projects involving community, national, or international problem solving

- guest lecturing, which promotes interaction between students and persons in the larger community
- didactic teaching, that is, supplying course content, posting assignments, or other information germane to course work
- retrieval of information from online information archives
- course management, for example, advising, delivery of course content, evaluation, collecting and returning assignments
- public conferencing, such as discussion lists using mainframe Listserv software
- interactive chat, used to brainstorm with teachers or peers and to maintain social relationships
- personal networking and professional growth and such activities as finding persons with similar interests on scholarly discussion lists
- facilitating collaboration
- individual and group presentations
- peer review of writing, or projects involving peer learning, groups/peer tutorial sessions, and peer counseling
- practice and experience using emerging technologies that may be intrinsically useful in today's society
- computer-based instruction, such as tutorials, simulations, and drills. (p. 3)

There are many instructional strategies available for use in the online environment. These strategies have not been invented for specific online use, but already exist in the traditional classroom. Pitt (1996) found ten basic instructional strategies which can be utilized in the traditional environment as well as the online environment. They are; learning contracts, lecture, discussion, self-directed learning, mentorship, small groups, collaborative learning, group projects, case study and forum. According to Knowles (1991), educators must be able to choose a learning technique that is "most effective for accomplishing a particular educational objective" (p. 3). Instructional strategies are tools that educators have available for use when designing methods to facilitate learning.

Conclusion

In this paper, we have tried to briefly touch on the technology issues facing educators today. There are many issues involving educators, learners and educational institutions which currently exist. We cannot expect educators to be able to meet these challenges alone. Support systems need to be established which can assist educators and their educational institutions in meeting their goals. These support systems consist of education programs which include courses on incorporating technology into the curriculum, high quality professional development opportunities and perhaps even an educational technology course provided for those Ph.D. students who intend on teaching within our university systems.

Technology is exploding into the field of education at an astonishing rate. We cannot stop nor slow this flow of new technologies down, therefore we need to learn to work within it before we are over run by it. Educators need clear and concise documentation that permits them to make informed choices regarding development of on-line educational activities. Educators also need to be provided with education, training and professional development opportunities.

We as educators need to work toward a better understanding of technology and what roles it can effectively play in the field of education. In order for us to be able to do this, we require the support of our institutional administrators as well as the support of the schools responsible for preparing us in the first place.

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Classroom Collaboration in Cyberspace

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Electronic collaboration tools are outcomes of the exciting growth of networking and networked technologies that have arisen during the 1990s. Prominent technologies for computer conferencing and collaboration (Bonk, Medury, & Reynolds, 1994) bring students together and enhance the learning environment. Networks, email, bulletin boards, synchronous writing environments, and computer video conferencing are all having an impact. The Internet is also quickly becoming the focus for shared learning environments that transcend geographical and temporal boundaries and alter the limitations of time and place to facilitate the adoption of new learner-centered strategies for instruction.

We begin with an umbrella discussion of learner-centered instructional strategies and focus on our experience with this environment. We will examine the use of electronic collaboration tools that support student interpersonal communication and facilitate learning activities within five university courses: educational technology, freshman English, business telecommunications, social work, and business communication. Instructor-focused instructional strategies and an analysis of student participation within discussion forums will be presented.

Learner-centered instructional strategies are quickly becoming the focus of reform in higher education. According to Barr and Tagg (1995), colleges and universities have historically focused on a paradigm that defined a college or university as an institution that exists to provide instruction. Now, colleges and universities are increasingly becoming institutions that exist to produce learning. Faculty at universities are beginning to recognize

> that our dominant paradigm mistakes a means for an end. It takes the means or method—called "instruction" or "teaching" — and makes it the college's end or purpose. . . We now see that our mission is not instruction but rather that of producing learning with every student by whatever means work best. (Barr & Tagg, 1995, p.13)

Physical space and the time-frame for learning opportunities to occur often categorize learning environments (Chizmar & Williams, 1996). Four categories have been identified: same time-same place, same time-different place, different time-same place, different time-different place. The traditional classroom is a classic example of same time-same space mode of learning environment. Within the traditional classroom, most of the organized and monitored learning activities occur within the confines of fifty minute meetings, three times per week, in the same classroom.

Same time-different place modes of learning often focus on distributed classrooms. By electronically linking learners from different geographic regions, opportunities to learn are available to individuals that otherwise would not be economically possible. Audio-conferencing, text-based conferences (online chat groups), and fill-audio and video links are all methods that create same time-different place learning environments. This mode still calls for organized learning activities to occur within the fifty minute classes, three times per week. Its ability to reach learners that are distributed and unable to commute to a single classroom makes it different from the traditional classroom.

Different time-same place modes of learning are created by sharing space but not requiring concurrent attendance. Computer Assisted Instruction (CAI), computer simulations, and reserved-reference materials are used commonly for different time-same place learning environments. CAI and computer simulations often allow students to receive instruction at the student's convenience (different times) but usually require the student to receive the instruction in a computer lab (same place). Reserved-reference materials are often used in libraries to allow students access to limited-supply learning articles.

Finally, different time-different space modes of learning represent true "anywhere-anytime" learning environments. The freedom to participate at different times and different places challenges the instructor to better understand the learning outcomes expected while allowing the students the freedom to plan and control their participation and use of network resources. Electronic resources such as electronic collaboration tools, on-demand audio and video, CAI and simulation software distributed by wide area networks, and the resources of the Internet allow learners control of the time and place when and where learning transpires. Of special interest are the electronic collaboration tools. Discussion forums, synchronous writing tools, email, listserves, and chat groups create the opportunity to observe evidence of student learning outside the traditional classroom and foster student discourse.

Instructional Strategy

The initial setup for a discussion forum needs to be on the server. The process is short, taking perhaps fifteen minutes. Topics within a discussion forum may be posted by the instructor from any computer with Internet access. Students also can post their message responses on any computer with Internet access. This makes maintaining the forum possible from any computer with Internet access. This is the foundation of the same place-different time environment.

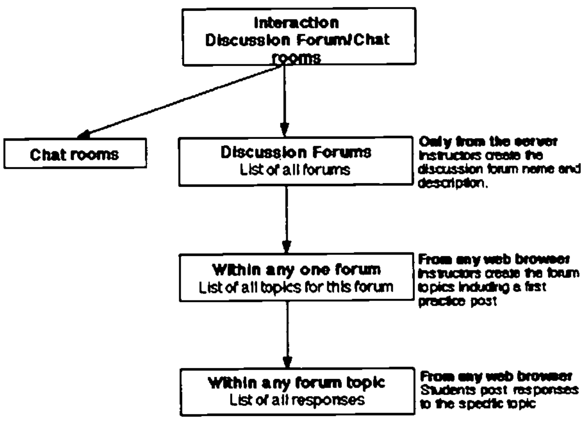

Figure 1. Discussion Forum Design.

Prior to setting up the discussion forum on the server, instructors should decide on a name for their class forum. A name descriptive of the course helps the students locate their particular forum. The goal of the first posted message should be to teach the students how to access the forum, how to post to the forum in the correct spot, how to read the thread once the class messages are posted, and how to respond via email to a peer's posted message.

Creating a simple first message helps students focus on learning the posting process rather than on the content of their message. We have used first messages such as: "Post a message about your experience in using technology in health care" or "Comment on the technology you've been introduced to since you enrolled here at MSU. Has your high school training helped you or do you find you are a beginner at this?" Be certain not to ask too many questions since students carry the posted message in their heads once they click to Post Message. One student posting to a first message containing three levels of questions stated, "This is all I can remember of the questions." We have used a handout on accessing the discussion forum to assist students through their initial posted experiences.

Since accessing the discussion forum is easily learned, the instructor's second posted message then can be directed more to course content. If the instructor is interested in directing students to a specific web site, typing the Universal Resource Locator (URL) in the instructor's message will automatically create a link to that site. Students can then just click on the linked URL and go immediately to that site.

Because this is a same place/ different time environment, the instructor will not be available to reword or interpret the message for students. The precise wording of the posted message is rather important. Students must understand their task from the instructor's posted message. When the assignment regarding the posting of a message is given to the students, it is a good idea to brief the students on the message so they can think about their response. This also helps the students understand their mission should the instructor's posted message seem unclear to some students.

Sample Student Postings

We have observed both positive and negative results from our experience with the discussion forums. On the positive side, students are reporting that they find the experience rewarding once they get over some of the technical difficulties. These negative student experiences include the difficulty of using computers for students who have never used the computer. Other difficulties have been due to the server performance and reliability.

Server performance has been poor during the group training sessions we use to introduce whole classes to the discussion forums. The current discussion forum is a Common Gateway Interface (CGI) program that dynamically creates the discussion forum pages that are delivered to the student's web browser. What this means is that when a discussion forum request is initiated by a web browser, a program is spawned on the server to create the current set of discussion documents. When twenty to twenty-five requests are sent to the server, the program must start over for each of the requests and performance declines. Of course, the discussion forum was not designed to be used primarily as a same time/same place server of discussions. Instead, only a few requests are initiated at the same time for the discussions once the training is completed.

The following messages illustrate some student responses to the use of the discussion forum. Both positive and negative reactions were included.

Other students also saw value with the discussion forums. Their reactions are paraphrased below.

- I think computer technology is something that will be around for the future and as nurses we will be working more and more with computers. I think being able to discuss with other professionals a certain topic is beneficial to patient care and professional growth

- I think that, minimally, as a prerequisite to beginning the nursing program, an entry level course (BADM 231 - Information Processing) should be had by all nursing students. On-line information can greatly enhance nursing education.

These student messages indicate the students' involvement in the messages posted by peers, the degree of comfort the students feel with the introduced technology, the student perception of the value of that technology in their lives, the problems experienced within the forum, and their positive reaction to the same place-different time format.

Instructors both posted questions and reacted to student responses. These posts are critical to the success of online discussions.

I feel I am learning a great deal from this class. The most important is that I am getting better at thinking and writing critically. In other classes I am using the techniques to study and to ask questions that are not so clear to me. My writing appears to be getting better also,though I am still uneasy about writing what is in my head. I'm not using the computer as a typewriter, I'm using it as a tool. This computer stuff was really exasperating at first but it is getting much easier. The discussion forum and the e-mail have made it easier for me to use the computer and to get into places of the unknown on the computer system. The more I use the computer the easier it gets. Sometimes it's hard to access the server itself and that makes my life a little bit harder to deal with. But, isn't that what life's all about. Jumping over hurdles, pushing stones out of the way, and learning to deal with things you have no control over. The knowledge that is building up in my brain is phenominal, and there is still more information coming in daily. WOW.

English 101 has taught me a great deal about writing and how to use assorted sources for my papers. In writing I learned that I have clutter within my papers. I have learned ways to help me pick out what is needed and what can be thrown out. I have, also, learned that revision strategies to pick out this clutter doesn't develop overnight--it takes time and practice.

Many of the new sources I have found deal with the Internet. One of the biggest sources so far has been from the discussion forums.

The forum has been an improtant and positive part of the English 101 class. It allows me to express what I have to say on assigned topics--topics which I would usually keep my opinions to myself. I am, also, able to see how other people responded, and recieve a greater understanding of the story. There have been many times that I was unsure what a story was about. I went to the forum, read my classmates responces, and felt more confident about what I read. Drawbacks are very few dealing with the forum. The problem I recognize most is the server is sometimes difficult to contact. I could and have sat at a computer for hours at a time trying to get into the forum. Besides this problem, there are scarce other complications. Overall, I give the discussion forum and the English 101 class two thumbs up!

Before I came to college and took English 101, I wasn't very familiar with e-mail. The internet was something that computer nerds played with and had no practical use in my life. Well, things changed and so did I. Now, I use my e-mail account with confidence and I am on the Web nearly every day

Technology is a large part of people's lives. I have papers to do which require more than one or two sources. The internet opens the door to many possibilities. I am thankful I have teachers that take the time to help us open that door.

Figure 2. Student Reaction.

Instructor's Posted Message in Nursing

This message was: "Post a clinical question or a helpful tip from your clinical practice. Let us know if you have found a helpful Internet address for clinical information."

- I found another interesting address that can keep you occupied for hours.
  http://www-sci.lib.uci.edu/~martindale/Nursing.html
  This is the Virtual Nursing Center.
  Have fun!!

Student Responses in English Grammar

- Syd: I have to agree with you that students do remember the extraordinary teachers. If you have had teachers that struck you by their teaching, then remember what it was you found so appealing and use it in your own classroom. Learning should not always be boring and I know that it is the teachers who really want to make a difference who will.
- I really like your ideas for teaching grammar in context. It makes sense. Teaching grammar out of context does seem sort of useless, it's like trying to teach the basics of math or science without actually using them. It is almost impossible. I think that reading and writing enhance understanding of grammar. Children and hopefully adults as well learn by looking at the whole picture, not just by examining the parts.

Continuing Education Class for High School Teachers

- We do not have access to the Internet yet, but I can see how it would be very beneficial in the research projects that we do in class.
- Please mail an e-mail address and Netscape program and a new computer to room 5-a, Beach High School. Include a computer-literate slave with the package. Send SOON! Thank you.
- Nine weeks ago, I was using a Compaq Presario 7200 with a Pentium Processor. Two weeks ago, my principal gave me a Macintosh II. I have no idea of what programs it has (ClarisWorks, I believe), and it's not even plugged in—only 2 plug-ins in the room. I am experiencing techno-anemia. This class is helping to boost my immune system (and sanity) until I can get my system up an working.

High School Teacher's Posted Message

- In 1992, the Americas celebrated the 500th anniversary of discovery by the Europeans. Of course, the Native Americans did not consider it a celebration; the decline of the indigenous peoples was rapid and devastating. However, the advent of the Europeans did benefit the growth of the United States. In response to your readings, discuss the advantages as well as the disadvantages of the European occupation of the New World.

High School Student's Responses

- The Europeans brought a new way life to a new world. This way of life did not benefit the Native Americans.The Europeans brought disease to the Native Americans, but without the exploration of new places we would not have the technology,religious freedom, ect. that we have today.
- When the Europeans came to the New World, they brought with them centuries of different civilizations. They brought their forms of art, dance, morals, and religion. If this was all they had brought, the world

would be quite a different place from the one we now live in. But this was not the case. They brought with them their superstitions, their forms of war, and new diseases that the natives had had no contact with. This caused unbelievable amounts of damage to the native people. The natives were conquered time and again by the invading Europeans. They were killed by war, their culture suppressed by the invaders' religions and ways of life. But the Europeans did bring some good. They brought advanced medical practices and thoughts of the world beyond the sea. The cultures of the Europeans and the natives mingled and created new, unique societies different from any other on earth.

Both the student's and instructor's postings illustrate student involvement in the messages posted by peers, the degree of comfort the students feel with the introduced technology, the student perception of the value of that technology in their lives, the problems experienced within the forum, and their positive reaction to the same place-different time format. It was also interesting to examine the patterns of postings from a more quantitative perspective.

Patterns of Postings by Time

Discussion forums were used by seven courses: Social Work, two sections of Freshman English, Educational Technology, Nursing Practicum, English Grammar, and a weekend workshop of local school teachers and college professors. Two courses, Management Information Systems and Business Telecommunications, are not included in this analysis due to problems with reporting. Three other courses, Interdisciplinary Issues in Developmental Disabilities, Communication Disorders, and Nursing Theory and Research, had not started their discussion forum activities. Discussion forum activity includes entries made between September 11, 1996, and November 22, 1996.

Instructor Posts

Instructors began the discussion by focusing student discussion on a topic or question. Reflecting the lead time in planning and their familiarity with the discussion forum software, instructors "posted" or made the first entry in each of the discussions an average of one to seven days prior to the first student response as shown in Figure 3.

Student Participation in Forums

Students participated in sixteen discussion questions across seven classes and generated 470 entries into discussion forums. Assignments for the discussion forums varied from class to class with most instructors requiring students to respond to questions within certain time periods. Student responses to discussion forum questions peaked early in the electronic discussions.

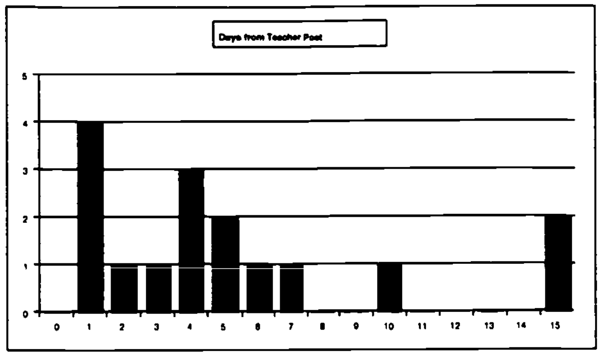

Figure 3. Days from Teacher Post.

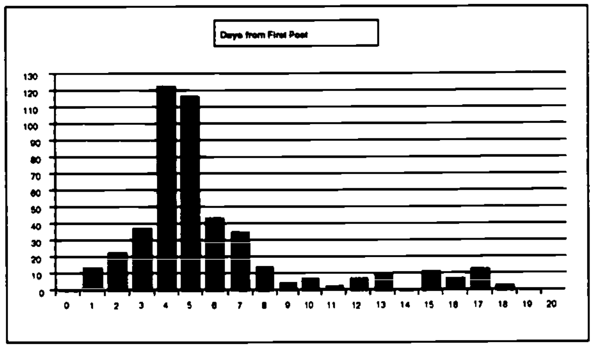

Figure 4. Days from First Post for Student Responses.

Interval Between Posts

Discussion questions were generated by the class instructor and focused the efforts of students around certain class topics. One of the advantages to the this web-based discussion forum was that instructors could post forum questions from the electronic classroom, from their office, and from home. Instructors typically posted topics well before the students were given the discussion assignment. This was reflected by the lead time between the instructor posting the question and student responses. Instructor posting of discussion topics led student replies by an average of just over five days. This indicates that instructor topics typically floated in cyberspace for days prior to the first student response.

A better measure of the starting date for the discussion occurs from the first student entry. The instructor may open a question and not assign it for days. The first entry for students indicates that the students have received the assignment and are responding. Using the first student entry as the starting date for discussions indicates that over half of the student responses occurred within the first two days of a discussion (see Table 1). After five days, over ninety percent of the responses were entered. Nine days after the first student entry over ninety-nine percent of the entries were completed. This indicates that most of the online discussions peaked early after the assignment and ended after nine days.

Table 1.
Student Reply Interval

Days	Entries	Percent	Cumulative Percent
0	170	37%	37%
1	109	24%	61%
2	81	18%	79%
3	20	4%	83%
4	16	4%	87%
5	23	5%	93%
6	12	3%	96%
7	8	2%	97%
8	7	2%	99%
9	3	1%	99%
10	0	0	100%
11	2	0	100%
12	0	0	100%
13	0	0	100%
14	0	0	100%
15	0	0	100%
16	0	0	100%
17	0	0	100%
18	0	0	100%
19	0	0	100%
20	0	0	100%

Results of this analysis indicate that online discussions have a typical "life" of no more than nine days with a peak participation in the first few days. This is dramatically different than our expectations. One of our beliefs was that online discussions might generate activity throughout the semester and even across semesters linking prior students to current students in a peer focused mentoring environment.

Conclusions

Discussion forums are an important part of the instructional environment at Minot State University. Strengths of the forum include:

1. Topics can be researched and discussed across days and outside of the scheduled class.
2. Students value the online discussion forums for the use of the technology.
3. Students report a greater comfort level with other students after working on online discussion forums.
4. Students and instructors shared more Internet resources and were more likely to examine Internet links from a discussion forum message.
5. Students reported a close link between the use of email and discussion forums and commented on the positive nature of communication that both provided.

Weaknesses of the discussion forum concentrated on technical difficulties with the system we used and included:

1. Slow response times for the server especially during group training sessions.
2. Difficulty knowing where student posts should be placed resulting in some student postings at the topic level rather than within a topic.
3. Too many questions within the instructor's posting resulted in some students either not responding to all parts or having to do multiple replies.
4. The lack of automatic word wrap for messages was difficult for students to adjust to. Students didn't understand where their message had gone.

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A Comparison Between Web-based and Notes-based Professional Development Netcourse Delivery

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In March 1996 the Concord Consortium was awarded a grant from the National Science foundation to investigate the use of netcourses as a substitute for on-site teacher professional development courses. The International Netcourse Teacher Enhancement Coalition (INTEC), creates and delivers a graduate-level professional development netcourse targeted at secondary mathematics and science teachers to enhance their use of project-based and inquiry oriented instruction. Eleven school districts and projects (Urban Systemic Initiatives in Columbus, New Orleans, New York, Philadelphia, and Phoenix, a Rural Systemic Initiatives in California, and Denver; school districts in Claremont, California; Hudson, Massachusetts; Scott County, Kentucky; and the Fermi Energy Lab) committed to systemic reform indicated, in the proposal development process, an interest in supporting teacher participation in the project.

An important goal of the project is to test and refine our netcourse model and its supporting technologies. We are experimenting with variations, including changing the size of the leadership team, changing the number of participants in groups, experimenting with the use of face-to-face study groups, as well as experimenting with different means of increasing communications such as digital video, on-line chats, regional meetings, and sessions at professional meetings. We will develop technology to increase the impact of netcourses, decrease their cost, and simplify their administration. The netcourse will be carefully evaluated to determine the costs and effectiveness of our model and its variants.

The final goal of the project is to perpetuate and disseminate the specific netcourse content as well as the general approach. We will continue the netcourses post funding on a self-funded basis, disseminate the support technologies, and help collaborators offer their own netcourses. The success of this project and its self-funded continuation will have major implications on professional development in general, since this model can be broadly adopted. We will contribute to this form of dissemination by making the netcourse model, technology, and evaluations widely available. The Concord Consortium had engaged in substantial research on the state of netcourses in the process of preparing to develop the proposal.

Definition

As we see in the history of any fundamentally new technology, the emerging capacity of information technologies for teaching creates new concepts that need to be defined. The concepts are so new, that there are no agreed-upon terms to refer to instructional activities that rely primarily on faculty-structured learning over digital networks; others have used the term "online education" (Harasim, 1990), the "online classroom" (Berge & Collins, 1995) or "telecourses" (Vogeli, 1995).

Riel and Harasim (1994) provide a good definition of the characteristics of courses using digital networks:

> Computer networking for educational purposes represents a new learning paradigm: *network learning* (Harasim, 1994)....the attributes of anytime, anyplace communication that distinguish network learning make group interaction and collaboration in this medium distinctive. The unique combination of place-independent, asynchronous interaction among groups of people linked by networks enables new educational approaches and new sets of learning outcomes. (p. 92)

In this model, all course activity occurs on-line, using computer conferencing or bulletin board systems, or, in a few cases, using e-mail interaction. On-line class activity resembles face-to-face classes in many ways: A teacher typically organizes the material, describes the sequence, establishes the pace, and determines the readings and other assignments. However, on-line courses are asynchronous and place-independent; students may live in different cities or even different countries from one another and the instructor. In on-line courses, students read the course materials, then log on to participate in on-line seminars, large and small group discussions, and individual or group projects. Face-to-face meetings do not occur or are optional. (p. 95)

We prefer to use the terms netcourses and netseminars. We distinguish between generic netcourses, which are any courses that rely primarily on networks, and a special subset of netcourses that utilize on-line discussion groups, such as those described by Riel and Harasim, that we have begun calling "netseminars." It is not necessary that a netcourse utilize seminar-like on-line discussions, but, as we discuss in this paper, our analysis shows that most often this is the strategy of choice for the best instructional use of this medium.

Agreeing on terminology is important because we need to distinguish between kinds of netcourses, ways of using networks for education, and other forms of "distance education." Of course, netcourses are a form of distance education but the term has become synonymous with either two-way video or live video broadcasts with real-time telephone back to the studio. These high-bandwidth approaches to distance learning are synchronous, relatively expensive, and do not easily support reflective thought and collaboration. Real-time interactions require synchronization that discourages reflection and is very difficult, particularly across time zones. In contrast, netcourses, as we have defined them, do not rely primarily on live video or simultaneous two-way communications.

The project's instructional approach is net-based, and more accurately described as a netseminar rather than a netcourse. Participants engage in inquiry-based activities, face-to-face meeting with local peers, internet-based discussion, and off-line activities.

Advantages

Netcourses/netseminars have a number of important properties that make them particularly valuable as a mechanism for any kind of learning:

Any Time

A participant can use the network at any convenient time: early morning, late night, after work, or on weekends. The episodes can be quick snatches at odd times or long late-night sessions. Emergencies, unscheduled interruptions, or odd vacations, do not interfere. Conversations do not have to be scheduled. Cross-time-zone communication, difficult to arrange in real time, is as easy as talking to someone across town.

Any Place

The participants do not have to meet. That means they can be anywhere. Native Americans in Alaska can collaborate with their peers in New York City. International sharing is feasible. Individuals can log on at work, home, the library, or from their hotel when traveling.

Asynchronous Interaction

Unlike face-to-face or telephone conversations, electronic mail does not require participants to respond immediately. As a result, interactions seem to be more succinct and to the point, discussion gets off track less often, and people get a chance to craft their responses. This can lead to more thoughtful and creative conversations.

Group Collaboration

Electronic messaging creates new opportunities for groups to work together, creating shared electronic conversations that are thoughtful and more permanent than voice conversations. Sometimes aided by on-line "moderators" these "netseminars" can be powerful learning and problem-solving environments that can leave a permanent legacy (Grief & Sarin, 1986; Winograd, 1988; Kraut, et al, 1988).

New Educational Approaches

Many new options and learning strategies become economically feasible through netcourses. For instance, the technology makes it feasible to utilize the best faculty in the world and to put together faculty teams that include master teachers, researchers, scientists, and experienced professional developers. Netcourses also can provide unique opportunities for teachers to try and publish innovations in their own work with the immediate support of electronic groups and expert faculty.

Integration of Computers

The netcourse learner is guaranteed to have access to a computer, so computer applications can be used that might otherwise be avoided for fear of excluding some participants. This means, for instance, that a mathematical model implemented in a spreadsheet can easily be incorporated into a lesson and downloaded so all participants can run, explore, and refine the model and then publish their findings and improvements.

Differences

Asynchronous communications using computers presents a different medium from face-to-face conversation and so has a different set of advantages and disadvantages. For that reason it is inappropriate to simply transfer, to this new medium, the techniques that institutions have developed around traditional lectures, and text-book oriented instruction. There are many people who believe that network-based asynchronous communications will be constraining and awkward. It lacks the non-verbal clues and rapid back-and-forth of verbal conversation between familiar partners. These differences need to be considered in designs that are developed to rely on the strengths and minimize the weaknesses. One of the interesting design problems however it the effects that personal style and preference play in the evaluation of the characteristics of any learning situation. (e.g. For the verbally strong, the rapid back-and-forth may be seen in a more favorable perspective that for the less verbal person.)

There are some who assume that asynchronicity is a temporary limitation that will go away when bandwidth costs drop and we can go back to the familiar synchronous interactions using voice and video.That assumption however is based on maintaining the status quo. How many times have you tried to schedule a meeting or conference call and realized that synchronicity can be extremely difficult to achieve. There are significant advantages to asynchronous learning in terms of thoughtfulness, long-distance collaboration, and quality, that the problems it introduces are outweighed by it's advantages. The shortcoming introduced by asynchronicity will become less pronounced as the technology improves, users become more familiar with the concept, more adept in its use, and hybrid approaches are developed that depend on a variety of forms of communication.

Initial Technologies

The initial course offering was presented via HTML files served from a Web server, supported by various web-based applications (e.g., HyperNews) received through Netscape 2.0 web client browsers. The instructional model worked for a class of 10 - 15. But there were problems with the technologies involved.

HyperNews, a web-based, threaded discussion area, was a management nightmare. Setting up new discussion areas was a time-consuming process. Submissions made to HyperNews were permanent. It isn't possible to edit a posting, nor could individual postings easily be deleted.

Changes to HTML files was fraught with difficulty. Editing a document, especially one that involved a file name change or location change could break all the associated HTML links resulting in confusion and missing information. Revisions needed to be made in the course schedule as we moved through the pilot phase of the course. Editing the schedule required changing the schedule and insuring all associated references were corrected.

In our instructional model the course content and approach are designed by content experts, then a Moderator, a generalist, works with a cohort of 25 participants to guide them through the course. The design then should allow a scaling up; the second round of the course begining January 1997, will involve between three and five cohorts of approximately 25 participants each. Ease of replicability and ability to keep cohorts on separate data sets was an obvious concern. The cohorts operate independently, each has its' own moderator. Although the overall schedule is essentially the same for each cohort beginning in the cycle, it is clear that there will need to be schedule variations based on the direction each cohorts' investigations take on.

LearningSpace

Concord Consortium had been looking for alternative solutions when we were offered the opportunity to become a beta test site for Lotus Notes LearningSpace. (We were already a member of the Lotus Education Consortium.) At the heart of LearningSpace are five specialized interactive databases that enable users to collaborate in a learning environment. These five databases allow users to engage in problem-solving activities, debates, discussions and exercises that result in the creation of new knowledge; manage and leverage knowledge that is key to an organization's success; access and use stored information; and receive personalized feedback from instructors.

"Networking technologies and the Internet have raised enormously the potential for sophisticated distance learning that is truly distributed," said Jim Krzywicki, vice president of Lotus Education. "Yet most on-line course offerings are little more than static repositories that bring the learner to the information. LearningSpace, on the other hand, allows the user to interact with that information, with others in the course, and with the instructor, for a truly rich classroom experience. This Notes-based solution literally brings the classroom to the student."

Lotus Notes, through the Domino Notes Server has speeded the creation of threaded discussion environments significantly. We have created new discussion databases and had them mounted on the server in under five minutes, from creation to making the first web-based entry. Notes has a sophisticated security system which can control individual access down to the page level. Under normal implementation the author of any entry has the ability to edit their entry at any time. A Notes discussion database is also fully accessible to the manager of the database. They can delete the database, change the design, control what others have access to, and can edit any of the data. It is a substantial improvement over HyperNews.

The discussion database is the central building block for LearningSpace's Classroom database, and a critical component of INTEC's approach. The Classroom provides the environment where discussion takes place. Participants can create their own discussion threads and determine if they wish the discussion to be public or restricted. The power here lies with the participants. Management and administration time has been significantly reduced over the previous technology.

The Schedule database is the organizing database for LearningSpace. The Schedule is the entry point. Assignments can be sorted by topic, date, or those marked as completed. Discussions, in the Classroom database) are linked to the specific assignments, and stay properly linked, even when the Schedule is changed. Each cohort will access their own copy of INTEC's LearningSpace databases. The moderator will be able to modify the schedule as needed without needing to worry about where other links are or be concerned about breaking links by making a schedule change.

Next Steps

Based on the INTEC experience, LearningSpace will also be used to deliver courses for the Virtual High School (VHS) National Technology Challenge Grant project where Concord Consortium is the major partner. The grant was awarded to the Hudson Massachusetts Public Schools in October 1996. The first student courses will begin in the Fall of 1997. Here the professional development course delivery system, starting in April 1997 progresses from a simple e-mail based discussion, through web-based presentation, to LearningSpace. The VHS courses themselves will be presented in LearningSpace. The teachers will need to become familiar with the LearningSpace environment.

This approach has advantages and disadvantages. It will present a confined development environment. That will initially be helpful but which may later be found to be a restraint. The future will hold the answer to that.

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Combining Distance Learning & Problem Based Learning with Multimedia Approach

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By definition, distance learning substitutes communications technologies for personal contact between instructor and students. Problem-based learning (PBL) typically requires intensive instructor contact with students and may be difficult to implement in a distance learning context. However, our course demonstrates that multimedia technologies and extensive use of the World Wide Web can make PBL feasible for both traditional and distance students. We use a combination of videotaped lectures, e-mail, and a comprehensive web site to involve geographically dispersed students in group projects. Since the biotechnology issues we address are often controversial and commonly misunderstood by the American public, our course has a broad potential audience. Consequently, we have developed techniques for providing geographically remote students with on-line PBL experiences which are equivalent to those we provide to on-campus students.

Our interdisciplinary course, *Biotechnology: Science and Socio-Economic Issues*, has been taught in the College of Agricultural Sciences for eight years. During that time, we have adopted and refined PBL strategies which encourage students to focus on specific topics covered in the course. This unique course brings expert guest lecturers covering topics such as:

- The history of genetic engineering
- Plant and animal tissue culture
- Food biotechnology
- Plant and animal applications of biotechnology
- Consumer acceptance of food products produced through biotechnology
- Biotechnology and the media
- Ethics

This wealth of expertise is not available in any other course in the country. However, students can take the course from virtually anywhere in the world, either through the University of Delaware's FOCUS/distance learning program or via satellite. Several of the lectures were made available for live broadcast throughout the United States by a grant from A*DEC, a consortium of universities that promotes distance education.

Problem-based learning has proven to be a valuable tool for integrating many perspectives on a given topic. Because they don't live near the university and may work full time, students require more flexibility in their learning experience. As a result, our goal is to provide the same rich learning experience by providing lectures for viewing via videotape or satellite downlink.

Our course demonstrates how network technologies can facilitate PBL in the context of mixed local and distance learning. Local and distance students learn how to collaborate with each other over the Internet. The experience of working in a group is even more valuable when combined with the challenge of working with remote group members. By publishing students' case studies on a publicly accessible web site, we are developing a public information resource to promote better understanding of some widely misunderstood biotechnology issues. Since we are a Land Grant University, this effort is entirely consistent with the broad public outreach mission of our institution.

Under a grant from the state's Department of Agriculture (FY 96 Cooperative State Research, Education, and Extension Service Higher Education Program) we are reaching distance students with a series of videotaped lectures. The University Focus/Distance Learning Program offers selected courses each semester. These courses are taught in specially equipped video classrooms to traditional students. Each lecture is videotaped in an unedited fashion. Student-faculty interaction is maintained through special telephone office hours in which faculty advise students and answer students' questions. Students may also schedule appointments to meet with faculty in person or communicate via email. The last unit of the course is a PBL exercise in which students in our local classroom are teamed with distance students to analyze and solve a particular problem related to biotechnology in agriculture.

The class web page is divided into public and private areas. The public areas are open to anyone and provide general information on the course and biotechnology as well as links to other biotechnology sites. Private areas are protected by passwords and are accessible only to registered students. The private areas contain class lecture notes and pages for each group's case studies. Within each group's case study page are sections for posting and reading messages.

Each instructor provides their lecture in a *Microsoft PowerPoint* file. The file has been converted to HTML with Microsoft's conversion utility. The web form of the lecture is identical to the lecture presented in class. On-line class notes are a supplement to both traditional and distance students.

Case Studies

Case studies present a biotechnology topic such as: the acceptance of gene-altered plants, animal versus human rights in a famine situation and the use of bovine somatotrophin to enhance milk production in cows. Throughout the case study, questions are presented. Students discuss the case, their opinions and how they would develop a research program to find answers to the questions. Each group has a web page for posting notes and messages. One member of the group takes notes during the discussion. Remote students use the same message page to submit their comments. These are often especially well received by the group because they are fresh ideas not influenced by the group discussion. The messages are not live. That is, the submission of a message is not immediately available to other group members. We hope to include this capability next year.

Presentations

After the groups have studied a case, they present their findings to the rest of the class. While distance students cannot currently participate in the actual presentation they can provide materials for the presentation. We hope to allow distance students to participate in presentations next year by asking groups to present their work on a web page. Students will be trained in basic hypertext markup language (HTML). They will then work together to create a public web page.

Problems

One of the major obstacles in teaching the course was the classroom itself. The studio is designed for the videotaping of lectures and is not at all suited for PBL group work. For instance, network connections were located at the front of the classroom away from student seating. Students were unable to move their chairs to work together. One solution would be to hold group work sessions in a different classroom, but we wanted to include the group discussions as well as lectures on videotape. Next year, the class will be taught in a traditional classroom. Special network connections will be added to allow groups to work together on-line.

The technical skills of groups differed. Those groups with a proficient computer user tended to make more information available to their distance group members. This magnified the variation of the experience of e distance students. Distance students required more computer and network expertise as they were required to connect to the web site and use the message center without any direct instruction. Of the four distance students taking the course in the first year, two dropped because they did not have ready access to the Internet. The other two had connections at their work place and, after some initial difficulties, were able to communicate with the other group members.

Passwords, implemented with Basic HTTP authentication, were used to protect class materials. For instance, some materials provided as background for case studies were copied from books or magazines. The material's use in the class is legal under the fair use act. But it is not legal and certainly not appropriate to make this information openly available on the web. Passwords were also used to keep each group's work separate. PBL experiences are created by the exchange of information in the group. Two groups studying the same case will take entirely different paths to their solution. Different passwords were used for each group and each case study. One drawback was that the passwords often proved difficult for students to remember.

Solutions for the Future

We found it was necessary to purchase a faster web server. A Sun Sparc Ultra I will replace the currently used Sun Sparc IPX. The new system, scheduled to go on-line Spring 1997, will speed up response time and provide more capacity for web material. Next year we will introduce an automated posting mechanism so messages, once submitted, will be immediately available to the group. We are experimenting with Common Gateway Interface (CGI) and Perl scripts as well as Java applications for implementation.

We plan to improve case study presentation by including links to other sources of information. Next year each group project will be presented on the web. Traditional students will work with distance students on an equal basis. Final projects will be accessible on the public pages of the class web site and will provide a forum for public education in biotechnology. As an added bonus, students aware that their work will be available on the web to the public will have more incentive to produce quality presentations.

Other innovations such as live "chat room" session will depend on the capabilities of the distance students. If the distance students are available to participate during classs hours and have access to high speed network connection, we may implement them. Otherwise, the current system should be adequate.

Conclusions

Problem based learning and distance learning can be combined. For the motivated student, the result is a rich and valuable learning experience. I encourage you to visit our web site at http://bluehen.ags.udel.edu/biotech

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A Virtual Schoolhouse

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With the federal administration's plan to have all schools connected to the Internet by the year 2000, it is expected that "cyberspace" will play an integral role in classrooms of the future. Initiatives to accomplish this are underway. However, connecting schools to the Internet is only part of the challenge. Another part is to provide teachers and students with resources they can use in the classroom. As the amount of content available over the Internet multiplies, there will be an increasing need for teachers to find places where they can conduct "one stop shopping" to obtain educational materials. We cannot expect teachers to spend the time "surfing" the net and weeding through countless material to find the subset that will be useful to them. The present paper describes a "virtual schoolhouse" which Research Development Corporation (RDC) is developing to serve teachers and students. The virtual schoolhouse is designed to be a repository of resources that would normally be found in a physical schoolhouse, but without the constraint that they be located within the school. The virtual schoolhouse is designed to have, among other things, a virtual library of educational materials, a chat room for teachers to discuss issues in education, a virtual lecture hall where teachers can attend colloquia at a distance, and a resource center where tutoring systems, virtual laboratories, and other teaching aides reside for student use.

It is expected that the Internet will play an important role in the future of education. According to the U.S. Department of Education's National Center for Education Statistics, as of 1995, 50% of U.S. schools had Internet access already. Another 40% were planning to obtain Internet access. New educational content is created and added to the Internet daily.

As this proliferation of Internet resources continues, with anyone being allowed both to create and use content, we must not lose sight of two objectives: (1) there must be organization to the material available, and (2) there must be quality control. One cannot simply send students and teachers into cyberspace and hope that they will find educational material that is both relevant and of high quality. Even the advent of web browsers is insufficient. For example, as an experiment, we entered the topic "high school science" in a popular web search engine. It returned approximately 1,000,000 matches. We then focused the search on "high school physics". A full 400,000 matches were found. The search was focused even more on "Newton's Laws". This produced a match of 10,000 responses.

We argue that such numbers will only increase as more and more people add content to the world wide web. If a topic as specific as Newton's Laws, which is a reasonable topic scope to develop lesson plans around can produce 10,000 matches, can we really expect teachers to have the time to search through even a fraction of these to sift out the high quality content and examples that may be useful to aid them in class?

We do not believe teachers will spend the time surfing the information superhighway looking for educational content. What is needed are organized resources in cyberspace much the way there are organized resources such as libraries, research centers and schoolhouses in physical space. These organized resources would be places on the Internet where teachers and students could go for "one-stop-shopping" and gain access to materials and activities relevant to their teaching objectives.

A Virtual Schoolhouse

Research Development Corporation is currently developing a virtual schoolhouse. The goal of the virtual schoolhouse is to be a repository of educational resources for students and teachers. These could be in the form of educational research articles, curriculum materials, educational games, simulated laboratories and forums for exchange of ideas. The goal is to provide the same types of resources found in an actual schoolhouse, but without the constraint that educational resources, students, and teachers be collocated at the same place at the same time.

When completed, the virtual schoolhouse will have the following components. First, there will be a virtual library where teachers and students can read educational research findings, commentary and other relevant educational publications. The virtual library will be a place where teachers can post and download curriculum materials so that these can be shared by all teachers.

Second, there will be a chat room, where teachers can discuss educational issues in real time. The goal of this is to give teachers access to a wider range of professionals than they might find within their own schoolhouse. In our previous research (Leddo, 1995), we found that one of the biggest needs cited by teachers for their own professional development is more interaction with other teachers and related professionals.

Third, there will be a lecture hall where teachers and students can attend, at a distance, professional development lectures. We envision both real time and asynchronous modes of presentations in three forms of presentation: text, audio and video. In cases where presentations are real time, we envision teachers and students having the opportunity for "live" question and answer sessions with the presenter. Where presentations are done asynchronously (i.e., prepared ahead of time and broadcast at specified times), teachers would either have to e-mail their questions in advance or send them after the presentation for subsequent response.

Fourth, there will be a resource room that contains educational technology. These could be in the form of tutorials, simulations, games, automated assessments, etc. Here, students and teachers alike (although the emphasis is on students) can engage in educational activities that provide instruction embedded within them. These technologies have a common theme in that they contain intelligent tutoring system technology (cf. Greer, 1995). An intelligent tutoring system (ITS) is an instructional program that contains a model of what needs to be learned, how to teach it and of the student's problem solving knowledge. The ITS then tailors instruction to the needs of the individual student.

One of the advantages we hope to realize in the virtual schoolhouse over the way cyberspace currently exists is to embed "intelligence" into the environment. By intelligence, we mean have the schoolhouse appear to have the same "user-friendly" characteristics that a real schoolhouse might have. For example, in a real library, there is a reference librarian who is not only knowledgeable about the resources available in the library but is skilled at eliciting from the patron what his or her needs are so that s/he can be directed to the right resources. As we argued earlier, we do not expect teachers to use cyberspace unless it is easy. Having a virtual reference librarian who can point teachers quickly to the material that is most useful to them is a big step in making a virtual library more valuable.

We now discuss two technologies that we feel will ultimately distinguish our virtual schoolhouse: intelligent agents and intelligent simulations. As of this date, we have yet to include these technologies in the version of the virtual schoolhouse that is available for teachers. These do exist to a limited extent in the version that has been developed for Government training.

Intelligent Agents

Intelligent agents are software programs that are designed to perform human-like tasks autonomously. For example, one commercially marketed agent observes how a person uses their computer (i.e., what operations s/he normal performs and in what order such as check e-mail, review daily calendar, etc.) and then offers to automate that sequence to save the user time. Another popular use of intelligent agents in cyberspace is to search the Internet for resources that match what a user needs. In our virtual schoolhouse, we see intelligent agents as playing two roles: as an assistant and as a tutor.

Collaborative learning is very popular in education today. The virtual schoolhouse that we are creating is designed to be a distributed environment where students in different locations can communicate in real time and engage in collaborative activities. However, one of the benefits of the virtual schoolhouse is that it is intended to be available at all times. Therefore, there is no guarantee that a student will find a human collaborator to work on a problem with him or her. In such cases, intelligent agents may play a useful role in simulating a human collaborator.

We give two examples of this. We are currently developing an educational game (described in a separate paper, *Internet-based Intelligent Tutoring Games*, in these proceedings) in which a student joins a team of detectives to solve a mystery. Here, the game characters act as co-problem solvers as well as tutors. In this game, the role of the collaborator is largely instructional. The student learns problem solving skills by watching the game characters in action and participating with them. In this capacity, the game characters "assess" the student's performance by observing behaviors and asking the student questions. Based on this assessment the characters can either proceed with the problem solving activities or pause to give the student remedial instruction.

The second example has been developed for Army leadership training. Here, the agents act as members of the trainee's team. The trainee is responsible both for directing the team's problem solving strategy as well as detecting team member mistakes and correcting them. Here, the agents must be programmed to perform a variety of behaviors. First, they must "recognize" the team member commands and be able to carry them out. Second, they must be able to make deliberate errors or adapt their behavior to make teaching points. In the former case, an agent, serving as a team member, might leave another team member unguarded. The team leader must both detect that this has occurred and redirect the agent to avoid the mistake in the future. The agent must be programmed to make this behavioral change. In the latter case, an agent might adapt its own behavior to demonstrate a potential consequence of a bad decision. For example, if a leader makes a decision that could put his team in danger, then an otherwise passive opponent might become aggressive to expose the danger.

This system, while not directly relevant to classroom teachers, does demonstrate an interesting application of intelligent agent technology in teaching leadership skills. The two components of effective leadership are good decision making and the ability to mentor one's team. The intelligent agents described above accomplish both. They help a student direct a team, not only by carrying out orders, but also by making deliberate mistakes that relate to the system's teaching goals to give the student the opportunity to mentor his/her team. The agents also evaluate the student's decisions and plan their responses accordingly in order to present the student with real time feedback as to potential consequences of these decisions.

There is another intriguing application of intelligent agent technology. Many commercially-available educational software products emphasize teaching through presentation of lessons and problem solving. Often people learn simply by engaging in a dialog with a knowledgeable source. Here, in the virtual schoolhouse, intelligent agents can act as virtual teachers to whom students can ask questions directly. We envision something more advanced than simply on-line "help." A good teacher is more than just simply knowledgeable about her field. A good teacher tries to understand how much the student already knows, what level of difficulty they are able to understand material that can be presented to them, and what topics have already been discussed that can serve as a reference to make new points. A good teacher has a variety of pedagogical approaches and tries to match them to the learning style of the student (e.g., reasoning by analogy, giving concrete versus abstract examples, presenting something pictorially versus in text). A good teacher will also vary the way she explains something if it appears that the student is not understanding. Also, a good teacher understands what the student needs to know (i.e., has a learning objective in mind) and will often tell the student what s/he needs to learn even if it is not exactly what they student as asked to learn.

There is an interesting variant to this. A similar type of intelligent agent could be used, for example, in the virtual library to serve as a reference librarian. Such an agent would serve a similar purpose as a human librarian, namely, helping students and teachers find resources that are useful to them, but in very "user friendly" ways. We envision something far more sophisticated than a search engine where a person enters a topic and the search engine looks for matches. As we illustrated in the introduction to this paper, such search engines may return far too many matches to be of value to the user. A good reference librarian spends time to determine the needs of the library patron. As would be the case with the virtual teacher, this includes understanding learning objectives (in this case the patron's), what the patron already knows, and what level of material difficulty is appropriate for the patron.

Future work in our virtual schoolhouse will include these types of intelligent agents. They will be populated in key areas throughout the schoolhouse. For example, we envision a general help desk to help new users learn about the schoolhouse, a virtual librarian to help patrons make best use of the library resources and virtual laboratory assistants to help students and teachers use the virtual simulations as well as gain tutoring in the principles being taught.

Intelligent Simulations

Another key technology in our virtual schoolhouse is intelligent simulations. By intelligent simulations, we mean simulation-based learning environments that not only model a real or imaginary world (such as a simulated laboratory or a game), but have teaching mechanisms built in as an integral part. Both of the environments presented in the Intelligent Agents section above are examples of intelligent simulations. The student is allowed to practice skills in a simulated environment. These environments do more than simply make the world conform to a set of rules or principles. Rather, the environments themselves perform assessments of student learning, have implicit learning objectives encoded within the activities, and update events to help insure that the activities and outcomes make teaching points.

We distinguish a typical simulation from an intelligent simulation by example. In a typical simulation, a student may repeat the same mistake over and over and the simulation will continue running the same way. An intelligent simulation would respond to the same situation by adjusting the difficulty of the problem or offering a tutorial tailored to the student's needs. A typical simulation treats every student the same way, i.e., is blind to the characteristics or needs of the individual student. An intelligent simulation assesses the needs and learning styles of each individual student and tailors instructional content and format accordingly.

There are several types of intelligent simulations that would be useful to have in the virtual schoolhouse. First, as we discussed in the previous section, games could serve as both an opportunity for students to have recreation while visiting the virtual schoolhouse as well as receive instruction while playing. In this way, learning becomes a fun experience.

Second, virtual laboratories can be constructed as a cost-effective alternative to real ones. By combining simulated experiments, offering chat and lecture sessions with real world science and including current research reports in the virtual library, we can recreate the features of a research center that real world scientists work at. Intelligent simulations would allow students to develop and test hypotheses or models they have regarding domains of science or related fields. For example, in chemistry, the student could "experiment" with creating different chemical compounds and exploring their properties. This would be both cheaper and safer than using a real laboratory. By including an intelligent agent as a virtual scientist, the student would have the benefit of engaging both in exploratory learning and guided learning.

Third, students can use intelligent simulations to pay "virtual visits" to areas of educational interest. These could either be geographical places such as countries or ecosystems they are studying or even different points in time and (outer) space. Such a virtual visit would be much more informative and engaging than reading a textbook description with accompanying pictures as students would be more immersed in a richer environment. Again, intelligent agents could be used either to portray human and non-human characters that are appropriate for that environment or to serve as a virtual tour guide to guide the students through the environment. The virtual tour guide would have similar properties to the virtual librarian in that it would have learning objectives, an awareness of teaching methods, and the ability to assess student learning needs.

We have created our own intelligent simulations through a combination of simulation and intelligent tutoring system technologies. We embed intelligent tutoring system technology into simulations by first constructing an expert model of the subject matter to be taught in the environment. This is indexed by teaching objectives which are then tied to specific simulation scenarios. For example, if the subject matter were Newton's Laws of Physics, then these would be tied to specified virtual experiments that could be run in the virtual laboratory.

We then develop a mechanism for recording student behavior within the simulation. Because students in an exploratory environment can find many acceptable ways to solve a problem, we are not looking for any one particular "right answer." Rather, our expert model looks for what constraints there are on an acceptable solution. For example, in our intelligent tutoring game, students are asked to solve cases using the scientific method. While it is not particularly important in which order they may gather evidence, there are constraints on what evidence is considered sufficient to confirm the hypothesis about who the criminal is and rule out that other suspects may have also committed the crime. Therefore, the intelligent tutoring component looks for whether appropriate evidence has been collected, not the order in which that evidence was collected (there would be too many acceptable permutations of this to enumerate and encode them all). There are some cases where procedures must be carried out in fixed order (e.g., data cannot be analyzed until it has been collected). In those cases, procedural constraints are imposed on the steps that can be taken.

While the student is progressing through the simulation, the intelligent tutoring system is evaluating student actions against its own internal expert model. The expert model is trying to determine the logical outcomes of the student's actions. For example, it may expect that in order for a student to "prove" the guilt of a suspect, s/he must both find incriminating evidence for the suspect and demonstrate that an alternative suspect is innocent. If the student is focusing only on the first suspect and is ignoring the other, then the tutor may realize that the student is violating the learning objective. One possible form of remediation would be to change the culprit in real time and have it turn out that the alternative suspect is really guilty. This could be operationalized by having the tutor plant incriminating evidence (such as the stolen goods) in the alternative suspect's house.

These examples illustrate the power of intelligent simulations to deliver rich learning experiences to students while allowing them to experience widespread access. There is one final opportunity for students to realize within this virtual simulation experience. We are currently developing distributed intelligent simulations that allow multiple students to learn with in real time regardless of their locations. We discussed earlier a simulation for the Army in which a student can practice leadership skills while intelligent agents serve as the collaborators. These agents have a "switch" that allows them to be overridden by a human participant. In other words, one student could be training in the environment. A second student may decide to join the simulation in progress. At this point, the second student assumes the role of one of the agent. The simulation transfers control of that agent from the system to the second student. The student can then direct that agent's behavior, thereby creating a collaborative environment between the two students and the remaining agents. Finally, when one of the students is ready to leave, s/he returns control of the agent to the system.

Summary

We see the virtual schoolhouse as a powerful resource for teachers and students. It allows them access to colleagues, mentors, materials and tutorials without the traditional physical limitations which requires that these resources be temporally and spatially collocated with the user. The strength of the virtual schoolhouse is that it represents an integration of technologies, as well as, an integration of resources brought together in one easily accessible location. We hope that paradigms such as our virtual schoolhouse will aid in the transfer of technological and other societal resources to physical schoolhouses from which they have traditionally been isolated.

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Graduate Degrees: The Time is Now, The Place is Anywhere

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At the University of Texas at El Paso (UTEP), the typical university graduate education classroom runs the gamut between two extremes — a lecture presentation by the professor, to a setting where students engage in collaborative learning with the professor. In the lecture class, the professor does nearly all of the work as the students faithfully take notes and asks questions from time to time. In the collaborative context, the professor organizes the syllabus, mentors the students, and helps them maintain focus, but rarely lectures. In both situations, there is often a sprinkling of technology — an overhead projector, a VCR and TV screen, an audiocassette player, a LCD panel tied to a computer, or any combination of the above.

Whether at the extremes or somewhere in between, the campus graduate class is usually professor-motivated and driven and is dependent upon activities that occur in a classroom. The students and professor are committed in time and place. There are scheduled weekly hours and an assigned location for class meetings. While limited absences are allowed, they are strongly discouraged.

The Distance Learning Virtual Classroom

Last year, Walden University began a Master of Science (MS) program in *Educational Change and Technology Innovation* taught in a distance learning style. Course delivery occurs on the Internet, utilizing America OnLine (AOL) as the service provider. AOL gives Walden access to the Electronic University Network (EUN) and its virtual university settings. Most instruction is handled through a Bulletin Board System (BBS) on which students and teachers exchange postings in a delayed-discussion format. The BBS is partitioned into five areas: 1.) the course description, 2.) the course syllabus, 3.) the lecture and discussion area, 4.) a place for posting and clarifying assignments, and 5.) an area for special projects such as the final course paper. It is in these areas that most of the course activity takes place.

Special communications requiring privacy (such as exams, quizzes, and individual feedback on grades) are handled on AOL e-mail, on the telephone, or by snail-mail. Each professor is expected to call all assigned students prior to the beginning of their course. The purpose of the call is to welcome the student to the course, establish rapport and answer any questions about the syllabus or course material and to exchange other vital information.

The Walden Distance Learning Online Classroom

Student Populations

Walden's students are drawn from all over the country. In fact, during the first course, one student was working in an American school in Egypt. There is a wide diversity in student age. Many students have delayed taking a master's degree because of conflict with family, job, travel, and a variety of other needs. There is also great diversity in cultural and socioeconomic background, as well as personal interests, life experiences, technology skills, and educational levels. Some students are taking the program as a second master's degree because of its strong emphasis on technology and educational change. Others are hoping to improve both their knowledge and their job performance. Still others aspire to find new jobs through the degree. Students find the flexibility of distance learning attractive. It is time-flexible with only a broad tie to specific time commitments, usually on a week-to-week basis. And there is no real commitment to place. Students can participate wherever they can access AOL.

Course Structure and Syllabus

A distance learning course needs to be more highly structured up front than a conventional university course. The syllabus for distance learning must be much more detailed and include weekly discussion topics, activities, and assignments — all clearly spelled out. Assignments are made for each of the twelve weeks which allows students a full week to respond and to interact with the responses of other students. This one week time- span gives students the opportunity to reflect and encourages thoughtful answers, discussions, and interaction. Students may also engage in a "conversational mode" during which they may interact spontaneously, thus improving the ability to think on their feet. By the end of the course, the students and professor have constructed and shared knowledge.

Expectations for Teachers

Teachers in distance learning classes are expected to be familiar with distance learning methods and delivery systems and to be knowledgeable in technological areas, They are also expected to maintain high levels of interactivity with students using highly developed facilitative, coaching, and mentoring skills. A caring attitude toward students and deep concern for student learning are essential.

Expectations for Students

Students are expected to be comfortable with the technologies used. Admission criteria include testing of communication skills to ascertain that the reading and writing skills of students function at a high level. In addition to self-directed learning skills, students need the ability to interpret and find applications for assigned reading, utilize related research, and critique the work of other students. It also helps if they are able to work both independently and as contributing members of a group.

Time Use and Commitments

Participants in distance learning are generally able to choose their own time commitments within the parameters of the weekly assignments and the constraints of spontaneous group online discussions. There are some students who like to move ahead, posting several weeks at a time. This is particularly helpful if they are contemplating some sort of travel or work assignment which will make it hard for them to hold firmly to the weekly schedule. The challenge, of course, is to keep up rather than let the work pile up. In general, professors who teach both conventional and distance learning courses feel that planning, presentation, mentoring, and general follow-up take more time than that demanded by the conventional classroom.

Relationships

Most of the time, there is only indirect student-to-student and student-to-teacher contact. Working at a distance by computer is impersonal by definition and can be partially personalized only by special effort. There must be constant and caring communication and interaction and strong sensitivity to diverse cultural and thinking patterns. Success is dependent upon the building of knowledge between and among students and teacher.

Testing and Grading

Assessment in online distance learning require different measures of student productivity, especially to assure originality of work. Self-assessment against clearly established standards and expectations is essential. There is a heavy leaning away from true/false and multiple choice models and toward responding through essays. One measure of student progress is to look at how writing, thinking, and debate skills have developed during the quarter. At this time, grading is quite conventional (A-F) with provision for an I (Incomplete) that can be sustained for no longer than one quarter.

Benefits

The most obvious benefits of distance learning are those of taking courses almost anywhere or doing coursework almost anytime it is convenient. Other benefits include an emphasis on the development of reading, writing, thinking, and technology skills. Professors learn from and with the students. There can be many cost-savings, including a major saving for facilities. Travel to learning locations is minimized, as is travel for research, much of which can be done online. Access to other cultures and languages are only two of the myriad possibilities for networking on a much broader scale than in the conventional classroom.

Frustrations

Technology breakdowns and service provider overloads must be the number one frustration of distance learning by computer. Delayed feedback from teacher and students can be another frustration, especially for students who tend to move more quickly than the rest of the class. Some students find frustration in the lack of live, face-to-face and the chance to "emote" with colleagues. For the most part, however, benefits far outweigh frustrations in the distance mode.

Staff Development and International Applications

Staff Development

It takes a team rather than a single professor to facilitate the successful completion of a distance learning course. In addition to the professor, a program director oversees course logistics; in-house technology consultants answer the hard questions about online communication within Walden; student advisors see to the acquisition of materials and timeliness of completing assignments; and EUN technology consultants help with the "big" problems involving the medium. Team members must share a vision of what distance education can do. The staff needs continual training in technology use and satellite-based instruction, constant strengthening of feedback skills and interpersonal communication skills, instructional support for experimentation, and ongoing peer support and interchange of ideas.

Applications in the International Forum

Distance learning can help students abroad. One of the downside of accepting a teaching job in another part of the world is the difficulty of finding graduate degree programs taught in English, especially if the teacher intends to move from to job every couple of years. Distance education programs can also help the foreign student who wants a graduate degree from an American university, but who cannot leave either country or family.

Summary

The campus-based graduate program at UTEP is designed to serve the needs of a binational population on the Mexican/American border. Yet participation is often restricted by commuting problems and job demands which conflict with campus-based time and place requirement. Online distance education programs could expand graduate degree opportunities for those unable to take advantage of conventional programs.

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DIVERSITY

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From telephones, airplanes, and television, to fax machines and telecommunication, technology has virtually eliminated time and distance as barriers to interpersonal communication. Accompanying our global interdependence and interrelationships is the diversification of national populations. In turn, national demographic diversity has led to a growing interest in multicultural education and the education of diverse learners.

It is not unnatural to bring together technology and diversity. Both are compelling and incipient fields for pedagogical investigation, reflection, and application. As educational applications of technology expand, educators ponder how to take advantage of its capabilities to attain multicultural goals. Similarly, as more computers appear in schools, more teachers and students gain access to them. Educators recognize the importance of meeting the needs of learners who differ in experiences, knowledge, values, language, and world view. Thus, we must deliberate on how to equitably and effectively use technology with an increasingly diverse student population.

The papers in this Diversity Section address the integration of technology both in preparing multicultural teachers, as well as in educating culturally diverse student populations. Although each paper makes a unique contribution to the fields of diversity and educational technology, there are several themes that connect some papers.

Barber-Freeman, at Mississippi State, and Ford, Dobyns, and Poe, all at the University of Southwestern Louisiana, focus on applications of technology to content-area instruction of diverse learners. Barber-Freeman addresses the use of cooperative learning and technology in preservice teacher education to enhance the mathematical experiences of African American females. This author also examines cultural differences and learning styles as factors influencing academic performance in traditional classrooms. Ford, Dobyns, and Poe look at the multicultural applications of telecommunications and literature in social studies instruction for the gifted. This paper describes a collaborative project between the university and a middle school enrichement program with a heterogenous student population. Both papers provide valuable background information and report on on-going studies to enrich and strengthen learning experiences.

The next three papers concentrate on distance applications of technology. Dickey and Kolloff share their experiences at Eastern Kentucky University as distance education instructors. They describe the model used for distance learning, the program elements, and ideas for presentation, organization and interaction. These authors provide concrete suggestions based on their personal experiences. The paper by Smith takes a slightly different approach. This author presents a collaborative program at St. Mary's University that brings together preservice teachers with pairs of elementary children in using the World Wide Webb. In this project, college and elementary students worked together to locate information centered around specific social studies thematic units. Both groups of learners benefited from the hands-on experience. Pinneli, at the University of Lecce, highlights the philosophical and pedagogical rationale for using Bulletin Board Systems in preparing multicultural educators at her institution in Italy. This paper offers teacher educators some thought-provoking propositions, as well as personal experiences in the use of telecommunications for teacher preparation. Together, these three papers offer valuable insight into the educational possibilities, potential pitfalls, and distinct advantages of telecommunications.

The last two papers directly address technology integration for multicultural education. In her paper, Allen provides several strategies for integrating technology in a graduate level course on Multicultural Education at the University of Central Florida. These strategies include the use of email, web chat sites, presentation graphics, and internet searches. Each strategy includes hands-on learning, modeling, and guided practice. Chisholm introduces and defines six criteria for the integration of technology in multicultural classrooms. The author provides examples of each criteria gleaned from instructional units created by inservice teachers.

These papers are indicative of the multicultural applications of computers both in teacher education and in the education of our children. As the Disney song reminds us, "it's a small world after all" and, as Pinneli suggests, technology has made the global village a virtual reality. The papers in this section represent the effort to connect teachers and their students with world beyond their classroom, as well as to provide all learners with the opportunity to attain academic success through equitable use of technology. Though there remain many unanswered questions and many avenues yet to be explored, the possibilities are exciting and the need for knowledge in these areas is urgent.

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Technology and Cooperative Learning: Enhancing African American Females Mathematical Experiences

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The mainstream model of education neglects female students because their learning styles do not coincide with individual and competitive learning environments. Mathematics language, its discourse mode, and classroom dynamics are opposite to the way females are taught to interact and communicate (Hanson, 1992). Independence is a quality that society discourages in females but promote in males. Consequently, school girls tend to be more dependent on others instead of being self-reliant (Mann, 1994). Women feel uncomfortable and excluded in a classroom structure that is designed to foster independent, non-collaborative thinking. Females prefer to use a conversational style format in classrooms that foster group consensus and builds ideas on top of each other where the interrelationship of thoughts and actions is paramount (Schwartz, Hanson, 1992). In addition, there is a continuous national concern about the apparent lack of mathematics achievement by females and by the lack of involvement of women in math and science related careers. Specifically, women of color are the most underrepresented group in mathematics and science (Catsambis, 1994).

A crucial step toward correcting the educational inequities is to identify and examine differences publicly and to develop reform agendas that promote educational equity in order to close the ethnic and gender achievement. Martin R. Delaney, the great nineteenth century African American nationalist, identified an important reality when he stated, "To know the conditions of a people, it is only necessary to know the condition of their women." The study of the conditions of African American females includes knowing and understanding their learning in order to implement instructional strategies that will promote participation of people of color in areas of mathematics, science, and technology.

In 1992, the American Association of University Women (AAUW) published an article *How Schools Shortchange Girls*. This report highlighted all aspects of education concerning the disparity of educational experiences between males and females. One critical component of this examination focused on classroom interactions - teacher/student and student/student. Through all levels of education, preschool to university, the study found that males demand and receive more attention from teachers than females - particularly true for mathematics and science classes. Consequently, this article prompted considerable attention towards discourse styles in classrooms that overlook females.

America 2000 is a project that places emphasis on national achievement of females in math and science in order to increase the number of women in mathematics and science related careers. Researchers of this project performed an international study using twelfth grade females from fifteen countries. The results indicated that, except in three countries (i.e., Thailand, British-Columbia, and England) mathematical achievement levels were lower for*all* females' than for males. The meta-analysis, summary of recent studies of gender differences in quantitative tasks, of Freidman substantiates that it is not the female student, but rather the classroom and social structure that limits females active involvement and achievement in mathematics (Hanson, 1992).

Nationally, there is a poor retention rate of women, especially African American, in mathematics and science. Whitney Ransome, a participant in the National Coalition of Girls' Schools, believes that poor retention rates for women in math and science are directly related to inhospitable teaching techniques and classroom environment (Mann, 1994). The "a typical classroom" model is individualized and non-collaborative instruction (Hanson, 1992); however, African American females are field-dependent learners (White, 1992). In addition, field-dependency directly relates to cooperative learning (Hanson, 1992; Farivar, 1992).

African Americans Females Achievement in Mathematics

African-American students need a proactive learning environment to have academic success. A study that used 758 African-American students from Howard University confirmed that a large percentage of African-Americans fell into the extroverted category. Simultaneously, most African-American students are field dependent. According to White (1992), field-dependent learners enjoy working with others to achieve a common goal. However, research shows students who are field-independent, which is not the modality of teachers, receive higher grades (White, 1992).

Research discloses that our educational system is not meeting the needs of various ethnic groups and females. For instance, females and males enter the educational arena roughly equal in measured academic ability. However, twelve years later, females have fallen behind their male counterparts in key areas such as higher-level mathematics and self-esteem in mathematics application (American Association of University Women Report, 1992). Further research shows that the proficiency gap for ethnically diverse groups, specifically African Americans, widens at the upper grade levels (NSF, 1990).

Cooperative Learning and Female Achievement in Mathematics

"Cooperative learning classrooms have been found to be superior to individualistic and competitive classrooms in promoting individual achievement, positive social relationships, and higher self-esteem" (Nidhi, 1991). In a gender-related study involving Lego TC, females' interest and achievement increased when groups were structured to integrate females and males into team projects (Hanson, 1992). Cooperative learning is an instructional methodology in which students work together in small, usually heterogeneous, groups on a single task or towards a single goal which often results with a group reward (Farivar, 1992).

Research shows that the enjoyment of mathematics activities, the level of engagement or time on task increases, and an overall positive affective reaction towards cooperative mathematics activities (Bono 1991). Research shows that females learn better when they work together to solve a problem (Mann, 1994). Gilligan and Belenky stated that females are commonly known to utilize a "connectivist" mode of thinking (Hanson, 1992). A 1977 study researched by McMillan concluded that women in small groups produced more modal constructions (Hanson, 1992).

Cooperative learning enhances academic achievement by having students work in teams to clarify concepts and solve problems (Markstein & Posner, 1994). Through numerous studies, it has been determined that females prefer more student centered and cooperative classrooms (Moffat, 1992). A 1977 study researched by McMillian concluded that women in small groups produced more model constructions (Hanson, 1992).

Impact of Technology and Cooperative Learning with Females

To close the gap between males' and females' achievement in mathematics, efforts must be intensified to see that females receive equal, effective education as males (Hanson, 1992). It is imperative that discourse in mathematics classrooms be changed in order for females to have greater achievement in mathematics. If our students are going to be competitive during the up coming century within a complex society where mathematics, science, and technology play an important role, it will be imperative for them to improve their problem-solving skills and mathematics, science, and technology literacy. Borasi asked the question that will begin the process of solving females underrepresentation and underachievement in mathematics: "How can school mathematics be changed in order to become more appealing to women and better accommodate their thinking and learning style?" (Hanson, 1992). Integrating computer applications provide opportunities to create real-life situations, hands-on opportunities, and provides equitable educational opportunities for the field-dependent learner.

Description of Study

The researcher implemented cooperative learning as an instructional methodology in which preservice students in a methods course worked together in small, usually heterogeneous groups on a single task or towards a single goal in the computer laboratory. There are several types of small group methods. They include: Group Investigation (GI), Co-op Co-op, Finding Out/Descubrimiento, The Structural Approach, Learning Together, Team Assisted Individualization (TAI), Cooperative Integrated Reading and Composition (CIRC), Student Teams—Achievement Division (STAD), Teams-Games-Tournament (TGT), and Jigsaw II. However, for the purpose of this study, it is only necessary to define Learning Together (Johnsons' Method). This strategy emphasizes positive interdependence, direct teaching of interpersonal and group skills, face to face interaction, and individual accountability. All students must perceive in order for a group to be successful - "We sink or swim together" (Johnson & Johnson, 1994; Thousand, Villa, & Nevin, 1994; Slavin, 1986). Students were introduced to the computer using the Learning Together method. They were required to join several list serves, to interact with the instructor and their peers, explore the web and submit assignments via e-mail.

Data Organization

The number of mathematics education majors at Mississippi State University is small; therefore, the Secondary Mathematics Methods Course is taught during the fall semester only. There were thirteen students enrolled in the methods course during the 1995 fall semester. This was the first semester that more than one African American female was enrolled in the course. In fact there were four African American females in the class. However, expected number of subjects at the completion of study will be 30-35 students, because the course is currently being offered during the year. Since thirty (30) is the recommended sample size, the extra five subjects are to ensure an adequate sample in case of unforeseen loss of subjects. Each subject was assigned a computer and unlimited use of the computer along with a Mississippi State University (MSU) account.

Analysis of Data and Results

The preliminary results of this study showed that African American females interacted more when permitted to assist in the structuring of the lessons; incorporated learning resources (manipulatives and computer) at their respective schools. The study also showed that African American females interacted (e-mail) with the professor more that the other students enrolled in the methods course. Figure 1 illustrates the interaction of mathematics students with the professor via e-mail. Students were required to interact a certain number of times with the professor; however, this illustration shows that forty-three percent of African American females interacted with the professor. Also, thirty-nine percent of European American females exceeded the required amount of internet communication. Whereas, only eighteen percent of European American Males interacted with the instructor.

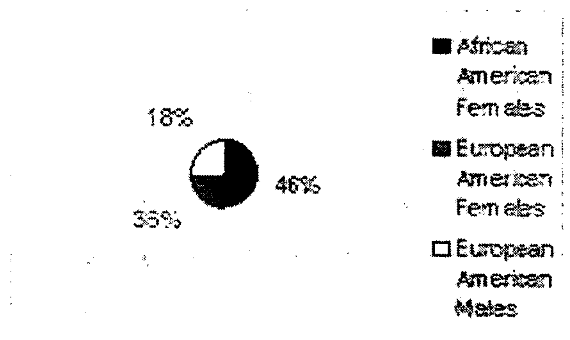

Figure 1. Interaction of Math Students with Instructor via E-mail.

Implications

Upon reviewing the literature, it was evident that there has not been a single study conducted on African American females achievement of mathematics when instructed through cooperative learning using technology as opposed to being instructed by the traditional method. As a result, the information generated from this study will be a significant addition to the knowledge base of the educational world. Also, results could confirm information from previous studies on the use of cooperative learning using technology.

Despite the fact that issues surrounding the education of females within various ethnic groups in the United States have been highly controversial and emotionally charged for almost twenty years, there still appears to be little consensus among policy-makers and educators about what organizational and educational programs, teaching, and hiring practices are appropriate. Emphasis must be placed on the importance of increasing the number of ethnic groups in mathematics, science, and technological areas that are underrepresented by various ethnic groups, specifically African Americans.

Applications

Einstein is noted as saying "...out of fear comes creativity." Many educators are fearful of diversity; yet, other educators have developed programs which were preceded by fear and or diversity (Baruth & Manning, 1992). For instance, when "at-risk" children were identified, the educational system academically developed effective programs which addressed the needs of all students (educated and mis-educated). Respectively, the Civil Rights and women's movements ushered in policies which addressed racial and sexual inequalities and harassment following much public fear and misunderstanding. Therefore, the planning and implementation of programs that promote the acceptance and respect of diversity will continue to be issues facing educators in the twenty-first century.

The results can lead to further studies of African Americans - females and males - in the mathematics, science and technology areas. If the study proves to be successful, educators of study may implement cooperative learning using technology as a major and permanent instruction of mathematics. As time progress, other educators may become interested in using the cooperative learning method. To meet the demand of the educators, the educational institutions would provide the necessary training.

As the nation becomes increasingly aware of the need to enlarge its pool of mathematicians, scientist, and technologists, attention should target African American females. They represent an underdeveloped resource. The most rapidly growing population sector in the United State today is that of the diverse racial and ethnic groups. In order to maintain the nation's human resource needs in all educational areas, it will be imperative to identify and cultivate African Americans and other diverse groups at an earlier age. Research discloses that demographic trends indicate that African Americans represent a younger and faster growing population than do European Americans (Levine, 1989). The increase of diverse ethnic groups will be felt in institutions of higher education. Thus, it is necessary that we begin to examine strategies for increasing the successful achievement of diverse groups within our educational systems.

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Using the Internet and Children's Literature to Understand Cultures

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Support for the use of literature in the teaching of social studies is well-documented and long-standing. McGowan, Erickson and Neufeld (1996) note that more than 150 years ago, Johann Friedrich Herbart suggested using literary sources in the study of history as a means of instilling desirable social attitudes in children. They further state that in the past forty years numerous educators have asserted the instructional benefits of literature in teaching social studies (Dahmus, 1956; Dawson, 1965; Norton, 1988). According to Lauritzen and Jaeger (1997), social studies educators suggest that in using historical narratives, students are better able to understand the human condition and specific events if they are "personally linked with the events and characters of the past and present" (p. 39). Advocates of the literature-social studies connection construct a compelling case for this practice by emphasizing instructional benefits in both cognitive and affective domains, as well as highlighting its natural "fit" in the acquisition of knowledge about and understanding of other cultures.

In addressing the cognitive benefits of using literature in the social studies curriculum, and alluding to the power of young adult novels to "encourage student engagement and critical thinking" (p. 227), Bean, Kile, and Readence (1996) report that students read and respond to novels differently than they read and respond to social studies textbooks. Students approach literary accounts "with an open, interpretive stance using their intuition" (p. 227) to figure out that which is implicit in the story. This contrasts sharply to the narrow, focused-on-facts approach students use with social studies texts. In comparing the conceptual understanding of students whose social studies curriculum was textbook-based with students who read selected works of historical fiction rather than the textbooks, Smith (1993) found that students in the literature-based classrooms recalled nearly 60 percent more information than students in the control classroom. Other studies support the claim that students involved in literature-based social studies instruction acquire more concepts and greater conceptual understanding than they do through traditional instruction (Guzzetti, Kowalinski, & McGowan, 1992), and that students in a literature-based social studies classroom become engaged in constructive decision-making about their own learning (Ellis, 1990).

The numerous affective benefits of using literature in the social studies curriculum are immediately apparent to its practitioners, and agreement on this issue is widespread. Among the many aspects of affective growth nurtured through teaching with trade books and recognized by teachers and researchers alike are heightened interest, increased motivation, and deepened understanding (Fassler & Janis, 1985; Michaelis, 1992). Although affective growth is not ordinarily the criterion by which student achievement is measured and reported, feelings of self-competence, constructive attitudes and values, self-motivated learning and self-esteem are closely related to experiences of success (Davis & Rimm, 1994; Silverman, 1993). As a component skill of leadership, Parker (1983) includes *interpersonal communication* , incorporating self-awareness, concern for others, cooperation, and conflict resolution, all of which are objectives of multicultural education (Michaelis, 1992). Graves states, "Literature is such a humanizing event because so many personal dimensions are present at one time. Children grow to understand the complexities, joys, and wonders of humanity as they act on the world" (1989, p. 779).

The new social studies standards (National Council for the Social Studies, 1994) support a curriculum that fosters multiple perspectives. One method of providing students with broader and deeper exposure to the diversity of human experience is to involve them in exploration of other cultures through literature. Through culturally diverse literary materials, students "examine ideas, issues, personalities, and groups from multiple perspectives" (Kim & Garcia, 1996, p. 208).

Too frequently the only images brought to mind in connection with specific cultures are negative stereotypes. Gay (1994) states that "descriptions and role functions of

Native Americans are translated into negative stereotypic images and used as mascots for...athletic teams" (p. 51). Hernandez (1989) adds that this same kind of stereotyping affects how an individual feels about their own group, culture (p. 26). Gay (1994) quotes Kimball as saying that cultural perspectives and experiences act as "screens through which human potential is filtered, interpreted, and made meaningful" (p. 49). If so, understanding another culture may help to understand one's own culture.

Technology and Content Area Instruction

Technology has allowed the classroom access beyond the traditional textbook. In no subject has this access provided greater potential than social studies. In addition to the vast amount of readily accessible information available through software (i.e., CD-ROM encyclopedias), technology has provided access to computer-mediated communication (Jonassen, 1996). Not only can students access vast amounts of information through Internet resources, but students can utilize networking to work with other students.

Riel (1996) views the Internet as "a place where people can go to meet others with similar interests, build new settlements, share knowledge through teaching and learning, and form communities around common practices" (p. 10). She points out that the classroom in today's society is constraining in that it "isolates both students and teachers from the experiences that will help them understand the past, develop skills for building a future, and prepare for their role as citizens" (p.14) but the "best way to reform schools is to lessen the gap between what is learned in school and what is needed in society" (p. 14). Telecommunications is a way to effectively lessen this gap since learning activities become more reality-based (Kearsley, 1993). Computer-mediated communication enhances socialization (Margolies, 1991) as it extends communication beyond face-to-face situations to interaction at national and international levels. Collaborative learning is enhanced (Berge & Collins, 1993) as time constraints are lessened due to the flexibility of access through email.

The use of technology in instruction is supported by the constructivist view of learning. Constructivism maintains that the learners construct their own personal knowledge rather than serve as receptors of knowledge. The construction of their own knowledge makes the knowledge more meaningful. White (1996) addresses three essential components necessary in a constructivist social studies methods class: (a) reflection, (b) active student involvement, and (c) development of a community of learners. Although White addresses these as essential components for pre-service teachers learning how to teach social studies, they are also essential for students who are learning social studies. All three components can be addressed through the use of computer-mediated communications.

Trentin's (1996) term "telematics" includes computer-mediated communications. He defines the Internet as "a powerful resource for accessing distributed information and interpersonal communication" (p.98) and indicates that an added value inherent in telematics includes using student's writing as motivation for communicating their ideas and experiences. Students may propose an idea, support their position, argue their beliefs with a minimum of conflict and often with a degree of anonymity that allows a freer expression of their opinions. Also computer-mediated communications through email and the Internet is a great equalizer (Forcier, 1996) since students can communicate with anyone who has access no matter the racial, the socioeconomic, the political, or the geographical situations. This makes computer-mediated communication

> "a flexible and productive tool for the classroom teachers" and "provides an inexpensive and immediate means of obtaining and communicating information" (Ryder & Hughes, 1997, p.53).

Social Studies Instruction for Gifted Students

Few would argue that students differ in areas of interest, motivation, and intellectual potential. It is also indisputable that all students, *including* highly able students, should be provided with educational experiences commensurate with their abilities (Renzulli & Reis, 1985). Definitions of *giftedness* vary among states and districts, yet educators concur on the types of educational experiences that should be provided to enable these students to work at the level of their highest potential. These include concept learning rather than skill learning, interdisciplinary curriculum, independent learning, the use of higher levels of thinking and experiences that are paced according to the needs of individuals, rather than to a prescribed grade-level sequence (Clark, 1992; Delisle, 1991; Gallagher, 1985;). Renzulli (1994) synthesizes these practices as he recommends: "perhaps most important, opportunities for students to exchange traditional roles as lesson-learners and doers-of-exercises for more challenging and demanding roles that require hands-on learning, first-hand investigation, and the *application* of knowledge and thinking skills to complex problems" (pp. 15-16).

Social studies is considered an appropriate content focus for gifted students becaus of the common goals that link the fields of social studies education and gifted education, such as encouraging inquiry, critical and creative thinking skills, decision-making skills, investigation of real-problems, and leadership skills (Breitner, 1987; Stewart, 1985).

Purpose and Procedures

The project participants will include fifty students in grades 6 - 8, three teachers and three university faculty members. All student participants have been identified as gifted and are enrolled in a middle school enrichment program. The ethnic composition of the student participants is as follows: thirty-seven Caucasian, eleven African-American, one Asian-American, and one Hispanic-American. The students represent all socioeconomic levels.

The purpose of this project is to develop social studies concepts and skills using selected literature and telecommunications. The National Council for Social Studies provides the following definition: "Social studies is the integrated study of the social sciences and humanities to promote civic competence (NCSS, 1994). The project described in this report has been designed in accordance with (a) the thematic strands that are the basis of the new social studies standards and (b) the essential elements for civic competence (NCSS, 1994). Participants will be engaged in concept and skill development from the following thematic strands: (I) Culture; (II) People, Places, and Environments; (III) Individual Development and Identity; and (IV) Global Connections. The objectives of the project include (a) providing opportunities for interaction among students of various cultures through technology; (b) assisting students in learning about populations in other regions of the United States; (c) encouraging interest in the history, geography, politics, and traditions of the cultures studied; and (d) developing research skills using trade books and Internet resources.

A bibliography of selections providing both fiction and nonfiction accounts of Hispanic and Native American cultures in the southwestern United States was developed by university education faculty members. The bibliography, appropriate for high ability middle school students, will be provided to gifted students in the 6th, 7th and 8th grades at a middle school in southwestern Louisiana.

The students will choose their own reading materials from this list. The students will work in cooperative groups, and group composition will be based on interest in reading the same book or author and exploring the same culture. Individual students will keep response journals and annotations of books will be generated by groups and published via an Internet home page. As students read selected books, they will develop questions based on the information gathered during their reading and research into the culture. Each student or group of students, via Internet, will then conduct an interview with a middle school student in the western United States who represents the culture depicted in the selected trade book. The purpose of the online interview is to allow each participating student to learn more about other cultures through interchange of information with an age peer who serves as a primary source.

Results

At the time of this writing the project is in its beginning stages; therefore discussion of results is in terms of a variety of expected student products. As part of the reading of trade books each student will keep a response journal including points of interest to the student along with the student's corresponding reflections; issues about which the student wishes to know more and potential interview questions. Student-generated annotations of the trade books will be published via an Internet home page, and these annotations will become part of the cultural bibliography provided to students next year as this project is continued. A content analysis of the response journals will be conducted. When students have entered the Internet/interview phase of the project, each will keep a log of time online, and total time online will be examined by student group, by title and author, and by student gender. Students will compare the literary cultural accounts with the cultural perceptions of the interviewed student. Teachers and university faculty will record their observations of behavioral indicators of student interest in the literature and the culture and purposeful engagement with the Internet. As a final assessment of the project all participants will engage in an evaluation session during which students, teachers and university faculty will reflect on the experiential approach to cultural understanding compared to the textbook/didactic approach to learning about other cultures. These results will establish the feasibility of extending the project into the next academic year and expanding it to include other student populations and additional cultures to be investigated.

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Enhancing Multicultural Education with Technology

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The changing demographics of the school population have been a topic of concern among educators at all levels. Professional organizations, reform reports, and accrediting agencies have all called for curriculum change that is inclusive of the cultures that are represented in schools in the United States. There have always been students in our classrooms which we did not see or hear. However, this invisibility is being challenged. "Old silences have been shattered; long repressed voices are making themselves heard" (Greene, 1993, p. 185).

In exploring factors that affect understanding and appreciation of diversity, Ladson-Billings (1991) analyzed the extent of preservice teachers' knowledge about diversity in the United States. Her findings revealed students lacked basic facts concerning diversity. She concluded that prospective teachers needed to learn not only the basic facts, but needed to engage in substantial exploration of societal inequities. Similarly, King (1991) proposed that teacher education must incorporate multicultural experiences that encourage students to closely examine their attitudes and beliefs about issues related to diversity. The response to this task at institutions of higher education has been to attempt to provide curriculum that better prepares the teachers of tomorrow for the realities of the classroom. The challenge is to provide meaningful change that facilitates students looking honestly at their values and developing the strength to publicly affirm these values. The concept of diversity must become personally relevant and be viewed as essential to effective teaching (Allen, 1995).

Computers are already in the homes of about one third of the American population and in middle class neighborhoods, up to 75% of families own computers. The prediction is that 80% of all families will have home computers by the year 2000 (Debeham & Smith, 1994; Friedman, 1994). Therefore, it is essential that educators be at the forefront of those in our society who have access to, and proficiency with technology.

As technology achieves the status of allowing the transcendency of time and space, the traditional textbook or professional journals in hard copy are no longer the mediums of choice for sharing information related to multicultural education. The traditional printed materials can no longer keep abreast of the rapidly changing world conditions and the knowledge explosion that is a part of our daily experiences. Additionally, the traditional approach to instruction is no longer an effective delivery system to prepare students for dealing with the complex demographics of the schools. Today, instead of reading about a situation in another country, individual can go "on-line" to speak directly with people who are more closely involved in the incident. Today, we can get information and a perspective from people who were previously denied a voice.

Given these circumstances, it is necessary to employ the technological advances to give students in a multicultural education learning environment the opportunities associated with this kind of learning. Appropriately utilizing technological enhancements also provides an environment that is more inclusive of a variety of learning styles.

In this paper, I will share a variety of strategies that are employed in a graduate level course on Multicultural Education. The strategies include using e-mail and web chat sites to engage in direct communication. Students are required to develop group projects and they correspond with each other and with people of other cultures via e-mail. Another strategy is to use appropriate presentation graphics programs in the presentation of their investigative findings related to a cultural investigation/immersion project. Finally, students engage in research based issues dialogue utilizing material gathered from the internet and professional journals. Each of these strategies involves modeling, hands-on training, and guided practice to facilitate the students becoming proficient in the needed skills.

Technology and Communication

There is no doubt that technology has changed and enhanced the ability to communicate with others. One important aspect of this change has been the removal of barriers previously associated with communication. For example, it is now possible to send "letters" that are received instantly. One strategy employed in my multicultural education class is the use of e-mail to communicate among the students and from teacher to student and vice versa. This is particularly beneficial as students work together on group projects. Time and distance barriers are no longer a problem. They can work from their home sites and still work together as a group. Another aspect of the communication process is that the students are able to speak directly with people about whom they would have previously only read. This greatly enriches their understanding and appreciation of cultures outside their personal experience. This is accomplished by accessing chat sites. As the students explore the internet and find addresses which provide appropriate opportunities to talk with people in other countries and/or cultures, they share these sites with their classmates.

Technology and Instruction

The second strategy that will be discussed is the use of presentation graphics to enhance their cultural presentations. Students are exposed to the use of technology as demonstrated by the teacher. Units of instruction in this class include the use of PowerPoint and Hyper Studio. After students have seen the integration of presentation graphics into instruction, they become participants in a workshop designed to teach the use of Power Point and other multimedia tools.

The Steps in this Multiphase Model are:

Observation of the use of presentation graphics and multimedia technology as components of instruction.

Formation of Teams

Each team identifies a culture about which they wish to learn. Teams begin investigation to gain awareness and understanding of the culture for the purpose of being better prepared to teach students of that culture.

Students attend a workshop in which they learn how to use presentation graphics and multimedia technology as components of an instructional strategy. Specifically, they learn to make instructional material using Power Point or HyperStudio, and how to integrate material from CD ROMs, laser discs, and the internet.

Students work in teams to develop an instructional unit of their chosen culture. Into the instructional unit, they integrate the use of presentation graphics and multimedia technology.

Each team "teaches" their unit. As the other students participate, they again see the use of presentation graphics and multimedia technology as they gain understanding of another culture.

Technology and Issues Dialogue

Multicultural education is a complex and complicated field of study. Banks (1993) developed a model of five dimensions which include: content integration, knowledge construction, prejudice reduction, equity pedagogy, and the empowerment of the school culture and social structure. Expecting educators to successfully implement some of these dimensions requires them to function at complex cognitive levels. Therefore, it is important that they develop these skills as a part of their training.

The issues dialogue is a series of discussions on topics related to diversity in society and specifically in educational settings. The goals of this project are (a) to challenge students to analyze typical habits of mind that many teachers bring to their work , (b) to explore ways in which these attitudes have contributed to the oppression of groups of people and the effects of this oppression, (c) to encourage students to find research that supports and/or refutes the belief systems, and (d) to engage in critical thinking in comparing material from the internet to traditional refereed professional journals.

Through a series of discussions related to assigned readings, the class identifies controversial issues related to diversity in society and schools. This list is narrowed to a manageable number of items. Pairs of students then make a choice of the issue they wish to research. One member takes the "anti" position and the other the "pro" position.

Students are introduced to on-line work and provided with the vocabulary that will facilitate their searching. This is accomplished through modeling and hands-on practice.

Over a two week period, students research their topic both on the internet and in professional journals. They are required to gather, analyze, and categorize their findings. The process of critical thinking is key at this point. They compare the quality of the internet and the professional journal findings. They are asked to consider such things as the source of the material, the research base of the position, the purpose of the writings, etc. For example, an article that has no citations, but which is strictly opinion, would not compare as favorably with an article that gives sound citations to justify various statements.

After this critical process, the students are required to come to class prepared to present their views and provide justification for their positions. While keeping in mind one of our class guidelines that "We will be hard on ideas, but gentle with people.", we engage in a point/counterpoint type interaction.

Because many students exhibit discomfort with exploring issues such as racial privileging, oppression, and cultural devaluation in schools, this project serves as a way to remove the more personal involvement. Because they are essentially role-playing the positions they take, they are more free to examine attitudes, beliefs, teaching practices, and institutional policies that negatively effect cultural groups in society and schools. As Springhall & Thies-Springhall (1981) noted, placing students in slightly more complex roles with an activity base shifts the learning process form a passive mode to that of an active analyst.

Since the students in the multicultural education class are, for the most part, either practicing or preservice teachers or administrators, they will directly influence a multitude of lives. Much of the future of our society depends on the values and beliefs that they take into their schools. It is important to remember that education at its best is a process of exploration, of discovery, and ultimately of self-transformation. School is a national institution that more than any other influences the lives of all children. "... school affects how students understand and pursue their life chances" (Grant & Sleeter, 1988, p. 19).

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THE WORLD GETS SMALLER WHEN OUR WORLD GETS BIGGER

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The Education Department of Saint Mary's University, a small liberal arts college in San Antonio, Texas, implements projects that make teacher education a practical program for the development of teachers as life-long learners in a culturally diverse, technologically enriched educational environment. As a member of the Center for Educational Development and Excellence (CEDE), founded in 1992 and funded for three years by the Texas Education Agency, Saint Mary's focuses on educating professionals skilled in teaching students from a multicultural background, many of whom are considered "at risk" of failure in the elementary and secondary schools in San Antonio. The faculty of Saint Mary's bring extensive experience to this task, based upon their work with a 10% minority enrollment, many of whom are the first generation to achieve higher education in their families.

The Texas Education Agency's Long Range Plan for Public Education, 1996-2000, proclaims that all Texas children must have access to a quality education that will enable them to achieve their potential and fully participate, now and in the future, in the social, economic, and educational opportunities of our state and nation. This proclamation presents a challenge to be met by education faculty and all persons involved in the Texas educational process.

The Texas State Board of Education's plan (1995) estimates that by the turn of the century the number of persons in the state's labor force will increase by 128% for Hispanics and 35% for African-Americans compared to 6% for whites. The jobs to be filled by these new workers will be knowledge-based, requiring technical skills and a solid foundation of theoretical and applied knowledge.

Students enrolled in Texas schools today will be expected to fill these positions. However, 1994-1995 state test data indicate that only 50 to 60% of the students at any grade level pass all of the tests they take. Economically disadvantaged students in grades 3-8 and 10 achieve 27 percentage points below students who are not at this economic level. Similar disparities are evident when comparing students from various ethnic and racial groups. In an attempt to provide students the opportunity to acquire confidence and skills that will enable them to develop an awareness of the global environment, St. Mary's developed the following collaborative program.

To meet the goals of increasing students' confidence and skills, a partnership united forty third grade students from a low performing, inner city school that is in the San Antonio area noted for gang activity; two third grade teachers, an instructional specialist, a principal, twenty-one teacher education students, and the St. Mary's supervising professor. The college students were enrolled in SS3300 - Essential Elements of the Social Sciences that requires ten hours of a practical teaching experience. The objective of this partnership was to develop problem-solving thematic units incorporating technology. Exploration of the globe via the tele-computing activity structure would provide all students, college and elementary, opportunities to answer theme-related questions that were to be solved using electronic connections. A world-wide tracking map demonstrating communication with other people and places was placed in the school corridor to expand the experiences of students who have had extremely limited global contacts. We predicted that, through aroused curiosity, student observers currently not involved in the program would become actively involved as they become motivated to expand their awareness of a culturally diverse world.

Social studies was chosen for this project since it is most often neglected by teachers as they focus on "the basic, the important areas, the skills". Learning magazine (1995) reported that students do not choose social studies as a favorite subject. Editors cited research that suggests it is the way we teach, not what we teach, that sparks interst in a subject.

After our initial project plans received approval, the instructional specialist was surprised to discover that the dedicated phone lines were in place. However, the available Macintosh LC was not adequate and the modem was not functioning. This should not have been unexpected. Handbock (1995) reported that the 1993 census data stated that fifty-two percent of the computers in schools were obsolete. Since no funds were available to rectify the problem, the specialist submitted a grant proposal to the Texas Education Agency to cover: (a) a TENET account, (b) a computer with adequate capacity for Internet use, (c) a modem, and (d) coverage of phone line costs. This proposal was approved during summer, 1996.

When school began, materials were not in place. Weeks passed with everyone becoming anxious to get started. To accelerate plans, the school children visited the Saint Mary's Computer Lab. Twenty-one computers were reserved for two hours on the designated day. College students paired with two elementary students and selected a station. The mentor students had previously updated or learned needed skills so they would be able to instruct their young partners. The entire group used WWW to seek information on medieval times. Excitement was evident in every area of the lab as the young visitors found pertinent information and waited patiently for each "precious" bit of knowledge to be printed, even when it took extra time due to the overload on the campus telecommunications operations.

One Pre-service Student Wrote in her Critique of this Experience:

Students also had the opportunity to visit the St. Mary's campus. During their visit our Social Studies class guided the students through the Internet in the computer lab. The college students guided the students in finding information on castles and medieval subjects. The kids loved it! They were so amazed at all the information that could be accessed at the touch of a finger. They were so excited to see how fast the information printed.

Following this visit, each college student worked ten hours helping the classroom teachers implement the program. Plans had called for six thematic units to be studied throughout the school year. Topics for development were chosen not only to meet state and district grade objectives but followed guidelines identified by Bluemenfeld, Krojeck, Marx, and Soloway (1994). Topics must be feasible, worthwhile, contextualized, and meaningful. These were: (a) investigation of money, (b) medieval times, (c) landmarks, (e) space travel, and (f) motion. The college students had the opportunity to be involved in only two of these, medieval times and landmarks.

These students were fortunate to be able to view realistic application of cooperative groups working to incorporate cross-curriculum problem solving projects into thematic units. This learning style had been chosen since most Hispanic students were thought to prefer environments that are student-centered, include small group and hands-on activities, and provide opportunities to exchange information with peers. (Poirot & Canales, 1993). Moreover, direct involvement permitted the pre-service students to become aware that the real world differs from that of the text. Developing an integrated curriculum takes much time, effort, and a strong structure with defined parameters. Students become aware of the interrelations of all information. As Eisner (1991) stated, the very term "social studies" suggests an integrated approach.

Using brainstorming techniques, the pre-service students were required to develop graphic organizers illustrating the connections among subjects and based upon relevant and appropriate experiences. These were shared with classmates and retained for sharing with future on-line peers.

Student-generated strategies were:

A. Art:

1. Study types of medieval artwork and artists. Draw a medieval type portrait or picture using medieval style.
2. Create a family shield.
3. Draw and construct a castle.
4. Draw a sketch of medieval homelife.
5. Make costumes of the dress of friars, serfs, etc.
6. Design a stained glass window.
7. Make and decorate ancient paper using glue and brown paper.
8. Construct models of the types of shelter used by people of this period.

B. Language Arts

1. Write a creative story with yourself as a medieval character: knight, squire, peasant, serf, etc. Use new vocabulary appropriate to medieval period.
2. Create a story about a visit to a castle.
3. Write letters to the king and queen.
4. Write a skit using medieval character.
5. Write a paragraph of the steps a man followed to prove his worthiness to become a knight.
6. Write a story describing the difficulties experienced while building a castle.
7. Write an announcement using medieval language or hieroglyphics.
8. Write a letter asking to be rescued from a castle. The letter should be authentic in appearance.
9. Pretend you are living in the medieval period and are writing in your diary.
10. Write a skit about a confrontation between two knights.
11. Write a story about the life of a young girl or boy of the period.
12. Develop a time-line following experiences during one day in the life of a knight.

C. Mathematics

1. Study types of currency. Compare food costs of the medieval era and today.
2. Study measurement through the use of maps and scales.
3. Study taxes in medieval times. Make comparison graphs.
4. Create a kingdom.
5. Make graphs illustrating the time spent hunting, eating, working, etc.

6. Investigate, discuss, and develop problems based on the construction of a castle.
7. Reconstruct the medieval economic system and have students purchase items using this system.
8. Turn word problems into situation utilizing medieval themes.
9. Investigate the quantity and kinds of food needed to feed all the people in the castle.
10. Use a map scale to determine distance from towns to rivers and other villages.

D. Music:

1. Listen to types of medieval music and look at instruments. Make a medieval musical instrument.
2. Create a mandolin and play along with medieval music.
3. Listen to medieval music. Identify instruments.
4. Dress appropriately and dance to medieval music.

E. Reading:

1. Have students research information that connects medieval music and art.
2. Read "Sword in the Stone". Respond in journal as to how they would remove the sword.
3. Develop a play with kings and castles. Read a book about the medieval period.
4. Analyze role of characters to gain knowledge as to life during the period.
5. Read about Knights of the Round Table, dragons, castles, and King Arthur.
6. Develop a choral reading activity around a specific theme: knights, castles, dragons, etc.
7. Have students read a story of medieval times and recreate the story dramatically.
8. Read medieval stories and have students write different conclusions.
9. Read fiction and non-fiction, analyze characters and plot lines.

F. Science-Technology:

1. Study and illustrate simple machines used in medieval times. Make a simple machine.
2. Investigate how drawbridges operate. (levers and pulleys)
3. Use the computer to locate information about medieval castles, clothing, music, etc.
4. Investigate what resources were available during the medieval period.
5. Investigate inventions of this period.
6. Research catapults, machinery, and weapons used in medieval times.
7. Develop timelines of the impact of the medieval period on history.
8. Investigate the types of plants that were used for food and the irrigation methods used at that time.

Students identified the following programs to be included within their unites to enrich planned activities:

1. Surfing the Web
2. Kid Pix - Spinmaker Educational
3. Kidwriter, Kidwriter Gold - Spinmaker Educational
4. Once Upon A Time Vol. II - Compu-Teach
5. Classroom Newspaper Maker - Tom Snyder Productions
6. Kid Works 2 - Davidson
7. The Graph Club with Fizz and Martina - Tom Snyder Productions
8. Time Liner - Tom Snyder Productions
9. The Louvre, Vol. I - Voyager - Laserdisc
10. National Gallery of Art - Voyager - Laserdisc

After the brainstorming sessions students selected specific objectives to be addressed in their unit plan. Lesson plans included specific content appropriate to the objectives. Following Walmsley's (1996) suggestions, all plans centered on student- and teacher-generated interests. The instructor scrutinized all activities to assure appropriate depth of knowledge, rather than superficial time-wasters. The instructor regulated the length of the units; however, the education students also self-monitored and adjusted their units. All mentor teachers were encouraged to expand their own knowledge through surfing the Web, CD-ROM, and library usage. Final plans included focus activities, strategies to enrich instruction, independent review materials, and many innovative methods of assessing learning.

At the conclusion of the first unit most pre-service teachers responded positively to the project. For example, one preservice teacher indicated:

> We studied castles and helped the students by giving them some ideas on different kinds of castles. The students displayed their finished products in the hallways of the school so that other students could view them. This gave the students a great sense of accomplishment. This was definitely a positive learning experience for them. Overall, any field experience was a positive experience. I learned a lot from the students as well. __________ is a great school. It is a school I would actually consider teaching at in the future.

A debriefing with the educational specialist produced the following information:

1. E-mail contacts have been initiated with teachers in Australia, Hawaii, and areas in the Untied States.
2. Service teachers "loved it" because the students were so excited and they learned without feeling pressured.
3. The teachers learned to work as facilitators within a flexible schedule.
4. The teachers plan to continue developing the units. Some have began using their home computers for the first time.

5. Students worked at higher levels than previously observed.
6. Lack of enough time in a day was cited as a negative.
7. All involved in program are eager to share their experiences with others.

The college supervisor noted that pre-service teachers discovered that some experienced teachers were threatened by the use of technology. They find their role is changing from lecturer to facilitators and mediators. They are becoming aware of their need for computer skills as well as an ardent desire to integrate technology into the curriculum if they are to be ready for the 21st century student. Some are finding stumbling blocks in order to prevent implementation. Even the greatest of these, the lack of available time, can be overcome when teachers recognize the extremely positive end-results as desirable.

Each collaborative effort between the teacher education program and elementary students is a new experience. Both groups are learning together and the benefits are tremendous. The experienced teachers learn and review skills and pre-service teachers acquire skills and experiences that will prepare them for their future careers. These people are all truly becoming members of the global society as they share on-line communications with "real people" in near and distant places.

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Distance Learning: Not Just a Landscape Romper Room

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The increasing importance of distance learning in higher education has led many colleges and universities to incorporate distance courses into their education curricula. Distance education refers to teaching and learning situations in which the instructor and the learners are geographically separated and use electronic delivery systems. The role of the student in this process may be referred to as distance learning and the instructor's role may be referred to as distance teaching (Lane, 1992). The use of new delivery systems are changing the roles and behaviors of both instructor and learner. Each must adjust to the model that they choose.

There are many different distance education models. Some models can be described as follows:

Model A: Interactive telecommunication technologies are used to extend a classroom-based course to one or more different locations. Students and faculty are required to be in a particular place at a particular time. Class sessions involve synchronous communication.

Model B: Students are provided a variety of materials and access to a faculty member who provides guidance. Contact between the student and instructor is achieved by a combination of technologies. Presentation of course content is through print, computer, videotapes or their combination. The students can view course materials at a place and time of their own choosing.

Model C: This model is similar to Model B but may be presented to groups of students. These groups of students can come together periodically in a specified location for instructor led class sessions (The Institute for Distance Education, 1996).

Because there are many different applications, purposes and technologies, educators are challenged to carefully plan models of distance education that meet the needs of the student yet still provide a quality academic program. This challenge makes it necessary for instructors and students to become aware of the principles of effective distance learning strategies. Therefore, a description of the experiences from educators and students in the process of distance education could provide valuable information in planning effective distance education programs.

The purpose of this paper is to provide a description of two educators' experiences as distance education instructors. Information will be presented in three parts. First, a description of the distance learning model which was used to deliver two different graduate courses will be presented. The description will include a listing of program elements such as: scheduling, site locations, class size, technical support, staff support, library services and material distribution/delivery. Second, some experiences that the instructors and students had in changing presentation and learning pedagogy will be presented. And, third, experience based application ideas in the areas of presentation, organization and interaction will be listed.

Description of the Distance Learning Model

Undergraduate and graduate level courses are offered via distance learning methods by Eastern Kentucky University. Three types of television distance education are available: satellite, two-way video, and video taped. These types of delivery systems are similar to Models A, B, and C as described above.

Teachers of satellite courses deliver classes from studios. The signal is microwaved to Kentucky Educational Television facilities and uplinked to a satellite. The satellite signal is then picked up with receiver dishes that are located at various sites at specified times. Students can see and hear the instructor but the instructor can only hear from the student by way of an 800 telephone line that is linked to the teacher's ear.

Two-way video classes are delivered from Eastern Kentucky University's Telelinking facilities. The use of compressed video technologies make it possible for the instructor to be able to see and hear their students during instruction. The instructor and students meet at a specified time and place. Site facilitators assist with technical and classroom management responsibilities at each site.

Teachers using video tape course delivery record their lessons and send the tapes to students who cannot come to campus or to a central distance site. Students are usually professionals who wish to complete a degree, improve skills, or begin a degree program then later attend classes on the main campus (Eastern Kentucky University, Division of Media Resources, 1995).

A two-way, interactive video system at Eastern Kentucky University was used to deliver the two different graduate courses presented in this paper. These two graduate courses include: Elementary School Curriculum and Instructional Media and Technology. These courses were presented on Tuesday or Thursday evening for two and three-quarters hours (which includes a fifteen minute break). Each course was offered for the duration of one semester and up to four consecutive semesters.

Site locations involved the Eastern Kentucky University's main campus plus four additional sites located in south, central, and eastern Kentucky. Much of the eastern region served by the Eastern Kentucky University's distance learning sites is located in a geographic location that is rural, mountainous, and referred to as Appalachian. The population that was served included graduate students in education programs or coursework. There was an attempt to limit the class size at each site in order to encourage interaction between the instructor and the students, between students at different sites, and between students within each site. Total class sizes varied between fifteen to thirty-four students.

Each site was provided a trained, technical facilitator to assist with the use of the equipment, distribution of materials, and verification of attendance. Technologies that helped facilitate interaction included: (a) the Kentucky Telecommunication Linking Network (KTLN) which is a two-way compressed video system; (b) on-line computers; (c) a document camera; (d) a fax system; (e) a telephone system; (f) a video player; (g) several different types of microphones (for students and instructors), and (h) a four camera classroom system.

Library services available from the university include: (a) information sessions concerning the services provided by the librarian responsible for supporting off-campus classes; (b) access to the university's on-line public catalog and other relevant Internet and World Wide Web search engines and databases via the computers located in the compressed video classroom; and (c) demonstrations of databases such as Proquest which are available to students at the extended campuses. Additional extended services provided by the librarian involves filling requests for materials or conducting online database searches on particular topics. Specific books or journal articles are then delivered to the centers.

A courier system was established for the delivery of materials to sites for distribution to students. Instructors and students also have access to a fax machine, telephone and on-line computers to exchange information and materials. And yes, in some cases, the United States' postal system (or snail mail) was used. Each student and faculty member had the opportunity to acquire "VAX" accounts with the university's academic and telecommunications services office. These accounts enable users to gain access to Internet, World Wide Web, and e-mail services.

Changes in Presentation and Learning Pedagogy

After interviewing a small group of adult learners, researchers Sebastion, Egan, Welch & Page (1996) concluded that, "Distance learners value instructors who are well prepared and organized" (p. 158). They also concluded that distance learners like instructors who displayed such behaviors as relating to them by looking through the camera lens, pacing activities well, using humor, and appears to be comfortable. In order to accomplish many of the valued characteristics listed above, the instructor and the student should receive some assistance in the use of equipment and technologies. Instructors should receive presentation and material development training. It is also suggested that students be introduced to equipment and interaction procedures. After training and introductions to the use of equipment are completed, instructors and students need to make changes in their teaching and learning pedagogy so that each adjusts to the two-way video learning environment. Examples and descriptions of some areas of change in pedagogy for distance instructors and learners are provided below.

Great care must be given to plan for and develop an interactive environment that is comfortable for the distance learner. To do this, the instructor and site facilitators must present an orchestrated effort to use effective classroom management strategies such as confirming attendance, distribution of materials, and creating seating arrangements for small cooperative groups and the viewing of presented materials.

When planning materials and activities, the instructor should remember to incorporate all three domains of learning: cognitive, affective, and psychomotor (Verduin and Clark, 1991). Content presentation, assignments, and questioning techniques should incorporate all levels of cognition. These levels of cognition should range from knowledge, to comprehension, to synthesis and evaluation.

Viewing the students and/or instructor is often limited by the television camera operator. Therefore, the instructor and students need to adjust to interacting with the individual(s) seen on a monitor. Also, since there is often a delay in audio delivery, the instructor and the students find it essential to modify speaking behaviors in a manner that accommodate this delay.

The instructor and students should prepare and deliver materials well in advance of a course meeting. These materials should be well organized, correctly sequenced and easy to distribute. Color-coding, decorating, stapling materials often assists students in locating the necessary materials in an efficient manner. Site facilitators should help distribute materials as the instructor concentrates on material presentation. Great care should be taken to focus material development on the main concepts of the course content. In this case the expression "less is more" may be a good idea.

Printed materials that are presented through the document camera should be developed that are bold in font size (36 point font) and color. Document cameras require print materials that are printed in "landscape" to match the format of the television screen. Distance learners appreciate some variation in presentation strategies such as the use of videos, demonstrations, peer commentaries, guest speakers, and the viewing of realia. Materials that are attached to the walls or presented on chalk or white boards are often difficult to see at distant sites.

Distinct verbal or visual cues should be established to begin and end the time of instruction or small group activity. A routine procedure to begin and end class helps the distance learner to recognize important transitions. A visual sign that announces the title of the course, group time, breaks, and/or the end of the class can be broadcast to the site monitors.

Two-way video provides a high-level of interactivity among participants. Questioning may occur between the instructor and learners, or between learners with other learners. Five or six questions may be presented on an overhead slide. Learners may select one to five responses. The instructor may then facilitate the interaction among the learners at the various sites.

Grouping of learners for interaction and/or presentations may involve forming cooperative groups among learners at various sites. On the other hand, grouping may also occur among learners across centers as they choose various topics for presentations. Thus, the learners can be grouped according to topic or issue rather than location. Computer technology such as e-mail or class listservs may facilitate discussion among group members.

Because there are many more elements involved in the learning process during a distance learning experience, the instructor and institution should plan for assessment in more than course instructional design, learning achievement, and instructor effectiveness. The instructor and students should be given the opportunity to provide information about the effectiveness of the technological systems and concerns about management or administration. It is also important to receive feedback about implementation elements such as: video and audio quality, interaction between students and the instructor during class sessions, delivery of materials, availability of other resources, etc. (Rezabek, Cochenour, Bruce, & Shade, 1995).

Experience Based Application Ideas

As both instructors and learners participate in distance learning experiences, adjustments are made to meet the demands of the delivery system and specific class needs. The student and teacher find that there is a constant demand for behavior and learning style change. Therefore, some helpful hints from persons who experienced distance learning events could motivate, assist, and reassure future participants. Some of these experienced-based application ideas are listed below in the areas of presentation, organization and interaction.

Presentation over the two-way video system requires more than an instructor delivering a dull lecture. Learners live in a media world and their attention drifts if not stimulated. Therefore, it is essential that instructors relax and become themselves. Planning for interactivity at least every ten minutes alerts the learners and focuses their attention. Humor also tends to decrease any tension that may develop from having to be "on camera".

Organization of the content should be well defined as discussed in the section on planning. On the other hand, instructors should also allow for the "teachable moment" and spontaneity. The best learning may come from this type of interaction.

Interaction among the instructor and learners, learners and learners is essential. But, allowing for local conversations about the content is just as important for learners to negotiate meaning of content or develop questions for interaction.

Summary

Participating as a learner or instructor in a distance education experience can be a rewarding one. Students may appreciate the location of the sites and the use of emerging technologies. The instructor may appreciate the opportunity to present information through a new medium or be able to contact distant learners for interaction and information exchange.

Education communities are embracing the concept of distance learning. Many universities and colleges are offering more academic and professional development programs every day. Interest is increasing and the use of distance education is rapidly growing. Therefore, educators and students must prepare for changes in instruction and learning.

As educators prepare for distance education instruction, they realize that they should make more adjustments than just printing their materials in landscape instead of portrait format. And, there is more to consider then just looking into a camera and saying hello to everyone at the distant sites (like entertainers did on children's television shows such as Romper Room). It is essential that they adjust their presentation, interaction, and organization techniques. Such elements as technology, content, student needs, facilities, materials, and administration duties, should be considered when planning and designing instruction.

Distant learners also have to make adjustments. They need to change and adapt many learning habits concerning acquiring information, performing in class, exchanging materials, and completing course assignments. All participants in the education community should carefully weigh the advantages and limitations of distance education. A careful study of how distance learning events can effect short and long term outcomes is advised.

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Six Criteria for Technology Integration in Multicultural Classrooms

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As the ratio of students to computers continues to decline (Hayes, 1992), computers have become a ubiquitous presence in American schools. In 1992, there were approximately 400,000 computers in our schools, about one computer for every 13 students (Anderson, Beebe, Lundmark, Magnan, & Palmer, 1994). Giving additional momentum to this trend is President Clinton's "Technology Literacy Challenge" and his goal of making all teachers comfortable with computers (NCATE, 1996). Clearly, "the tools of teaching and learning are rapidly moving from the traditional chalk and blackboard to computer terminals" (Reid-Wallace, 1996, p. 7).

At the same time, the United States is experiencing a rapid cultural diversification which reverberates in American schools. Between 1980 and 1990 the total foreign born population grew by 40% (Waggoner, 1993). Moreover, the majority of recent immigrants come from non-European, non-English-speaking countries (Croninger, 1991). In 1990, of the forty-five million school-age children in the nation's public schools, some 9.9 million lived in households where a language other than English is spoken (Menchaca, 1996). If current trends persist, by 2050 the total number of Native Americans, Asian Americans, African Americans, and Hispanics in our country will surpass the number of White Anglo Americans (Lee, 1995, Wise & Gollnick, 1996). Indeed, in 1990, minorities already constituted between 24% and 96% of the total school enrollment in eighteen states and the District of Columbia (OERI, 1992). These children bring with them learning styles, beliefs, interpersonal styles, and expectations that "create a different context for learning and teaching" (Pond, 1996). Thus, the classroom teacher is thrust into a cultural milieu that brings together the learner's culture, the teacher's own cultural background, and the computer culture. (Chisholm, 1995-96).

If schools are to prepare children for the challenges of the next century, teachers and administrators will need to implement educational strategies that help develop technological and interpersonal skills (D'Andrea, 1995). To educate a population that differs widely in income, ethnicity, language, and culture, schools must implement strategies and programs that are flexible, supportive, and equitable. Unfortunately, although there is much information on computer hardware and software, textbooks "say a great deal less about how to teach effectively with computers" (Ryba & Anderson, 1993, p. 11). The issues facing educators as they integrate computers into teaching, therefore, are pedagogical as well as technological. Of these two, the pedagogical issues have received the least attention.

Accompanying this dearth of information on teaching with computers is the lack among many teachers of the necessary knowledge and skills for working with minority students. Teachers and students generally live in geographically and existentially different worlds (Gay 1993). While almost a third of all elementary and secondary students are minorities (Gay 1993), ninety-two percent of new teachers are white ("By the numbers," 1994). Similarly, though a growing number of students live below the poverty level ("America's changing students," 1996), most teachers are middle class and reside in small or mid-size suburban communities (Gay, 1993). Consequently, their experiences, expectations, and reality are different from those of their students. Since only 13% of employed teachers are minorities, most students never have a minority teacher (Wise & Gollnick, 1996). Teachers, therefore, need to develop both cultural competence, that is, "the ability to function comfortably in cross-cultural settings" (Chisholm, 1994, p. 47) and cultural literacy, a knowledge and respect "of the history, traditions, and values of persons from diverse backgrounds" (D'Andrea, 1995, p. 46). This cultural competency and literacy must then carry into the educational use of computers.

Adding to the complexity of teaching in a multicultural classroom environment are the cultural properties inherent to computers. Computers, as cultural artifacts, connote the values, preferences, and cognitive schema of their creators (Chisholm, 1995-96). Hence, they are not culturally neutral, but, rather, culturally bound. Thus, if schools are to provide a high quality education for all children, teachers must apply equitable and culturally responsive strategies to the use of computers in culturally diverse classrooms. These strategies will benefit all students by meeting a variety of needs and differences.

Equitable and Culturally Appropriate Strategies

What, then, constitutes equitable and culturally appropriate strategies for educational computer use? There are a multiplicity of factors associated with culturally responsive teaching. Some aspects of culturally appropriate teaching are overt, such as using software with graphics that portray a variety of racial and ethnic people; some are covert, such as valuing interdependence and collaboration during computer activities. Equitable and culturally appropriate strategies do not require the impossible task of incorporating every aspect of cultural differences. Nor do they imply that educational goals and expectations in culturally diverse classrooms should be inferior or more limited than in traditional classrooms. Rather, culturally responsive teaching calls for the incorporation of some features of the child's own culture (Au & Kawakami, 1991).

Furthermore, equitable and culturally appropriate strategies in educational computing must be broad enough to be inclusive of diverse learners, yet specific enough to be valuable as a guide to multicultural teaching. Such strategies should not be so prescriptive as to squelch individual creativity or personal differences in teaching and learning. In addition, such teaching strategies must be grounded in sound pedagogical practices. Among the factors identified by experts in the field as important to effective teaching of diverse students are the selection of appropriate content and classroom materials, the choice of culturally responsive instructional approaches and methodologies, and the structuring of a supportive educational setting (Banks, 1993; Ladson-Billings, 1994; Reyes-Blanes & Daunic, 1996). In short, equitable and culturally appropriate use of technology must be good teaching for all students.

Multicultural Elements in Technology

I propose six elements for integrating technology in culturally diverse classrooms: cultural awareness, instructional relevance, classroom environment, equitable access, instructional flexibility, and technology integration. These elements, based on the research on effective teaching of diverse students, meet the above criteria. These elements are not exhaustive of good practices for technology use with diverse learners, but, instead, focus on key multicultural aspects. Recently, the author applied these six elements in the evaluation of thirty-two teacher-generated instructional units that integrated technology. These application of these elements proved both informative and effective in identifying how teachers integrated computers for diverse learners. Extensive thematic units illustrating some of theses elements are available at the Creighton Elementary School District Web site www.ariz.com/lomalinda.

The first element, cultural awareness, refers to instruction and learning activities that demonstrate support for differences in learning preferences and language. Although there is much variability between individuals within a cultural group, research suggests that across cultural groups there are different preferred ways of learning (Griggs & Dunn, 1989; Jacobs, 1990; Rhodes, 1990). Awareness of cultural and individual learning preferences and behaviors is essential for culturally responsive technology use. This awareness grows out of a knowledge of multiple intelligences and learning styles, as well as from knowing one's students through careful observation, conversations with parents, and direct communication with students.

An example of the application of cultural awareness to educational technology comes from one of the teacher-created units. Ms. J found that many of her children acquiring English as a second language benefited from kinesthetic activities. Consequently, she designed hands-on learning activities, such as tallying the number and types of transportation that passed in front of the school during a thirty-minute period. She then had students transfer their observations to the computer as charts, graphs, and, eventually a slide show. Thus the teacher provided her students with learning opportunities that took advantage of their strengths and then linked these activities to computer applications.

The second element, instructional relevance, exists where educational technology, topics, activities, programs, and resources relate to the children's background, prior experiences, current knowledge, and personal interests. Instructional relevance induces students to become actively engaged in their own learning. When learning makes sense and is important to children, intrinsic motivation emerges (Wlodkowski & Ginsberg, 1995).

There are three types of relevance: personal experiences, prior learning, and immediate relevance. Explicit reference to previous learning to previous learning helps the student organize new learning within the framework of existing knowledge. Thus new concepts gain relevance through their association with prior knowledge. Associating new learning with personal experiences links learning to personal events, knowledge, understanding, perceptions, emotions. Thus new knowledge becomes relevant as it acquires personal significance. A learning activity has immediate relevance when the student finds the activity purposeful, pertinent, challenging, and product-oriented. In short, immediate relevance emerges from interesting and engaging activities.

An example of relevance through prior knowledge comes from a unit on oceanography in which the teacher asked her students to recall things that are necessary for survival. They then word processed their lists. Next, students used their personal experiences to talk about the beach. Finally, the teacher created immediate relevance by sharing objects she had found on a west coast beach. Students then compared these objects with objects found at an east coast beach. They drew conclusions about the differences in the objects found on the two beaches and used a CD ROM encyclopedia to find additional information.

The third element refers to the classroom environment in which the computer is used. The culturally responsive environment is inclusive and demanding. There is an expectation for higher level thinking and academic success from all students. Activities provide for differences in learning preferences and afford opportunities for both individual and collaborative work. It is a safe, accepting environment in which individuals genuinely respect all forms of diversity. Therefore, the student's family and culture are part of the learning experiences.

An example of a culturally responsive classroom environment is that of Mr. R. Using an interactive simulation program, students worked in small groups to resolve the social problems presented by the program. They learned to give each other feedback, monitor their responses to disagreements, and negotiate solutions to problems. This activity required higher level thinking, collaboration, and interpersonal skills. A second example is that of Mrs. S who had students compare and contrast their own culture with that of the native American cultures they were studying. Students then created Venn diagrams on the computer showing the similarities and differences. In this lesson, the students used higher level thinking and developed a deeper understanding of native American cultures by associating it with their own experiences.

The fourth element, equitable access to technology, refers not only to the students' access to the hardware, but also to varied software. Teachers determine access to computers by deciding who uses the computer, with whom, for how long, and for what purpose. Equitable access means that children can use the programs that best meet their own needs. Consequently children may not all use the same programs or in the same ways. However, equitable access does not mean that less knowledgeable students or those with learning needs should be relegated exclusively to drill and practice programs. Though they may use and benefit from such programs, equitable access means that they also use other more challenging and interesting programs. Moreover, equitable access provides for language differences. Though provision for a child's dominant language may be take the form of dual language or native language software, there are other types of language support. These alternative forms of support include peer facilitation and adaptive instructional strategies.

One teacher who provided instructional adaptation to increase student access to computers created a flow chart in Spanish so that her monolingual Spanish speakers could work independently in creating HyperCard stacks. Another teacher provided peer support by pairing native English speakers and non-native English speakers at the computer. The proficient English speaker could read the menus and help the English learner to navigate the software. A third teacher allowed students to prepare their computer-generated reports in their native language; bilingual students translated the reports for the class.

The fifth element, instructional flexibility, supports differences through varied modes of instructional delivery and evaluation. There is instructional flexibility when teachers present instruction and assess learning in ways that support multiple intelligences, varied learning preferences, and differences in linguistic ability. Culturally supportive classrooms give student choices in content, learning modes, and assessment methods (Wlodkowski & Ginsberg, 1995). In using technology, students select programs and media, choose topics, and pick the partners with whom they work.

A fifth grade teacher demonstrated high instructional flexibility by encouraging students to choose partners for their projects, allowing them to select an aspect of the class topic for a focus, and having them decide their responsibility for their share of the work. Although all students used HyperStudio to design their presentation, students progressed at different rates through the various stages of their projects. Another teacher provided alternative ways of demonstrating learning. His students could choose to create a slide show presentation, create a graphic demonstration, or create a three-dimensional model.

The sixth element, technology integration, refers to the degree to which technology becomes an integral part of student productivity and information gathering for all learners across a variety of academic disciplines. Tutorials and drill-and-practice applications are not generally productivity-focused programs. Their purpose is to provide practice on specific content or skills. Although they can be useful for their specific purpose, they limit creativity, problem-solving, and thinking. Technology integration goes beyond such program uses to the application of computers for purposeful, productive, and challenging educational endeavors. Technology becomes an essential part of the curriculum and learning activities. Therefore, learning with computers becomes meaningful and practical.

Technology integration is evident in a geography unit in which students used a map software program to locate U.S. cities and gather information on those specific cities. Students then used a spreadsheet to compare the population of the cities and graph the results. They also created a treasure map on the computer and wrote directions for other groups to follow. As this example illustrates, the unit integrated social studies, language arts, mathematics, and several computer applications. In addition, the students attained several final products, rather than engaging in rote skill practice. Moreover, the activities called for higher order thinking, creativity, and interpersonal communication.

Discussion

The six multicultural elements for educational computer use presented here incorporate many of the practices identified in the multicultural literature as effective in teaching linguistically and culturally diverse students. The multicultural elements include such effective practices as the incorporation of student language and culture, use of students prior knowledge and experiences, support for a variety of learning styles, active student participation and interaction, implementation of cooperative learning, and respect for diversity of opinions. Thus, sound pedagogical practices underlie the six elements presented here.

Although the author successfully applied these six elements to the evaluation of computer-integrated instructional units for multicultural classrooms, the multicultural elements still need validation through additional research and application to a variety of classrooms. Once validated, they will have direct application in the professional preparation and development of teachers. Teachers can learn to self-assess the cultural congruency of their computer use by utilizing the six elements as a checklist. Education faculty and student teacher supervisors might also use the six elements in observing student teachers use computers with a diversity of learners. Finally, in-service training on computers could incorporate the six multicultural elements so that teachers become culturally and technologically competent.

Further research on effective teacher use of technology in multicultural settings is needed. Researchers have investigated teachers' computer training, perceptions and attitudes toward computers, and educational applications of technology. Nonetheless, there is an urgent need for further exploration of teachers' multicultural understandings and their application of instructionally compatibility strategies in working with diverse learners. As the nation moves towards increased educational use of computers, the absence of culturally compatible strategies will only widen the academic and socioeconomic gap between those who have computers at home and those who, at best, experience them only at school.

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Intercultural Education And Telecommunication Networks In Teacher Training

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This paper discusses bulletin board systems (BBS) as one very useful tool for supporting intercultural education courses. The theoretical basis for the proposal is the idea of interculturalism as an educational response to the interest aroused by actual interaction with multiethnic and multicultural societies. This paper describes a basic system that, from our point of view and presents a pedagogical plan and, then, discusses a special educational plan.

Education today is set within the historical and cultural context of a society that is increasingly complex, continuously-changing, becoming more international, and moving towards a crisis model of dealing with rigid structures and traditional values. In such a context, the problem of communication becomes very important; the problem is how to establish relationships both at a personal level and between groups, people and nations, without competitive comparisons or disparagement.

Many individuals, and groups, in society today feel considerable discomfort in a wide range of interpersonal relationships that require communication and interaction. That, together with intercultural incompetency when approaching and meeting the "other" (Paparella, 1996), are a sign of the need for an education that drives and orients us towards an ethics of comprehensive cooperation, in fact, toward an intercultural ethics.

So, I agree with Rossi who remarks that "communication today has a lot of strong contradictions that characterize our society and culture" (Rossi, 1992, p. 98). In fact, it is easy to verify that when a person's self-identity derives from the affirmation and recognition received from others; that person's free and autonomous development is often denied. So, while the dignity and the value of each person is recognized, at the same time, there is often a "phenomenon of the hierarchicallization of the cultures" which classifies and ranks members of cultural groups (Fitzinger, 1992, p. 71).

Today's focus on the problem of communication across different cultures has not caught up with the explosion of cross-cultural communication opportunities made possible by a new communicative practice: telecommunications. The new technologies for distance communication have achieved, by now, a capillary diffusion. The characteristics of the technologies available have rendered even the most sophisticated informational applications easy to use. The informational network, Internet, connects every corner of the globe, forming a community of electronic exchange that has indeed resulted in the foreseen *global village*.

The Role of the University

The university is where new forms of intervention should be promoted and tried; it is the environment from which new proposals, new values, and ideas should emerge. In short, the university is the natural cradle and catalyst for innovation and change.

Among the activities carried out for many years now by the Department of Pedagogical, Psychological, and Didactic Sciences at the University of Lecce in Italy is the study and research of intercultural education. Work in this area at the university has become an important influence on a post graduate course for teachers, *Intercultural Education and European Dimension of Teaching,* which Professor Angela Perucca directs. The program structure we describe here is an appropriate response to the new formative demands that come from our schools and which will benefit not only teachers, but also their students.

Distance Learning and Intercultural Communication

Telecommunications, seen as access to information nodes and to remote resources, was at first an experience reserved for the few. Now it has become a very cheap resource available to all. In just a few years, it has led to the development of a planetary web, a distance communication highway connected by the famous Internet, "the net of the nets."

At the University of Lecce, we prefer to use bulletin board systems as a specific tool of communication among individuals and groups of individuals. Thus, we plan to develop collaborative and training activities in the field of intercultural education that incorporate electronic bulletin boards. The fundamental purpose of our plan is the design of a theoretic framework to develop intercultural education courses using a telecommunications network consisting of a server and clients of the BBS.

BBS are tools that provide easy use, powerful and quick means of information transmission, both on local (LAN) and geographical (Internet) networks, as well as on public telephone lines accessible by modem. All over the world, including Italy, there exist a conspicuous number of BBS, which can be used primarily as e-mail systems, as systems for managing electronic lectures, as systems for public or closed group presentations, and as all of these things combined.

Different kinds of BBS exist with different groups of consumers registered to each. They differ according to the type of connection, the user network developed, the services offered, and, also, the interface model adopted for human-machine interaction. Because BBS employ either a text interface or a graphic interface and, for this reason, navigation can be of greater or lesser complexity and may differ in degree of interaction.

Media and *education* are more and more becoming synonymous with *fads*. Often media creates new ways for old methods and content rather than furnishing additional educational *substance*. Our work, instead, was born from methodological-disciplinary necessity and from a precise pedagogical awareness, not from a wave of technological enthusiasm. In our curricular plan, BBS are not used like a virtual container to be filled with a generic informational content. To the contrary, their use stems from the idea that the "media" is more that an empty box and should be considered a tool with its own message. Consequently, it is really an appropriate intercultural and international tool (Pinnelli, 1996). By using a BBS as a tool for social communication, intercultural education can move from a theoretic-epistemologic dimension to an operative one .

To explain this position and clarify the terms of the plan, I shall address the following questions: (a) Why do we think telecommunications is a useful strategy to improve intercultural education?; (b) Why use a BBS?; and (c)What new possibilities does this electronic tool offer the field of education?

Telecommunications as a Useful Strategy

Distance learning, open learning, and collaborative learning certainly were born in a pre-telecommunications era. They, nevertheless, can find in telecommunications a source for enrichment, development and substantial modifications . Telecommunications brings informative and remote resources, as well as permits equal participation and interaction among individuals of different cultures, sex, age, and religion.

"Despite the growth of technological possibilities, there exists a certain scarcity of conceptual models relative to the employment of telecommunications in the learning processes " (Olimpo, 1992, p. 7). There is, first of all, a discrepancy between the actual rhythm of technological innovations, which are necessary for mastery and integration of technologies into every day activities, and the internal slowness of the cultural transformation. Second, we find an innate resistance in the academic world to understanding and useing new tools, methods, and resources. Finally, we find a certain incapability in the technological world to present practical applications for the new tools that it makes available.

These difficulties have often contributed to wide conceptual and operational discrepancies between technology and education. These discrepancies have sometimes caused a myopic vision of the positive impact that telecommunication experiences can have on the formative development of teachers. This impact, from our point of view, can be expressed in terms of three dimensions: horizontal, vertical and diagonal.

On the horizontal axis are the technical formalities that telecommunications imposes. These technical formalities affect the cognitive effectiveness of the media (Briano, Midoro, Trentin, 1995-96). On the vertical axis are the cognitive-heuristic dimensions that are linked to the use of distance-training systems, as demonstrated in the literature on this topic. The third dimension, the diagonal, evidences the participation of users in a *wide*, atypical community. Such participation stimulates teachers and students to a broader involvement in the study, awareness, and exploration of new cultures. As preceding experiences in this area confirm, communication and learning via a network develops in students and teachers "a sense of community to which they very strongly belong" (Aa.Vv, 1995-96) . This community goes beyond the social circle in which they are fisically situated to the telecommunications virtual community in which they participate. These experiences produce a sense of responsibility in sharing language and ideas. They drive users "to a collective-building process of knowledges" (Aa.Vv, 1995-96, p. 85).

Learning as a social experience becomes truly possible through telecommunication. It is, necessarily, the key-idea that will drive the development of systems for distance education. On -ine education implies an interaction of the user in a real and personal exchange of learning that overcomes individual isolation and encourages the exploitation of a relationship with the group and the sharing of meanings (Briano, Midoro, & Trentin, 1995-96, p. 62). There are some methodological and formative reasons that strongly support the pedagogical value of using the new technologies for distance communication as an intercultural key.

Reasons for Using BBS

Many reasons have led us at the University of Lecce to prefer BBS over other distance communication tools. First of all, the use of this electronic mail system could be an effective strategy to protect users *against the disorientation* that they would inevitably experience upon first entering the Internet. This disorientation is certainly detrimental to learning. Although a first-time visitor to the Internet can immediately have an idea about the numerous possibilites offered by the net, such as discussion groups, news groups, and social networks, it is likewise easy to realize that most of our students are absolutely lacking in methodology and reference points which may guide their electronic interactions toward a pruposeful goal. Electronic communication can be created for and by a random group of users who establish the rules and the objectives of their on-line interactions. However, things are very different when using the internet for didactic or educational purposes

BBS are one of the most popular lanes on the great super highway of information that is the Internet. Using the already existing telecommunications network, BBS offer a preferred means for exchanging messages among a closed, or at least definable, number of users. Secondly, there is a *personal dimension* implicit within electronic communication. Any one who subscribes to a BBS becomes part of a public group of people. He or she participates in a public list of names of people who share certain rights and duties. In fact, subscription to a BBS implies acceptance, more or less formal, of some communicative conventions and of the rules for interaction among users. Each one is subject to periodic controls from the administrator of the system. The expansion of the group to affiliate groups can be decided according to the purpose of the group. Potentially, each BBS could have an endless number of users, but the system can be set up in a specific way. The users determine the types of user "privileges", the kind of participation, i.e. active exchange of messages or only "reading," the nature of discussions, and the type of messages.

The opportunity, on the one hand, to have a basic software tool that selects, organizes and leads the user to the discovery of information, and, on the other hand, the possibility of forming groups of people that responsibly decide to comply with the system, are strong reasons to legitimately prefer this tool. Another important factor influencing our preference of BBS as a useful tool for educationally structured exchanges, is the interface interaction. Those who keep abreast of the application of these new technologies to learning know well the importance of human-computer interactions and, in particular, the design of the *interface* (Anceschi, 1992) The user interface is a membrane comes between the individual and the computer. This membrane becomes thinner and more transparent the more it meets the cognitive, ergonomic, and communicative needs of the human mind. An answer to such demands is offered by the FirstClass software platform. This software has the advantage of facilitating the interaction of the user with the system through an extremely intuitive and simple graphic interface which only requires the use of the mouse and the management of icons.

Additionally, all FirstClass BBS are part of one or more One Net network and offer the capability of diffusion and of access through a single site. They provide access to discussions of public interest and of public utility promoted by different BBS. Thus, they allow users interaction on a more extensive circuit than a single BBS provides. Each FirstClass BBS accessed through this broad network is organized into a system of gateways that allows all registered users of specific BBS to participate in an international circuit. With this system, each BBS user could decide to communicate with an extensive circuit of consumers interested in a specific topic.

New Possibilities

We move, then, to the third question: What new possibilities does this electronic tool offer the field of education? One of the particular characteristics of the BBS is the possibility of organizing virtual meetings and collaborative groups for the purpose not only of distance interaction, but also for the achievement of a specific educational goal. Building a social space within the global village allows one to approach distance communication in a clearer and friendlier way. The matter is not only to add a human dimension to cyberspace, nor merely to provide appropriate activities with specific educational objects that follow sound methodology and promote the interaction. Instead, it is also a matter of taking advantage of the principal benefit of telecommunications, that is, its ability to "widen the frontiers of the classroom by developing a net attitude" (Olimpo, 1992, p. 11) and adapting this frontier to an educational and learning plan.

These kinds of experiences can truly encourage interpersonal dynamics, individual growth, and group development. Such exchanges facilitate sharing problems and solutions to situations that have originated under conditions of isolated thought and organization. Some experiences in this area (Olimpo, 1992, p. 11-12) support the position that, in using telecommunications as a learning tool, the creation of work groups involves several steps:

- Formation of a circle in which the members of a group are known.
- Choice and planning of a learning objective.
- Collaboration among the members relative to the objective.
- Creation and sharing of the final relationship.

This structure highlights how, in a broad interactional system, the success of , or at least the capability of conducting effective educational exchanges, is linked to the preliminary formation of closed groups of users, i.e., of *virtual classes*. Also, from a functional point of view, a finite structure optimizes the exchange of documents, simplifies the verification of exchanges, and increases the capability for rigourous evaluations.

Training on the use of a BBS for distance communication can occur in different work spaces so as to require communicative exchanges, transfer of documents and informative materials,and research and production of elaborate shared projects. Among the structured activities that the instructor can use are:

1. The creation of *lecture* spaces, that is, thematic areas for public debate moderated by an "expert" who manages the technical aspects of the electronic forum and assures the quality of the content;
2. The formation of closed groups, *virtual classrooms* of students who participate in an educational course of learnings transmitted through the teachers remote station. These participants will contribute to the development of the formative course in varying ways, according to their own experiences and culture. They are linked to the same predetermined educational plan, which assures the authenticity of their intercultural experiences.
3. The on line participation among two or more users of the same BBS in real-time direct debates and question-and-answer exchanges that allow them to know each other.

In addition to these three specific experiences, there is another aspect that should not to be undervalued. This additional element is the possible use of BBS as a personal mailbox which lets people stay in touch, one on one, or one to many, with other users and across great distances.

The ability to exchange, within the space of a day, personal messages and documents with BBS subscribers from the other side of the globe constitutes an incentive to develop foreign language proficiency. In addition, the use of a common tool for the mediation of ideas and exchange documents also provides an incentive to become open to the "other", that is, to broad cultural and individual differences.

In synthesis, this media has a double value. It offers the capability to stay in touch with a different social and cultural reality from one's own, thereby establishing affective relationships around the world . It also makes possible the formation of geographically distributed groups that are of a limited and manageable size, thus optimizing the completion of functional assignments.

Conclusions

According to Secco, " interculturality is not a new discipline which has to be inserted among the others; rather, it is a diagonal dimension, " that crosses all teachings and implies engaging in the revision of teaching methodologies and of educational plans" (Secco, 1992, p. 55). The goal is to avoid all forms of monoculturalism; the plan implemented at University of Lecce answers this demand.

As often happens when someone wants to establish a good collaboration between those who are knowledgeable about the new technologies and those who engage in the formative development of teachers, operationalizing such a proposal requires very careful planning and consideration of the different professional competencies each participant brings. This cooperation involves the development of a technical plan and the design of a functional network capable of supporting an ever-growing circle of users. Similarly, it demands the formation of a pedagogical design that gives meaning to the initiative and, above all, that moves the collaborative work toward the attainment of educational objectives.

The Department. of Pedagogical, Psychological and Didactic Sciences at the University of Lecce affords students an innovative, educational experience in its teacher preparation course, Intercultural Education and European Dimension of Teaching. The content and organization of this course creates an environment suitable for initiating students into telecommunications and for establishing a net of students and teachers for the purpose of applying integrative and intercultural educational practices.

It is possible through initiatives of this kind, across different cultures and nations and in a unified way, to establish a macro-circle that is united by a similar purpose and by the same pedagogical goals. Thus, the telecommunications "cable", could become the correct metaphor for this global electronic linkage.

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THE EDUCATIONAL COMPUTING COURSE

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In the preface to the book, *Integrating Educational Technology into Teaching*, Roblyer, Edwards, and Havriluk (1997) assert, "Everything has changed so quickly, in fact, in education and in society at large, that it is often difficult to determine just what is happening and what response is required of us. We teachers stand before technology as we would a mirror. What we see is determined largely by what we are and what we consider important. We may see technology as a creature of speed, precision, and efficiency, able each day to squeeze more tasks into an hour of time than we could the day before. We may see an explorer and discoverer, able to lead others to see the images we see, to pursue the new worlds we envision. We may see something else, something novel and original, capable of making possible the unimagined and undreamt-of —an agent of reform, change, and progress" (p. v).

The educational computing course is growing and evolving as it tries to keep pace with learning theory, teaching practice, learner needs, and curriculum integration. Questions such as, What should be taught?", "How should it be taught?", and"How should the learner be evaluated?" are all valid and relevant to the evolution. The papers in this section address many of these questions.

The first issue to be addressed is idealism vs. realism. With all the objectives that need to be accomplished in a three-hour course, how can these objectives be realistically met? Aschermann's paper discusses the new NCATE standards for technology and the OTA report, then asks the question, "How does a teacher education program begin to deal with the standards of NCATE and the conclusions of the Office of Technology Assessment?" He concludes that "a proper balance must be found between idealism and what is actually taught." Even after this actual teaching, when the preservice or inservice teacher is ready to apply the new knowledge in the classroom, planning for technology use must occur and re-occur. The next paper by Galloway and Blohm discusses the importance of planning for technology with the process of integration being guided by technology-using educators.

The next four papers deal with the restructuring of the educational computing course and the technology component of the teacher preparation program. Sindt, Summerville, and Persichette discuss the changes made to the educational computing course so it more closely relates to teacher preparation courses. The revisions and results are discussed, and although it was concluded that much effort was required for the changes, the achieved results were worth the effort. The next paper highlights the issues considered for the redesign of the technology component by the teacher preparation faculty and the educational technology faculty. The author feels new courses which feature "an integrated, project-based format" lay a strong foundation for the preparation of future teachers. The paper by Keizer and Wright emphasizes a constructivist approach to the computer course that results in self-discovery and adaptation by the learner, but more importantly, this approach leads to exploration that never ends. The paper by Farragher, Francis-Pelton, and Riecken presents a model for teaching content-area subjects with technology.

Other papers in this section deal with the evaluation of students, particularly with the use of portfolios. Russell and Butcher describe the evolution of student evaluations and the applications of portfolios. Carlson addresses portfolio assessment and its application in two case studies assessing learning of instructional technology.

With the restructuring of the teaching of the educational computing course and the revamping of evaluation procedures, the course content has also been revised. Two of the papers in this section deal with the use of the World Wide Web. Hattler presents the Web as one important vehicle for integrating technology and provides "driver education" for navigating the information superhighway. Woodcock provides evidence for using the Web as an interactive and affordable teaching tool.

This section concludes with a paper by Finch presenting the issues of whether or not the educational computing course should be included in the university's list of required courses. Both sides of the issue are presented equally with the readers drawing their own conclusions.

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The Evolving Preservice Technology Course: Idealism vs. Realism

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Today it is assumed that all graduating teacher education students will be familiar with and will be able to use the instructional technology that is available to schools. Beginning October 1, 1995, teacher education programs seeking National Council for the Accreditation of Teacher Education (NCATE) approval must meet the following NCATE standards for technology:

- **Standard 1.C.1 Content Studies for Initial Teacher Preparation** expects that candidates complete a sequence of courses and/or experiences to develop an understanding of the structure, skills, core concepts, ideas, values, facts, methods of inquiry, and uses of technology for the subjects they plan to teach.
- **Standard 1.D.2, Professional and Pedagogical Studies** expects that professional studies for all teacher candidates include knowledge and experiences with the impact of technological and societal changes on schools and with educational technology, including the use of computer and related technologies in instruction, assessment, and professional productivity. (Wise, 1995, p.1-2)

A 1995 report from the US Office of Technology Assessment, *Teachers and Technology: Making the Connection,* expressed a major concern: "Despite over a decade of investment in educational hardware and software, relatively few of the nation's 2.8 million teachers use technology in their teaching." It was concluded that the returns on the huge capital investment were negligible because

- teachers did not have adequate training to prepare them to use technology effectively in teaching,
- teachers reported feeling inadequately trained to use technology resources, and
- technology is not central to teacher preparation (Office of Technology Assessment, 1995, OTA).

How does a teacher education program begin to deal with the standards of NCATE and the conclusions of the Office of Technology Assessment?Four alternatives can be considered:

- ignore the NCATE and state standards required in technology,
- integrate the learning about and the use of technology into the entire teacher education program,
- require an instructional technology course of all students, and
- create a combination of the integration and requirement alternatives.

Trade-offs evolve from the selection of any of the above. The teacher education program at Missouri Western has accepted the fourth alternative. The rest of this paper discusses the required course for all elementary education majors and how the class changed from a 1970s audiovisual class to a instructional technology class for the late 1990s.

Requiring an instructional technology course or modifying an existing course creates a problem for the person who is assigned to teach that class. How can the traditional "audiovisual course" move to an appropriate instructional technology course for the 90's? What is appropriate for the teacher of 1996 who will also be teaching in the 21st century? How can the preservice course develop the technology proficiencies with the latest educational technology but at the same time prepare the new teacher for the realities that will be faced in many of the public schools? Which operating system do students use while in the class? How does the class move students from simply knowing how to use technology to a complete integration of technology within the teaching day? How does the instructor cope with the idealism of what the course should contain to what is realistic in terms of what is actually possible in a two credit hour class? How far can computer novices be taken in a short semester course? How should the course be structured so that the confidence level and attitudes of students about technology become greater?

Missouri Western State College (MWSC) has required an audiovisual class for all elementary majors since the late 1970's. In 1992 the course made a radical change from "audiovisual" to "instructional technology."

The old "audiovisual" course consisted of learning how to operate "sophisticated" equipment like the 16mm projector, how to make color-lift overhead projection transparencies, how to preserve instructional materials with the dry mount press, and a study of the appropriate procedures for the evaluation, selection and utilization of instructional materials. The 1980s course was expanded to encourage preservice teachers to experiment with video production and utilization.

By 1992 it was again time for a major change in the class. All students at MWSC have personal electronic mail accounts, but few knew how to log-in for the first time. Some students were familiar with the computers of the time but would only use the computer for remediation of multiplication tables or word processing.

If a radical change in the class were to come about, decisions had to be made very early. Is the new class going to be a theoretical textbook oriented class or a hands-on class with practical application projects? What should have the higher priority: learning of content or the practical application of fewer ideas? Should students study and investigate topics such as distance education, telecommunications, LOGO, Hypercard, ASCII, baud rate, spreadsheets, computer gradebooks, data management, desktop publishing, networking, bytes, bits, Internet, computer operating systems, theories of learning related to technology use, graphic design, instructional development, technology related to subject matter disciplines, and pthers.

Constantly a conflict developed between idealism and realism — what it would be nice to do and what is practical to do because of the entry level of students and the time available. Initially idealism prevailed. All of the above listed topics were studied plus students were required to demonstrate the skills of using several computer programs.

Changes were made in the two credit hour class, but the changes were not made without frustrations and pain. Students are resistant to change. From peers, they had heard about what they would study and do in the former "audiovisual course." The new course required a new conceptualization of instructional media. Many MWSC students are re-entry students or older females who have never touched a computer. The use of an institution computer lab was beset with problems. Students would learn one method of doing something. Overnight the lab technicians would reconfigure the computers so that to a novice there was no connection between the process used one day and the process that had to be used the next day. Something as simple as finding Word 6.0 on the harddrive became a daily challenge. Students had an extremely difficult time realizing that the new class would require computer lab time. They understand that time must be spent in a biology lab doing biology assignments because of the specialized equipment associated with biology. They could not understand, however, that a computer application course would require the use of computers at times other than the regularly scheduled class time.

The new course developed creditability problems. Students would talk to teachers in the area who would profess disbelief about the new MWSC class. "Technology" to many of these teachers meant the occasional use of the overhead projector or videotape. Again the question: should teachers be prepared to move with ease into the existing world of education, or should preservice teachers be trained to become leaders in schools that house older and more traditional teaching styles? Preservice teachers could not see any value in learning something that could not be applied the next day in an elementary classroom. Why learn to use Internet when this is not available in rural northwest Missouri schools? Why learn to use Macintosh application programs when the area classrooms either do not have a computer, or the only computer available is an Apple II-e?

Instructional and lab times became a disaster. Trying to demonstrate and explain the process to use a computer program to twenty-five novices is almost impossible. Invariably one person (or twenty people) will get lost on step three. One false step on a computer can take a person on a completely different path. Which of the twenty people with hands in the air does the instructor help and at the same time be able to finish the explanation or demonstration within a sixty minute class period?

Students became very frustrated trying to use the Internet. If a person used explicit directions from the instructor to reach a particular web site and were then were denied entry into that site (peak time usage), it became the fault of the instructor. Within one semester, a class that had for twenty years been very favorably evaluated by students became the least popular class within the Department of Education.

Three years later a middle ground between idealism of what should be to the realism of what actually is possible for a preservice instructional technology course has been found. Many of the earlier problems have been minimized. Students now know what to expect from the class. Rather than making color lift transparencies and using a dry mount press, they will be doing computer application assignments. Area schools are quickly updating the use of technology. The dissonance between a campus class and the realities found in the schools is becoming minimized. School administrator comments are now beginning to filter back to MWSC. Missouri Western students have technology skills that are much more developed than those of students from other area colleges. Thus, a reason to employ a MWSC graduate. First year MWSC graduates are already assuming leadership roles in area schools. A lab assistant has been employed to help with the twenty hands in the air. (The computer lab assistant is a grandmother who previously took the class. She is able to solve procedural problems with application programs.) Computer labs are open for more free use hours. During the past three years additional faculty within the Department of Education have integrated the use of technology into other classes. The burden of teaching "everything" a preservice teacher needs to know about technology is being shared by most of the staff members. Attitudes of students are beginning to shift. They know and realize that they will be using different forms of technology in the classes offered by the Department of Education. Additionally, they know that many of the things being done in the campus class can be immediately applied during a clinical experience.

An additional shift in attitude was made by the instructor of the instructional technology course. Rather than to try to teach "it all" within a two credit hour preservice class, it was decided that the purpose of the class was to teach basic computer usage skills and to develop a positive attitude about the use of technology. Earlier, students acquired good information and did in-depth projects. In doing this, however, student attitudes became very negative to the point that many stated that they would never use a computer again. Computer anxiety was increased and confidence level was decreased. The idealistic course produced the opposite combination of desired preservice attitudes.

Today, a more non-directive and non-threatening approach is taken in the class. The overall goals of the class are to develop a favorable attitude about technology and to teach foundation skills that can be expanded at a later date. If beginning teachers are going to use technology, computer anxiety needs to be reduced while competency in skills and confidence must be increased.

> Pelton and Pelton (1996) studied the correlation between teacher attitude and the acceptance of technology. Their research led them to conclude "Although many teachers believe computers are an important component of a student's education, their lack of knowledge and experience lead to a lack of confidence to attempt to introduce them into their instruction. This lack of confidence then leads to anxiety and reluctance to use technology" (p. 167).
>
> The research shows that personal confidence building should be an essential part of a technology course. Knowledge about computers and technology do not guarantee that a teacher will integrate technology into a course of study. A key component is attitude and a course that is realistic.

Today, what is realistic in terms of content and student performance? Final student grades for the MWSC technology class are in large part determined by the depth that each student selects, e.g. contract grading. A student who contracts for an "A" will complete the following projects:

- Basic Word Processing,
- Advanced E-Mail (set up, save files, create signature file, subscribe to and participate in professional education discussion groups, compose and send mail),
- Advanced Internet/web search (use of search engines to learn how to navigate on the Internet),
- Advanced PowerPoint presentation program using a concept from the state mandated list of concepts (application of instructional development process, demonstration of PowerPoint processes as build, transition, insert picture, insert clip art, multiple colors, etc. and an instructional plan for the use of the program),
- Advanced development of a personal web page (application of html tags and the selection of a state mandated concept for which web sites have been found and an instructional plan developed), and
- Overhead transparency production (three processes using technology).

The above projects keep the student busy for almost an entire semester. Those who enter the course without the knowledge of where to turn the machine on are able to proudly show what has been accomplished: use of electronic mail, PowerPoint instructional program, and a personal homepage. Tangible products show the non-computer person that it is possible to learn how to use a computer. Confidence and skills encourage the learner to continue learning about technology and the integration of technology into lesson plans.

Should the course be more intense in terms of content? Does the course really prepare the beginning teacher for the first several years of employment? The purpose of today's course is different from that of the early 1990's. Today the major goals are increasing the confidence level and basic skills to use technology. Every instructor would like to have the assigned credit increased for a class that is being taught. Should all MWSC students be required to take two three-credit hour instructional technology classes? Definitely the answer is "yes." Realistic? "No."

Are the above course goals being met? The summer class of 1996 was restructured. Student course evaluations reverted to the high levels of the mid-1980's. Observation of students engaged in pre-student teaching and student teaching assignments shows they are using and integrating technology into their teaching. Evidence indicates that students are not forgetting about the course after they receive the final grade. Instructor intuition says that the course goals are being met.

Additional empirical evidence, however, is needed. Students in the fall 1996 sections of the class were asked to complete a questionnaire that assessed attitudes about technology and the use of technology for teaching. In mid-December students will complete the same questionnaire. Data from August and December will be analyzed to determine if experience in an instructional technology class creates a more favorable attitude and greater confidence about technology. (The questionnaire is a modified form of an instrument developed by Pelton and Pelton 1996.) Additional observations will be made to determine if students do use more technology in the MWSC clinical experiences.

Completion of the course projects and the course in general meets NCATE accreditation standards and expectations for knowledge and use of technology. The course also begins to deal with the concerns listed in *Teachers and Technology: Making the Connection.* (OTA, 1995) Students at MWSC are learning how to teach with technology rather than simply learning about technology. The required technology course goes beyond the current requirements for teacher certification in the State of Missouri. Data collected in the fall of 1996 will determine if the course is increasing the confidence level of preservice teachers to use technology in their teaching.

In four years the required MWSC course has evolved from an innovative course for the 1970's to an innovative course in the 1990's. Change creates frustrations in both students and instructors. A proper balance must be found between idealism and what is actually possible.

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Planning for Technology in the 21st Century: Perspective, Knowledge, Commitment and Process

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As virtually every school district in the country is now on some path toward computer integration, administrators and teachers everywhere are aware that computers and instructional technology are becoming a fundamental part of education. While many have been the pioneers of educational computing development and thus have clearer notions and directions, it is necessary for all educators to establish a foundation in supported technology for survival in the 21st century (Mageau & Chion-Kenney, 1994).

Many are addressing this by procuring grants, allocating funds and other resources to establish or enhance their technology program for the future. The key to that future is planning. It has been said that, "The plan is nothing; planning is everything" (Eisenhower).. However, the nature of the planning process and the philosophy or perspective and expectations about the role of technology in education can drive the planning process toward a fruitful bounty for all or, unfortunately, toward a failed crop of dinosaur hardware, frustrated educators and students unprepared for a technological future. In other words, in spite of "rapid advances in multimedia technology....many teachers continue to emphasize the same instructional strategy (lecture) and technique (chalkboard) as educators did of the 1920's." (Barron & Orwig, 1995, p. 3).

The role of technology is vital in teacher education and is essential in a constructivist model of teaching (Brooks & Brooks, 1993). Certainly, computer technology has become a fundamental part of education across the curriculum and will likely be more so in the future. Instead of simply being a source of information, computers are becoming multimedia workstations for students. Innovative use of technology combines telecommunications (e-mail, video-conferencing, online resources, Internet navigators), multimedia authoring (home page editors), user-friendly, convenient applications software and are turns students into producers as well as consumers of content (Avots, 1994). The role of the classroom teacher is evolving from that of a giver of information to that of a facilitator of student learning. New technologies already exist to help teachers complete that evolution (Downs, Clark & Bennett, 1995).

The process of planning for technology integration should consider teacher beliefs and teachers' knowledge about technology which affect the decisions they make about strategies, procedures and materials for instruction (Hutchinson & Kung, 1995). The use of technology must directly relate to the context of teaching specific course subject matter (e.g., searching online databases via the Internet about volcanoes as par of a geography unit). Teachers need to see that technologies are selected and included according to sound instructional planning and not merely haphazardly placed within a lesson or instructional sequence (Wong & Smith, 1995).

Although than 90 percent of teacher training institutions require prospective teachers to take a course in technology for teaching and 85 percent or more require or recommend that the course be taken in the 3rd or 4th year of the program (Vagle, 1994), there is still a lack of demonstrated inclusion of technology in teaching methods courses. Citing a lack of assistance, time for development and unavailability of technologies, few methods professors use current computer hardware or software as an integral part of their presentation of teaching methods (Vagle, 1995).

A key concern is how much prospective teachers are aware of the technological revolution in accessing and communicating information and whether they are using technological resources to participate in the interflow of information within and outside classroom instruction (Slaughter & Knupp, 1995).

This paper examines the role of technology in learning and the implications for planning processes. New data are presented which reveal the perspective and awareness levels of preservice teachers about specific technologies, the role of technology in education, and how they will prepare for integrating technology into their professional lives.

Methodology

A survey was administered to 20 preservice teachers to determine their level of knowledge and understanding of computer technology and their perspective on how computer technology will affect their future as teachers. Subjects were first and second year education students at a midwestern university enrolled in a beginning educational computing course. The survey was administered at the completion of a one-semester beginning-level computing course for preservice teachers. Virtually everyone was inexperienced with computers before the taking the course.

The course involved projects with standard applications software (word processing, database, spreadsheet, graphics). Students also studied the usual computer history, terminology, and equipment. However, after only one such course, students would still be considered beginners and relatively inexperienced.

The survey was administered in two parts. The first specifically focused on what subjects deemed essential for classroom teaching in the 21st century. Subjects were asked what types of computer input/output innovations they knew about and to describe each for teachers and students of the 21st century. The survey solicited their responses to the following areas:

1. What hardware innovations in computer technology (e.g., input/output devices) would be considered essential for teaching and learning in the 21st century?
2. Describe the value or role of each device for teachers and students in a 21st century classroom?
3. Describe your primary method or resource for learning to master the technology tools and applications of the 21st century classroom?
4. What person, persons, or institution has the primary responsibility for educators reaching this mastery?

In the second part of the survey, subjects were asked to categorize specific technologies as hardware, software, communications, peripheral or multimedia. Multiple selections were allowed. That is, an item could be classified as both hardware and communications. Subjects were also asked to rate each innovation device as essential, useful, or useless. Subjects could also mark that an item was unfamiliar to them and was therefore not classified.

Items presented were:

- Video E-Mail
- Computer-TV-Internet Integration
- Digital Computer Cameras (Still & Video)
- Poster-Size Color Printers
- Professional-Level Video Editing
- Video Desktop Computer Conferencing
- CD-Rewritable Disks
- Desktop Web Publishing
- Digital Personal Message Pads
- Desktop LCD Projectors
- Plain-Talk Text-to-Speech Capability
- Home Page Editors
- Multi-platform Servers
- Mobile Computing Assistants (e.g., Newton)

Responses were tabulated and compared, and a descriptive analysis was generated to detail the nature of knowledge levels and perspectives of the immediate future of instructional technology. The survey also collected data on respondents' gender, age, computer experience, and career directions.

Results

Respondents were almost 80 percent female, and 60 percent of respondents were elementary education majors. 75 percent were between the ages of 18 and 22 with 25 percent older. About 75 percent had taken some sort of previous course in computing in college, high school, or elsewhere. About half claim to use a computer at home regularly for their needs as students. While about half occasionally visit computer stores, most seldom or never use the Internet, attend seminars or other events, nor read computing magazines. Subjects were asked whether technology will be an integral and fundamental component for studying and learning and for teachers in terms of professional service, basic teaching skills and classroom instruction. All respondents believed that technology was very important (50 percent extremely so) for education in the 21st century.

Part One

In part one of the survey, respondents named a large variety of things which they considered essential for teaching and learning in the 21st century. Items included miscellaneous hardware from keyboards to fax-modems and voice synthesizers and software from word processing and hypermedia to e-mail and Internet access. The largest number of responses named printer options, computer voice control, touch screens, and CD-ROM. 20 percent of respondents had no ideas and described nothing.

The remaining 80 percent described their choices for the three most important technology items. A summary of those items and descriptions follows:

- Fast computers were described by respondents as interesting and efficient. Speed is important.
- CD-ROM technology was described by respondents as providing easy, unrestricted access to lots of information, were durable and versatile. Unfortunately, one can't change CD information. For teachers, CD's hold interesting information (e.g., encyclopedia), and students can use CD's for homework. Possibly due to subjects' misconceptions, CD-ROM technology was also described as serving as a visual aid and to be used for storage. Subjects thought that CD's can make subjects easier to teach (as compared to merely being a tool which must be properly fit into instructional planning).

- Touchscreen technology was included by a large number of respondents in spite of being relatively older technology. Descriptions accounted for touchscreens being useful for the disabled and for making computers easier and important for children. Students may find such technology less intimidating, more fun, and useful as a learning tool. It was suggested that a touchscreen might be useful in graphics or drawing tasks and that students may find it less intimidating, more fun and useful as a learning tool. Respondents thought that touchscreens could encourage the use of visual aids.
- Spreadsheets and databases were included and considered useful for teachers and students alike. Respondents basically described their own experiences from the course they were completing (spreadsheets as gradebooks, databases for helping students complete assignments). They oddly described a database as better for records than for manual files presumably meaning that computerized storage was better than using paper file folders.
- Modem technology was described by respondents as important for connecting to other machines and provides limitless access to information including exchanging faxes. Respondents thought that they can be expensive and problematic in that people don't know how to use them. Teachers can download professional services and students can access information for reports, contact other students and conduct research. Apparently unknown to respondents, modems are cheaper than ever before and still one of the most inexpensive components in a computer system.

Respondents also described other items such as hard drives, monitors, mouse, graphics, hypermedia, and software in general, specialized or enhanced printers, networking and direct voice control. Interestingly, respondents even included the importance of calculators and Braille keyboards and the possibility of a whole-class input device for group responses. They were also aware that the Internet or web can provide important access to information, people and ideas; and that teachers can distribute assignments to students through the Web.

While respondents described a scanner as an important input device, expensive and difficult to learn, they mistakenly thought that teachers could scan a gradebook worksheet they forgot to save. Of course, without OCR (optical character recognition) software, scanned text cannot be converted from a mere image into text which can be directly edited.

In summary, very few responses in part one indicated knowledge of newer or emerging technologies (Internet use: 15%, Hypermedia: 5%, Voice activation: 20%, Enhanced or braille keyboards: 20%).

Regarding the resources for learning about such technologies and acquiring the skills needed to use them in teaching, respondents primarily selected college classes (44%) and self-study (35%). However, respondents offered a rather disturbing response to the question about who has the primary responsibility for teachers' reaching that mastery. Subjects were split evenly between public school/ college versus teachers themselves as having the primary responsibility. The concern is that individuals may expect to passively await the delivery of knowledge and skills from their instructors rather than taking the initiative to learn on their own. Also, this is contrary to data which accounts for over 83% of computer-using teachers learning to use computers and software on their own (Galloway, 1997).

Part Two

In the second part of the survey respondents classified technology innovations (left blank if unknown) by type and usefulness. Items were primarily labeled as communications and described least as peripherals. Items were described more as software than hardware even though most involved both.

The ratio of known and classified items to unfamiliar and blank items for the overall group was 50/50. The items with which most respondents were familiar included video e-mail (72.2% of respondents), computer/TV/Internet integration (68.4%), digital cameras (61.1%), and poster-size printers (61.1%). The items with which respondents were least familiar included home-page editors (36.8%), multi-platform servers (26.3%), and mobile computing-assistants (26.3%).

Generally, items were considered more useful than useless at the rate of 13 to 1. Less so, items were considered essential only 1/3 as often as merely useful. Those items most considered essential were video e-mail and video-desktop conferencing. Those items most considered useful were video e-mail, poster-size printing, computer/ TV/Internet integration, and digital cameras. Only 4 items were labeled by any respondents as useless: computer/TV/ Internet integration, digital cameras, mobile computing-assistants, and digital personal message pads. Respondents identified most of the listed hardware products as software rather than hardware, which might be a more applicable descriptor. Respondents seem to value video-based technology over print output or data input devices. On the contrary, however, they do not seem to value digital computer cameras which might be used for capturing their own video images and real-time footage for presentation or product development.

Subjects generally demonstrated little knowledge of the technologies. Only two respondents (10%) read computer magazines and publications as a source of information while only one (5%) visits computer retail stores regularly.

Discussion

This set of subjects (students across two classes) is obviously small and thus limits the scope of these findings. Nevertheless, these subjects did seem quite typical of preservice teachers as beginner users of technology and as students at the early stages of a teacher training program.

While the group as a whole seemed generally familiar with technology for beginners, individually they were more limited. Although there was an occasional insightful notion, there was also a number of limited or confused and misunderstood ideas. Educators' fundamental misconceptions of computing can encumber the integration process and slow or limit progress. The support of teachers in learning to use technology must be a significant and fundamental part of any integration or adoption plan.

Data suggest that preservice teachers need to be increasingly encouraged to explore the progress of emerging technologies for teaching through professional publications, teleconferences, and Internet sources. Such technologies should be demonstrated and included in required class research and class presentations. Teacher preparation institutions must do more to stay current with new technology purchases and to integrate their use into the instruction and student activities throughout the teacher education program. Instructors of teacher education courses traditionally not involving technology should begin to adopt and model the use of various technologies for teachers to better understand their application.

Although teacher-educators and institutions should do more, the teachers themselves must recognize a greater degree of responsibility for their own mastery. It is the individual's marketability, usefulness, and effectiveness which is at stake, and the individual must take action. Most users over the past twenty years have taught themselves, and while as a society we must improve the quality of services our institutions provide, it is ultimately up to the individual to seek out the resources and put in the time and energy to gain the knowledge and expertise of new technology.

Planning for integration and computer development typically targets the expenditure of funds and acquisition of exciting technology. Occasionally, planning addresses pedagogy and the nature of learning as it will be with technology in place. Unfortunately, such planning models typically do little to address the nature of the misconceptions, confusions, and limited learning and experience of the educators who must implement the changes. Technology cannot be adopted or successfully integrated into teaching without competent, trained, technology-using educators guiding the process.

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Restructuring of Undergraduate Educational Technology Courses

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The purpose of this paper will be to discuss the changes to the undergraduate educational technology classes at the University of Northern Colorado. To meet the needs of the restructured teacher preparation curriculum, it was determined that the required educational technology component also needed to be revised. As part of the restructuring, the original course was split into two separate courses, one which students take early in their college career and the other to be taken later in the their teacher preparation program. Both courses were designed to be more closely related to the students' teacher preparation courses. The educational technology component of the preservice teacher preparation program is taught almost entirely by doctoral students in Educational Technology with supervision by a graduate faculty member. This paper will discuss how those changes were accomplished.

Original Structure of Educational Technology Course

The original Educational Technology course was delivered in a loosely structured fashion. There was no official syllabus, and every instructor taught some basic computer applications (e.g., word processing, Hypercard, Pagemaker), but other content decisions were left to each instructor. The course was taught to upperclassmen, usually the last semester before student teaching. Students were not able to apply these skills to their professional preparation because the experience was so late in their coursework. There was, virtually, complete emphasis on the "tools" and little or no relationship to the use of the tools in the classroom. Also, since this course was a known part of the teacher education program, the faculty in other departments expected students to have certain skills, which might or might not have been included, depending on the instructor. This course was taught three times a week in 50-minute segments.

As part of the teacher education program revision process, the educational technology faculty worked with the teacher education faculty to design the educational technology component for the teacher education program. The original course was split into two courses, with the first emphasizing basic computer skills and various software packages, and the second concentrating on more advanced computer applications and the integration of various educational technologies within the classroom setting.

Pilot Implementation

During the spring of 1996, the first revised educational technology courses were piloted. These classes were taught once a week for 50 minutes, a significant decrease in the amount of time spent in class. Essentially, this course consisted of the "tools" portion of the original course and used the same packet of supplemental instructional materials. The only "tool" not included in the pilot course was Hypercard. At the end of the pilot, the course was informally evaluated by discussions with the instructors of the pilot classes. The formative evaluation concluded that the syllabus attempted to cover too much content. In addition, the pilot syllabus for the new course was not detailed enough to outline specifically what was to be taught. The evaluations of the course and the instructors were positive, overall. However, student comments indicated that their preference was for instructors to spend more time on the subject material. Based on the results of the pilot, the instructors and the coordinating professor used the summer to revise the instructional materials, the syllabus, and the required projects before full implementation of the new teacher preparation curriculum in the fall of 1996.

Final Revisions

Syllabi for the two courses were completed first. The syllabi were developed by the coordinating professor and approved at the college level. They were reviewed carefully for their contribution to the teacher education program. The new syllabi were designed to provide students with a broader understanding of educational technology; even though each course has a different focus.

The first course (ET201) is the "tools" class, while the second course (ET301) deals with issues of integration, how to use various technologies in the classroom, and some advanced skill development. The syllabi include specific course outcomes and correlate all of the course outcomes to current NCATE standards. Some examples of course outcomes for ET201 are to design and demonstrate a brief lesson using presentation software,and to design and produce simple video programs for instructional purposes; outcome examples for ET301 are to design a proposal requesting classroom equipment for specific instructional purposes and work cooperatively with a practicing school library media specialist to identify roles and expectations for collaboration within the school setting.

After the syllabi were completed, the professor and instructors worked together to develop projects directly related to the outcomes specified in the syllabi. Each project had specific requirements that must be fulfilled, and the course outcomes were clearly identified for each project. Along with the projects, evaluation rubrics published to allow the students to understand fully what was expected of them for each assignment. In addition, a textbook was selected to provide supplemental information for the students (Merrill, Hammons, Vincent, Reynolds, Christensen, & Tolman, 1996). Additional readings were assigned from *Instructional Media and Technologies for Learning* (Heinich, Molenda, Russell, & Smaldino, 1996).

Once the projects and syllabi were designed, major revisions were completed on the instructional packet so that it paralleled the syllabi. The original ET401 packet was expanded/revised into two parts: one for ET201 and one for ET301. The ET201 packet had the following sections revised and/or added:

- Macintosh and Computing basics (revised)
- Microsoft Word 6.0 (revised)
- Microsoft Excel 5.0 (added)
- Aldus Persuasion 3.0 (revised)
- Microsoft PowerPoint 4.0 (added)
- Software Selection (added)

The ET 301 packet had the following sections revised and/or added:

- Aldus Pagemaker 5.0 (revised)
- Hypercard 2.2 (revised)
- Software Selection/Evaluation (added)

The revisions and additions were designed to make the supplemental packet more user-friendly and to enable the students to be more independent as they work on the projects. The packets include individual tables of contents for each software application; expanded, step-by-step instructions for each project; and additional suggestions for extensions for those students who wish to do more than the assignments required.

Final Results

All sections are currently taught with every instructor using the standardized syllabi and projects described above. This should ensure that every student who passes the class has the same basic knowledge and skill set. This approach should also eliminate the possibility that a student might complete the class without the knowledge/skill level expected by faculty in other departments.

To continue the formative evaluation, the coordinating professor and instructors met at midterm to discuss implementation concerns. At this time, changes were made to the rubrics and to projects which were judged too ambitious to be accomplished in the time allotted.

Another problem addressed related to the availability of resources for the students. Too few computers in the existing lab will be alleviated with the addition of a new computer lab for the spring of 1997. The lack of VHS video cameras for student use continues to be an issue with only three cameras for 330 students.

Other ideas for revision include moving the copyright and distance education components from ET201 to ET301 and adding web page design to the ET301 course. Class size and teaching load for these courses are also a continuing concern. In conclusion, the course revisions have required much effort by many people, but we feel the results have been worth the effort.

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Redesigning Preservice Teacher Technology Training

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Today we are faced with a challenge.The needs of the rapidly changing instructional environment for K-12 education are placing new demands on the preparation of our future teachers. In an attempt to meet these new demands, many teacher preparation institutions are focusing efforts on restructuring their entire undergraduate program for teacher preparation. The University of Northern Colorado, whose primary mission is the professional preparation of educators for Colorado, began their redesign effort in 1994. The result is a fundamentally different model for undergraduate teacher preparation which emphasizes integrated, field-based experiences at every stage. This new model was implemented in the fall of 1996.

This paper discusses the most important considerations for the redesign of the technology component of the new teacher preparation program. The educational technology component has historically been a single, service course offered by the graduate program in educational technology. Although there was little attempt to integrate, or parallel, the content of the educational technology course with any other portion of the teacher preparation program, this course was the recipient of the STATE Award for Best Information Technology Course in 1994. Since that time, statewide K-12 student standards of performance have been instituted, professional teacher licensure has been mandated, licensure for practicing educators has been refocused on a performance-based portfolio system, state teacher preparation standards have been instituted (which include technology use and integration standards), and there is progress being made toward the completion of evaluation criteria for the higher education institutions and faculty associated with teacher preparation. It was under these parameters that the educational technology component for teacher preparation entered the redesign tumult.

The Issues

The primary issue which drove the redesign of the technology component was a strong desire on the part of the educational technology faculty and the teacher preparation faculty to integrate both technology proficiency development *and* pedagogical development across all stages of undergraduate teacher preparation. Clearly, public schools today place an increased emphasis on teachers' abilities to appropriately use multiple technologies and media in their preparation for and delivery and evaluation of structured curricula. Technology use is no longer viewed as just an extension activity or a tool for the classroom management of the 'active' learner. To address this issue, the current technology courses require students to complete structured projects which have been designed to meet multiple standards/criteria and which can easily be accomplished within the curriculum of their other teacher preparation coursework. For instance, in the early technology course, students must use electronic presentation software to create a short, instructional presentation relevant to their content or grade level. While enrolled for the technology course, students are also enrolled in an introductory seminar that includes a field experience component. Many students completed this technology requirement by creating the presentation for their seminar cohort or as a brief practice teaching experience for the classroom which they observed.

Recent advances in hardware and software are a concern when designing these technology components. While students may have access to relatively high-end equipment and updated applications in the university setting, the reality of technology access for many public schools is still far from the university standard. It is difficult to create experiences for these preservice teachers which 'whet their appetite' for the potential of technology to aid effective instruction without frustrating their attitude about professional growth when they see limited access to the tools they are trained in within the school setting. Ignoring the disparity, however, does nothing to prepare our future teachers either professionally or culturally.

Another issue for consideration is the increase in the number and types of technologies appropriate for educational settings beyond the computer. These two technology courses include content, at the beginner level, in distance education applications, video production, information literacy, copyright, trends in educational technology, changing roles of public school professionals, media selection and instructional design. Each of these topics serves to extend the students' knowledge base and increase their understanding of the breadth of the educational technology field.

Finally, the technology component redesign was heavily influenced by the state mandated professional standards for teachers which relate to technology use and the use of portfolios as the evaluative tool of choice for inservice teachers. The preservice teacher preparation program now utilizes portfolio-based evaluation criteria which supplement traditional coursework evaluation to judge students' readiness for the next stage of the program and to demonstrate professional growth as the student enters the career market. The new technology courses allow students to meet multiple objectives with the integrated, project-based format. With each project, students have the opportunity to:

1. meet required technology course objective(s),
2. use the technological skill to complete requirements in another teacher preparation course,
3. extend their personal uses of multiple technologies,
4. add to their personal portfolio documenting professional growth, and
5. engage in the same types of professional practices which must be self-disciplined as an inservice teacher.

The Future

The preparation of future teachers is a tremendous responsibility during these times of dramatic change and increasing expectations. The potential contribution of educational technology is dramatic if our preservice teachers know *how to use* the various technologies and *when, where, why, and with whom the technologies are most efficiently and effectively utilized.* The technology courses designed as required service components to the University of Northern Colorado undergraduate teacher preparation program will, hopefully, move our future teachers closer to reaching their personal and professional potential. Continued formative evaluation of these technology courses and attention to the mutating instructional environments within our K-12 schools are the tasks which now confront the educational technology faculty. There is much work ahead, but a strong foundation has been laid for preparing our future educators.

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Constructivism Implementation in Undergraduate Computer Application Classes

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Many educators and policymakers think of subject matter and pedagogy as separate entities. "The apparent assumption of such policies is that pedagogy and subject matter are not only separate, but that they are fixed in a zero-sum relationship, such that increases in one area necessarily result in decreases in the other" (Kennedy, 1990, p.13). But some teachers who are thoroughly competent in content are incapable of effective teaching (Ball, 1990). There is emerging evidence that the teacher's knowledge of content is not as important as the knowledge developed by the learner.

The typical curriculum at the K-12 and college levels is based on a structure where important knowledge is identified for students to acquire, usually stated as behavioral objectives or outcomes. The teacher and the curriculum disassemble knowledge, breaking it into small segments that are considered easier for the students to learn. In some classrooms, task analyses are so complete that each step of the learning sequence is identified. The teacher's role in the classroom is to transmit knowledge to students, a process that has defined steps and procedures separate from the subject matter content (Rosenshine & Stevens, 1986). The student's role is passive, to listen, sometimes take notes, and answer questions (Ausubel, 1963, 1968). In this model the teacher's performance is based on "effective" eye contact, different kinds of questions, appropriate pauses to allow pupil reflection, introduction of concepts, redirection of student questions, and so forth. This instructivist process disassembles knowledge into small bits for students to comprehend. The constructivist model, on the other hand, assumes that prior knowledge affects the process; therefore, current knowledge is constantly constructed and individualized (UMPERG, 1996).

At the University of Alabama, the instructional technology faculty of the College of Education was faced with staff reductions and limited equipment for basic computer skills' instruction. To maintain a quality product with limited resources, the faculty developed an asynchronous model of instruction based on constructivist principles. Using methods familiar in distance education, a course was specifically designed that essentially tripled the enrollment without increasing staff or the number of computers available. In this paper, we discuss the constructivist model and how it is applied in the course outlines, explain how technology can be a capital-intensive strategy, and describe some of the experiences of using constructivism where students, instead of the teacher, organize information, explore the learning environment, conduct learning activities, and monitor their learning.

Constructivism

Conventional instruction has grown out of a positivist tradition, a belief system that embraces and endorses scientific methods that enable scientific inquiry to lead to understandings of problems and their remedies. Much educational research has been undertaken to find "what works" in natural classrooms so these techniques can be understood as a process-product model to be transmitted to new teachers (Rosenshine & Stevens, 1986). Constructivism has emerged in opposition to conventional teaching, from the perspective of research and as well as from other education aspects. The contrasts are evident throughout education: constructivism versus instructivism, quantitative versus qualitative, standardized testing versus performance assessment, whole language versus basal reading, and fundamental epistemological conceptions. Rather than emphasizing content and presentation, the constructivist is interested more in creating authentic learning tasks, engaging the learner in realistic, thematic learning activities, and attempting to interpret the needs of learners as they become evident. These reflective teaching practices avoid interpretations of reality but direct energy into the development of individual students to accept responsibility for learning.

In keeping with the theory, constructivist principles for teaching seem far less clear, relying on the clinical skills of teachers and reflection. Brooks (1990) contrasts traditional teaching with constructivist instruction: "The traditional way of structuring lessons is concept introduction, practice, application, and further exploration, if time allows" (p.

69). But models of learning based on constructivist principles must adhere to a sequence in which exploration comes first, for this is how it occurs in a natural context for all organisms (Brooks & Brooks, 1993). Much of the incentive for constructivism is in response to the practices of memorization (Lipman, 1991) and "deconstruction" of content by the teacher. Rather than lecture and specific step-by-step presentation, curricula have been based on projects, authentic tasks, real-world contexts (e.g., Anderson & Roth, 1989; Roth, 1989). Constructivism asserts that learners create meaning and are not passive recipients of information. There is substantial evidence to show that students do not learn effectively by passive reception of information or by memorization.

Constructivist theory is based on the observation that learners construct mental models of physical phenomena. The teacher's knowledge of content, while important, is insufficient, alone, because "knowing" content does not mean that one can also teach it. Teachers must be able to make subject matter understandable to students, which requires more than a knowledge of subject matter. For knowledge to be more than information, and for students to become constructive, the curriculum must avoid piecemeal, decontextualized, teacher-transmitted learning.

The conceptual framework for all programs in teacher education at the University of Alabama, is organized around the theme that educators are reflective decision makers who facilitate student learning (Conceptual Framework, 1995). This conceptual framework has existed formally for several years and is periodically revised. In principle, according to the conceptual framework, reflective teaching is the analog of constructivism. While some faculty object to the emphasis on reflection and construction to the apparent exclusion of behavioral principles, constructivist views clearly dominate. The faculty is guided by a belief that educators are facilitators of student learning, a more comprehensive view than conceptions of the educator as a manager, a technician, an academician, or a therapist. This concept brings into focus the important role of learners as active participants in the teaching-learning process.

Basic Computer Course

The basic computer course requires students demonstrate skills in word processing, database and spreadsheet use, presentation graphics, electronic mail, and Internet searches. Students who can demonstrate competency in these skills can "test out" of individual course sections or the entire course. While the course has changed frequently because of improvements in hardware and software applications, in the past, it was presented in a conventional manner. Students were provided with daily lectures and whole-class instruction. With cutbacks in staff, the faculty decided to implement a new model based on constructivist principles for philosophical and experimental reasons, and to meet a practical need.

The course was radically redesigned with a shift from whole-class to small-group instruction, from individual to tutorial instruction, from lecture to coaching, from summative tests to performance assessment, and from isolation to cooperative learning (Wiggins, 1993). At the outset, the intention was to have student outcomes identical to traditional courses, except that a greater number of students would be enrolled. The basic framework for the course was changed from large group lecture and individual practice to teaching practice based on coherent themes, reflection, and relevant contextual experiences. The curriculum is based on major concepts rather than a long list of objectives; it is focused on competencies rather than meeting externally imposed criteria. The intent has been for students to learn content and skills within an authentic context of carefully selected authentic problems (Carter, Cushing, Sabers, Stein, & Berliner, 1988) and to practice skills over a long period of time. The classrooms are less teacher-centered and more student-centered. The students know the requirements and the assignments, but receive individualized, group, and project-based instruction. Students are expected to assume responsibility for their own learning with respect to the time they spend studying and working in the computer labs. Faculty, graduate assistants, and peer coaches (students who have had these classes and are hired by the technical support group) give students guidance but not step-by-step instructions. Therefore, these "teachers" become "facilitators" and "coaches." The students explore software programs through tutorials at individualized speeds and engage in authentic, real-world projects.

Classroom Examples

Two teachers in parallel classrooms assign the same word processor problem. While the teacher in the first classroom writes all the instructions, step-by-step on the board, the other classroom teacher allows the students time to learn the commands independently. The students from both classes finish with no problems. Later, when faced with a similar assignment, the students from the first classroom cannot complete the assignment without the step-by-step instructions, while the students from the second classroom remember where to find the commands that aid them in assignment completion.

At the University of Alabama, the instructional technology faculty take the second classroom approach. After a brief explanation, an assignment is given. The students follow tutorials and graduate teaching assistants and peer coaches are available to assist each learner on a problem-solving basis. The students ask themselves what, when, where, and how questions related to the assignment. What do I need to know to solve this problem? Where do I find the needed commands? When will I obtain the needed results? How will I work on this problem? The students search pre-existing knowledge to find answers, thereby incorporating new knowledge along the way. By doing this, the students have an active participation in the shaping and augmenting of their learning.

At the introductory level course, students are assigned specific skills to master regarding word processing, database, spreadsheet, and presentation delivery. Each section begins with a simple exercise, followed by a second implementing additional skills, and then a third exercise as a self-discovery. For example, the students' third word processing assignment is to construct a personal resume. The third spreadsheet assignment organizes a home grocery budget. The instructors do not give a "laundry" list to follow, but instead, allow each student to explore the various programs. Independent thinking is encouraged, thereby creating individualized computer-related realities for lifelong applications.

This philosophy is carried through the upper level computer application courses. At the 300 level, students implement prior skills learned while completing various Internet applications. At the beginning of the semester, students enjoy a "scavenger hunt." The students begin their "hunts" on one common home page and from there link to various sites based upon each student's interests. By the hunt's end, students have developed and exhibited skills such as downloading information and saving graphics to diskette, have developed a database of favorite musical groups, and have "booked" airline and hotel reservations. Each student experiences the Internet through individualized self-discovery. Once the student enrolls in the 400 level course, these additional concepts help students create personal home pages, business cards, and authoring programs relevant to their fields of study.

Within each course, the instructional technology instructors' goal is to individualize learning so that each student creates his or her own meaning, therefore creating a sense of ownership in the end-products and skills achieved. It is the faculty's general belief that this is important in order for the students to embrace the technology for lifelong learning and use.

Course Analysis

In the fall of 1996, one year after this model's implementation, the department authorized a survey to assess attitudes of those students enrolled in the undergraduate computer application courses. A group of graduate students in a survey research course administered the survey and analyzed the data. The results shared in this paper summarize the survey analyses (Hardin, Keizer, Saphore, Tinley, Wright 1996).

The instructional technology faculty had specific questions it wanted addressed in this survey. They were:

1. Are the courses perceived by students as different from other courses?
2. Does the coursework increase students' confidence in computer usage?
3. Demographically, are there any major differences in attitudes toward computer use?

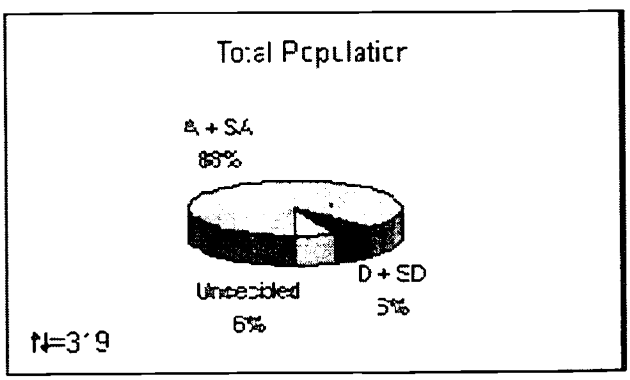
Survey Instrument

The instrument consisted of two parts: Likert items, and demographic information. The Likert items were based on a five point scale from low (1-Strongly Disagree) to high (5-Strongly Agree), with 3 as undecided. The Likert scale items were developed to aid researchers in measuring attitudes toward computers, computer technology, and the undergraduate computer application classes at the University of Alabama. Demographic information in the categories of sex, grade point average range, classification, and course enrollment was added for future correlation to determine differences among respondents. Within the operationalization process, specific statements were written to aid in measurement of the independent variables.

Analysis

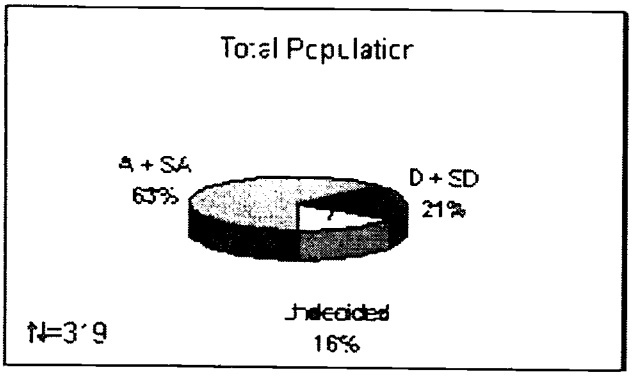
Numerical values ranging from one to five (1-5) were assigned to the scaled responses for scoring. A score of 5 is high and a score of 1 is low. Any score of 3.5 or above was considered to be in agreement with the statement, and scores of 4.5 or above were considered high agreement. Conversely, scores below 2.5 showed disagreement and scores of 1.5 or below showed high disagreement.

The students enrolled in the undergraduate computer application classes at the University of Alabama, during Fall, 1996, seemed to perceive these courses as being different from other courses at the university. For the research question, "Are the courses perceived by students as different from other courses?" the mean score for total population was 4.22, with 88% either agreeing or strongly agreeing (Graph 1). In general, agreement with this statement also increased with Grade Point Average (GPA). Furthermore, agreement increased with the class levels. For example, those students enrolled in 400 were more likely to agree than those students enrolled in 100.



Graph 1. Are the courses perceived by students as different from other courses?

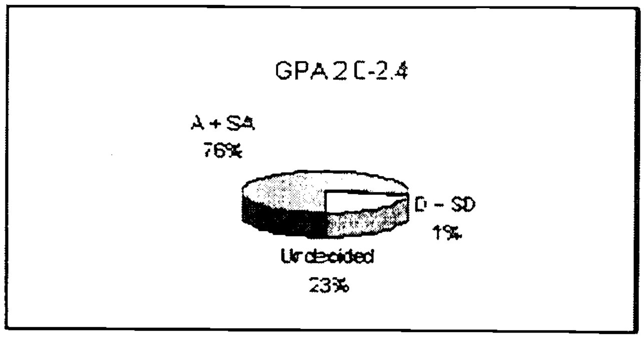
With the second research question, "Does the course-work increase students' confidence in computer usage?" the researchers used several items in the final analysis. These items assessed confidence in using the computer independently, intimidation toward computers prior to taking the class, and perceived self-confidence increases. The responses were reported across the items for the total population and for various subgroups. The respondents agreed (3.6) that the coursework increases their confidence in computer usage. All GPA groups and each class level (100, 300, and 400 groups) were in agreement. Of the total population, 63% either agreed or strongly agreed that the coursework increases their computer usage confidence (See Graph 2).



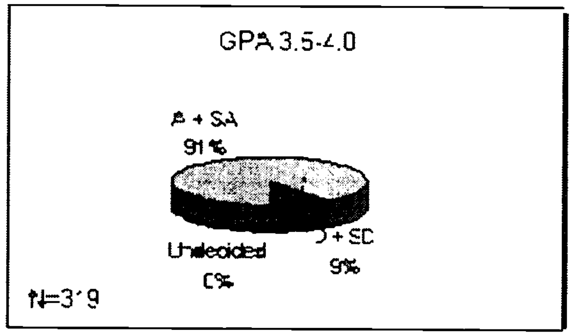
Graph 2. Does the coursework increase students' confidence in computer usage?

The third research question was, "Demographically, are there any major differences in attitudes toward the importance of computer technology?" Again, several items were used to answer this question, including assessing computer ownership, importance of computer skills in today's job market and in school performance, and self-directed computer knowledge growth. The data across the items were compared with gender, GPA, and class level subgroups. The data suggested that gender and class levels do not have an effect on attitudes toward the importance of computer technology while GPA does have an effect. The group with the highest GPAs showed a 15% increase in agreement over respondents in the average GPA group (See Graphs 3, 4).

In conclusion, the researchers' data seemed to indicate that while the respondents do perceive the courses as different, most agreed that the courses increased their confidence in computer usage. Further study using a stratified sample from specific demographic groups could reveal additional information to aid the instructional technology department.



Graph 3. Taking GPAs in consideration, are there any major differences in attitudes toward the importance of computer technology?



Graph 4. Taking GPAs in consideration, are there any major differences in attitudes toward the importance of computer technology?

Conclusion

This survey authorized by the instructional technology department somewhat validated its constructivist approach in the College of Education's computer application courses at the University of Alabama. While the learning sequence must begin with exploration, the teacher, as facilitator of learning, also must encourage that such exploration never end. Through real-life experiences, the major concepts should become individualized. Through such contexts, as technology changes, the student can adapt because the preparation for adaptation came through self-discovery. As Nicholas Negroponte states in his book, *Being Digital,* "True personalization is now upon us" (p. 164).

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Content Based Technology: Learning by Modeling

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Many universities now require students to complete a course on using computer technology as part of their teacher education programs. These programs are often designed to familiarize students with existing technology, tools, and software. Unfortunately, most undergraduate programs do not provide enough time to cover the scope of technology use in the classroom (Bruder, 1989). Recent studies indicate that less than one-third of students leaving teacher education programs felt that they were prepared to teach using technology (Handler, 1993; Scrogan, 1992; Fulton, 1989). Powell and Reiff (1993) found that most students agree that computers should play an important role in the schools, yet indicate a lack of confidence and are insecure using computers to teach others. Barker (1994) noted that teachers show great enthusiasm for using computers, but find it difficult to integrate technology into the curriculum.

Those that use computers use them primarily for enrichment and/or remediation (Becker, 1991.) A 1995 study by Huinker, Fuller and Ellwood found that computers were rarely used in any math and science classes. Most preservice teachers have had only limited exposure to computer technology during their public schooling. This trend continues at the university level where 44% of faculty either disagreed or strongly disagreed with the notion that computers could be beneficial to the teaching process (Misfeldt & Stahl, 1991). Darby (1992) states that there is an unwillingness on the part of universities to recognize and reward effort put into improving teaching, including both the use and development of computer-based materials. The resulting curricular lag in universities causes even recent graduates of professional programs to lack adequate understanding and skills in the use of technologies that they will be expected to use in their careers (Hurd, 1988). Thus, we believe one reason for this disparity between the intentions of the teacher education programs and the reality in the schools is that new teachers have had very limited exposure to appropriate models of how the computer can be used in a classroom setting.

This paper describes a preservice technology course taught at the University of Victoria using the elementary science, math, and social studies curriculum as the focal point. The main goal of the course is to provide students with a model of how to teach these subjects with technology rather than just how to use technology. The content of the course includes the use of computers for discovery learning, experimentation, simulation and modeling, forming and testing conjectures, problem solving, decision making, computation and data processing as well as communication, information retrieval, and course management.

Technology tools used to facilitate these activities include spreadsheets, database, Hypercard/Hyperstudio, Internet applications (including html and web page construction), computer concept maps, graphics packages, computer-based lab equipment and software, CD ROM/ laser disks and other multimedia, as well as some subject specific packages. Students learn these tools by participating in sample activities in class in one or more of the three subject areas.

The course is team-taught by three curriculum and instruction specialists in the areas of science, math, and social studies. It begins with a segment including a general introduction to computers in education, ethical issues surrounding computer use, and introduction to the Internet, searching strategies, and html. Students begin constructing their own web page as an ongoing assignment. Following this introductory component of the course, the three instructors each teach a separate segment of the course, focusing on tools which have application in their particular subject area.

Computer Applications in Science

No one doubts the major impact the computer has made in society in recent years, and the impact has been strong in science education. Its power revolves around its versatility as both a production tool and a presentation tool (Newby, Stepich, Lehma, & Russell, 1996). Because of its impact and potential, it is essential that elementary science teachers recognize its power and how it can be used for learning.

Many colleges and universities that train science teachers do not require a separate course in computer applications such as this course (Ed-E 438A) offered at the University of Victoria. Preservice science teachers may take a computer literacy course as an elective or may get brief exposure to microcomputers in various methods courses (Woerner, Rivers, & Vockell, 1991). Since a microcomputer is only one of many instructional tools that preservice teachers must study, little time is spent examining and implementing various science software programs. Hence preservice teachers may lack the expertise needed to make good use of the new technologies available to them.

According to Maddux, Johnson, and Willis (1997) the Office of Technology Assessment (OTA) has announced preliminary findings for a new study, and their findings underscore the need for excellent faculty preservice and inservice at all levels. The National Educational Advisory Board (1993, p.1) has summarized these findings and identified the following problems:

1. Practicing teachers do not have the expertise to use educational technology wisely.
2. School districts are not increasing spending for inservice training to keep up with spending for new hardware and software.
3. Teachers in training see very little technology used in their education courses or in their student-teaching placements.
4. College faculty members do not have the expertise needed to integrate technology into the teacher education courses they teach.
5. There are serious computer hardware and software shortages in colleges of education.
6. There is not enough good technology inservice education offered to college of education faculty members. (1993, p.1)

These findings underscore the importance of competent instruction in the use of technology for teachers at all levels. This course attempts to eliminate some of the problems mentioned above through the activities listed below.

Introduction to Using Microcomputers in Science Teaching

Students are introduced to computer applications in the science area by first developing an awareness of the major types of applications in science teaching. These include:

A. Providing Instruction

- tutorials
- simulations
- instructional games
- drill and practice
- data analysis
- word processing
- microcomputer based labs
- equipment management
- record keeping

B. Managing Instruction

- word processing
- information retrieval
- database creation and use, test generation and administration

C. Integrating Microcomputers into Science Teaching

- scheduling and using microcomputers for instruction
- demonstration
- station activities
- multiple microcomputers
- designing a lesson
- instructional strategies and microcomputers

Instruction then moves to ways to use the computer as a tool in science teaching and how to implement these tools in instruction. Topics discussed include:

Information Acquisition
- telecommunications
- optical disks
- microcomputer based labs (MBLs)

Analytical Tools
- databases
- spreadsheets

Graphing/Statistical/Transformation Tools

Creativity Tools

Communication Tools
- setting goals
- planning for implementation
- locating courseware
- sources of information

The science component of the course finishes with a section on how to integrate such new technologies as interactive video, Internet, and CD-ROM into the science class. Science assignments for the course include the following:

1. a) Develop a science database (any science area) that will:
   i. require up to three search criteria
   ii. include low level and higher level questions that can be answered by searching or sorting the database
   iii. generate and test hypotheses

   b) Describe how you would use this database in a classroom (select the grade) situation.
2. Develop one detailed lesson plan in science to demonstrate how a microcomputer or microcomputers can be incorporated effectively into the lesson. The software packages demonstrated in the lab <u>or</u> software package of your choice may be used.
3. a) Locate the top 10 Internet sites that you believe would be most useful to elementary science teachers.

   b) What is the value of the Internet to:

i. teachers
ii. students
4. Integrating CD-ROM Technology into Elementary Science Teaching

The Task:

Develop one question to be assigned to students in this course. It should be phrased in such a way to require consideration of the information contained and available through the CD-ROM version of the World Book Encyclopedia. The assignment must take advantage of this incredible database and search engine, rather than merely duplicating what could easily be found using the print version. The objectives of the assignment should include evidence of familiarity with the disc and its structure.
These are sample questions:
- Is "regeneration" limited to plants?
- What does gravity have to do with black holes and ocean tides?
- Why does safety have so much to do with science?
- Have nuclear accidents occurred frequently?

Please provide your question together with the answer supported by printed references from the CD-ROM.

Mathematics Component of the Course

Tool packages investigated in the mathematics portion of the course include both generic packages such as Clarisworks and subject-specific packages such as Geometer's Sketchpad and Tesselmania. Students begin by learning the general features of the package and then participate in problem-solving activities using the software.

Clarisworks is introduced first as it is a popular software package often used in schools. The spreadsheet is a good tool for mathematics as it is readily adaptable for problems that are iterative, recursive, or tabular in conceptual format and enables teacher and students to tinker with values of variables, constants, and step size as well as to explore the tempting "what if?" type of questions in the problem-solving process.

Spreadsheets can enhance the user's insight into the development and use of algorithms and modeling for the solution of mathematical problems. They free students from being hampered by laborious manipulation of numbers and allow them to concentrate on the mathematical problem itself. This permits the in-depth exploration of meaningful mathematical application without concern for the possible complex calculations needed.

Sample problem-solving activities in which the students engage using spreadsheets include:
- Estimations - then make actual calculations and/or graph;
- Make predictions based on initial data gathered;
- Statistical surveys and analysis of the data using both formulas and charts;
- Metric (or English) measurements of the body, objects of various sizes, perimeters, areas;
- Equations, functions, relations;
- Time needed to accomplish various tasks;
- Mathematical Patterns - spreadsheets are ideal to use as an exploration tool to investigate various patterns because of their ability to do quick calculations and to copy formulas to new locations using relative addresses rather than absolute addresses;
- Discovering Properties.

The students are next introduced to a variety of draw and paint programs including Clarisworks, Superpaint, Kid Pix, and Tesselmania. Students learn to use these packages both for managing instruction (e.g. preparing handouts with geometric figures on them) and as tools for students to use. Sample activities students complete in this section include creating figures with various types of symmetries and transformations, and making tessellations using both generic paint programs and Tesselmania, a dedicated tessellations package.

Geometer's Sketchpad is a graphics package which allows exploration of geometric concepts by constructing figures using traditional Euclidean means and then dragging on points or lines to modify the figures. Students participate in investigations to learn how to use the packageand also to discover some geometry relationships they may not have previously known. Sample investigations include:

1. Midpoints of parallel chords: Trace the midpoints of a chord as you drag a line in a parallel manner. Then use the information about this locus of midpoints to shed light on tangents parallel to a line.
   Construct circle AB and line CD. Construct E & F, intersection points of the line and circle. Construct segment EF and midpoint G. Add segments AE and AF. (See Figure 1). Trace point G. Drag CD in a parallel manner. Make a hypothesis about the geometric object traced by point G. Test your guesses.

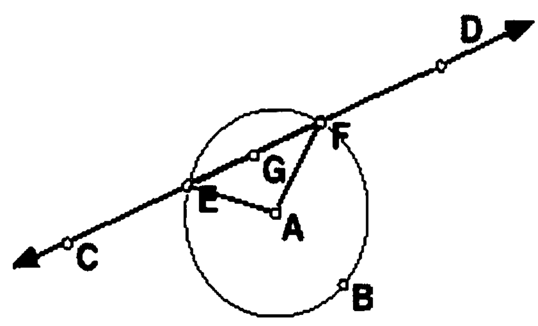

Figure 1. Diagram for investigating midpoints of chords.

2. Midpoints of chords dragged with a fixed point: Trace point G as you drag point D (line CD will be fixed at point C). Make a hypothesis about the object traced by the midpoint. Since location of C may affect the trace of G, make an animation button. Select D and the circumference of the circle. Choose Action Button in the Edit menu and Animation from the popup menu. Double click the button to activate it. You can use the animation button to experiment with the trace of point G for different locations of point C.

The math component of the course finishes with a section on various mathematics software packages for the elementary student. Students engage in model activities for a variety of packages, such as Millie's Math House, How the West was One + Three x Four, The Factory, Puzzle Tanks, Maps and Navigation, Safari Search, and Blockers and Finders. Following this, students discuss the strengths and weaknesses of each package and share other ideas for incorporating their use in a mathematics class.

Assignments consist of planning classroom activities using the tools of this section of the course. Students must design math activities which use spreadsheets, a graphics package of some type, and any other package of their choice. Criteria for marking assignments consists in equal parts of demonstrated mastery of the technology and appropriateness and quality of the planned classroom activity.

Social Studies Component of the Course

The third segment of the course begins with an overview of computer technologies in social studies. Students participate in a computer-based simulation using computers and laser discs linked interactively. They also discuss the use of CD-ROM technologies in the social studies field. Several sample CD-ROMs are presented, and students choose one to review in depth. Reviews must include a discussion of how the CD-ROM would be used with students, the age and grade level for which the CD-ROM is most appropriate, and the advantages and disadvantages of this media compared to other forms of representing the same content.

Electronic mail as a tool for knowledge building and sharing is discussed, and successful model projects are highlighted. Students also investigate other ways in which the computer can be used as a tool for representing knowledge, using concept mapping tool packages, and presentation software.

Hypercard, the original multimedia tool, is introduced, followed by alternatives such as HyperStudio, a more user-friendly package for the elementary classroom. Students learn the elements of hypermedia design and then use these principles to build a stack that utilizes material from a laser disk. The stack must be designed to be interactive and require the learner to do something with the video and text rather than simply read or watch what is presented on the video.

Summary

The format of the course has been very successful. Students have the benefit of instructors with expertise in a subject area who can use technology in their subject. Participation in model activities allows students to become learners in the subject area while learning to use a variety of computer tools. Students completing evaluations consistently rate this course as one of the most useful in their preservice teacher education program.

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Using Portfolios in Technology Courses

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In many schools, students are being evaluated on the basis of portfolios that document what they can do in language arts, science, social studies, and other skill areas. Portfolios often include such items as student-produced books, videos, and audiovisual presentations. (Heinich, Molenda, Russell, & Smaldino, 1996, p. 64) This article describes the evolution of student evaluations. Traditionally a major, if not the sole, method of student evaluation was paper-and-pencil tests. In the past, some instructors assigned a number of small-scale, disconnected practice exercises. Later they offered a menu of projects of a larger scale. Today the trend is to encourage students to compile portfolios of professional quality work, organized around major themes. The nature of portfolios and their advantages and limitations will be explored. The use of portfolios in two different educational technology courses will be described.

Evolution of Projects

Educators frustrated with standardized testing and conventional paper-and-pencil assignments are having students demonstrate their achievements by compiling portfolios of their work. Many educators feel that preparation of portfolios gives a truer, more rounded view of an individual's strengths and weaknesses. Further, portfolio assessment is consistent with the constructivist philosophy, which emphasizes that what is important is the knowledge that students themselves construct (Heinich et al., 1996, p. 96).

With increased attention on multidiscliplinary inquiry, open-ended explorations, and more complex learning tasks, the focus of evaluation has shifted from traditional student achievement measures (e.g., paper-and-pencil tests) to case studies of student work (e.g., portfolio outcomes) (Seely, 1994).

One example of this shift is the evolution of projects in media utilization courses. Twenty-five years ago many instructors required every student to do the same small-scale projects — a bulletin board, an audio tape, one dry mount, one permanent rubber cement mount, one temporary rubber cement mount, etc. Later instructors provided a list of projects from which students could choose. In fact, at their suggestion, our *Instructional Media* textbook (Heinich et al., 1996, p. 96) included "Possible Projects" in its first four editions. Now many instructors are using portfolios — a collection of projects often related to a single topic and a single audience and that usually include student comments and reflections about their projects.

What is a Portfolio?

Paulson, Paulson, and Meyer (1991) describe a portfolio as "A purposeful, integrated collection of student work showing student effort, progress, or achievement in one or more areas. The collection is guided by performance standards and includes evidence of students' self-reflection and participation in setting the focus, selecting contents, and judging merit" (p. 295).

Components of a Portfolio

The idea of portfolio assessment, then, is to measure students' achievements by their ability to create tangible products exemplifying their talents. Portfolios may contain the following components:

- Written documents such as poems, stories, lesson plans, or research papers,
- Media presentations, such as slide sets or photo essays,
- Audio recordings of debates, panel discussions, or oral presentations,
- Video recordings of the student's athletic, musical, or dancing skills,
- Computer spreadsheets of student data, and
- Computer multimedia projects incorporating print, data, graphics, and moving images (Heinich et al., 1996, p. 96).

Advantages and Limitations of Portfolios

On the following page Table 1. lists several of the advantages to using portfolios. And even though there are many advantages of using portfolios, they also have limitations. Table 2. lists a number of the limitations of portfolios identified by the authors and confirmed by their experiences.

Applications

Portfolios have been used for peer review, to show progress and experiences, to demonstrate abilities and experiences, and during employment interviews. Other uses include showing competencies, focusing on learning, reflecting on experiences, and assessing accomplishments.

I have used portfolios in an instructional media course for preservice and inservice teachers and in a technology for teachers course. Fortunately the classes have enrolled fewer than 30 students and the staff has included two instructors (a professor and a graduate student) which facilitates grading of portfolios. For large-enrollment courses it may be necessary to cut back on the magnitude of the portfolios or to increase the number of evaluators.

Media Utilization Course

Several years ago I began using a portfolio approach to evaluation rather than written quizzes and a final exam in my media utilization course at Purdue University. My co-instructor suggested the idea and proved you can "teach an old dog new tricks!" After trying portfolios for one semester, I was willing to give up paper-and-pencil quizzes and unrelated projects for portfolios.

How a portfolio approach to evaluation is being used rather than written quizzes and a final exam in a media utilization course will be described. Student select, modify, design, and produce a collection of media and methods to teach a topic of their choice to an audience of their choice. At the end of the course, the complete portfolio is also evaluated in terms of how well the portfolio "hangs together" as an integrated product.

Students select, modify, design, and produce a collection of media and methods to teach a topic of their choice to an audience of their choice. The topics tend to be broad ones like aviation, biology, calculus, dinosaurs, engineering, forestry, home economics, and industrial technology. The audiences may be specified by grade level (fifth graders, middle school students), employment levels (assembly line workers, upper level managers) or age level (senior citizens, preschool children) with whom the students are familiar. Students meet individually with the instructor(s) to discuss their topic and audience as well as their course goals.

Table 1.
Identified advantages of portfolios

Interest	make learning more interesting
Individualistic	allow students to determine what they want to learn and how they will demonstrate their knowledge and skills
Relevance	should be designed to be highly relevant to current study or future work
Developmental	provide a perspective over time during a course or curriculum
Variety	include a lot of information and artifacts
Organization	allow students to organize their knowledge, skills, and materials
Understanding	lead to an in-depth understanding of the content
Demonstration	show peers and professionals what they have learned and can do
Evaluation	provide a method for students and instructors to assess learning, for students to reflect on their work and abilities, and for formative evaluation and revision of instructional activities

Table 2.
Identified limitations of portfolios

Time	requires more time from the students and the instructors than other evaluation approaches
Resistance by students	are not appreciated and resisted by some students; they perceive them as more work and may not see the benefits
Research	lack of research evidence in value of portfolios
Evaluation	may not reflect most important aspects of task or product
Content vs. process	some students and teachers may focus on the content to the exclusion of the process
Consistency	not all students may learn the skills taught in a course
Over-emphasis on technology	there may be an over-emphasis on the electronic aspects of portfolios to the exclusion to simpler ways to demonstrate progress
Amount of material	the quantity of materials in a portfolio may be overwhelming; how to display and store these materials becomes problematic
Representative	may not represent work or ability of students
Subjective	"grade" influenced by person doing the evaluation
Teacher-centered	may be designed to "please" the teacher rather than to meet the needs of the student
Number of students	courses with high enrollments may not lend themselves to portfolios
Attendance	with primarily portfolio evaluation, some student may choose not to come to class
Use of textbook	students may not read the textbook; some may not even purchase one

Select. Using the Appraisal Checklists in either paper or electronic form included in *Instructional media and technologies for learning* (5th ed.), students preview different media/materials for possible inclusion in their portfolios. Each preview is accompanied by a brief explanation (one or two paragraphs) as to why the media would or would not be effective in teaching the portfolio topic. If the material was judged appropriate to be included, the student specifies how it would be used.

Modify. Students also modify existing media/materials. These materials are selected based upon congruence with the portfolio topic and audience. For example, a student could add slides of a local environment to a commercial slide set or use an existing set of visuals but change or omit some of the labels or captions. Students are cautioned to be sure their handling and use of materials does not violate copyright laws and restrictions that are described in the textbook.

Produce. As another part of the course portfolio, each student produces different pieces of media for the chosen topic and audience. They are required to incorporate different types of media which encourages them to expand on their current media production skills. For example, they can not produce two audiotapes, but they could produce an audiotape, a bulletin board, a set of overhead transparencies, and a videotape. The choice of media formats is up to each student, but they must be varied. Where appropriate, the projects are evaluated using the corresponding Appraisal Checklist from the textbook.

Design. Each student designs a lesson using the ASSURE Model described in the textbook. The student again chooses the topic and audience. The recommended length of the lesson is from 30 minutes to one hour. The student can use the printed template in the textbook or the computer template in "The Classroom Link" as a guide.

The design must include:

- **Analyze Learners** including the general characteristics, entry competencies, and learning styles of the students/trainees.
- **State Objectives** describe the learning outcomes and are written in the Audience, Behavior, Conditions, and Degree (ABCD) format.
- **Select Methods, Media, and Materials** provides a rationale as to why the methods, media, and materials have been selected, modified, or produced.
- **Utilize Materials** describes how the materials and media will be used. The students describe how they will preview the materials, prepare the materials, prepare the environment, prepare the learners, and provide the learning experience. (The 5 Ps of utilization)
- **Require Learner Participation** describes the activities which will get the learners involved, particularly through practice with feedback.
- **Evaluate and Revise** indicates how the objectives will be measured and includes evaluation of learner achievement, media, methods, the instructor's role, and the overall process. To ASSURE quality instruction, it is important to evaluate and revise the experience, if necessary, before future use.

Evaluation of Student Portfolios

The individual components (select, modify, produce, and design,) are evaluated as they are completed. Students are encouraged to make weekly progress and not to put everything off to the end of the course.

At the end of the course, the complete portfolio is evaluated in terms of how well the portfolio "hangs together" as an integrated product. How well do the pieces fit together to support a user's understanding of the selected topic? Is the portfolio well organized, making it easy to locate specific items? Is the work neatly arranged and attractively presented?

Technology Course

In an instructional technology course that integrates computers, media, and instructional design at Florida State University, I used portfolios as the major part of the course evaluation. This course typically enrolls 30 students. The portfolio format was based upon the work of my co-instructor Terri Buckner. The textbook for the course is *Instructional Technology for Teaching and Learning* (Newby, Stepich, Lehman, & Russell, 1996).

Goals. Student state their goals for the course. The course enrollment ranges from undergraduate education majors to graduate students who were employees of the Florida Department of Education. Each student meets with an instructor to discuss and review goals. The goals can be modified and adjusted during the course.

Artifacts. Materials (lesson plans, work samples, materials developed, evaluations, position papers) are used to illustrate progress toward the stated goals. The nature of the goals determines how the artifacts are organized in the portfolio. Each section includes an index listing the artifacts in that section.

Caption. A short written description is included with each artifact stating what the artifact represents in the portfolio. The purpose of each artifact is to convince a reader (and the instructors) that learning has occurred. Each caption/description is a part of that argument. It is recommended that descriptive captions be between 50 and 250 words.

Rubrics. Students develop the rubrics (explanation of evaluation criteria) for assessing their own portfolio. Each section of the portfolio includes a scoring rubric used to "quantify" the student's learning. For example, a student might want to assess each section on a •five-point scale. Each scale point has a description of what would constitute a rating at that level. The student provides a description of each scale point.

Self Evaluation. Students complete a self reflection comparing their results with their intentions. Students evaluate their own portfolios twice during the course. Each evaluation includes the strengths and weaknesses of the goal statements, the artifacts included, and a self-reflection on how they are progressing in learning about technology, teaching, and learning. During the course this reflects what was learned to date and what still needs to be explored. The end-of-course evaluation addresses how the student plans to proceed after the course.

Peer Review. Twice during the course two classmates review each portfolio using the rubrics developed by the student who produced the portfolio. The purpose of peer reviews is to help students look at their own learning from a different perspective. The reviewers are given the goal statement, the artifacts, the captions, and scoring rubrics. This not a grading session, but an opportunity for students to share what each has done and to receive feedback from peers for the purpose of improving the learning experience. Copies of the written review are given to the students who did the portfolio, are placed in the portfolio of the reviewer, and are given to the instructors. Reviewers look for a match among the goal statements, the artifacts, and captions produced. If the scoring rubrics are not understandable, the student is given an opportunity to revise them before the end of the course. Both the portfolio developer and the reviewer learn from the experience. Peer feedback includes an oral report (debriefing) between the two students followed up by a written report that becomes part of each student's portfolio.

Instructor Review. The instructor review procedure is identical to peer review except it is graded. The instructor evaluations occur midway through the course and at the end of the course.

Summary

Portfolios have been used for peer review, to show progress and experiences, and during employment interviews. Other uses include showing competencies, focusing on learning, reflecting on experiences, and assessing accomplishments. It was pointed out that some colleges and universities use portfolios as a graduation requirement.

Portfolios can make learning more interesting. They tend to be individualistic and can allow students to determine what they want to learn during a course. As a perspective over time during a course or curriculum, portfolios pull together a lot of information and artifacts. These materials lend themselves to formative evaluation and revision. Portfolios have the added advantages of allowing students to organize their knowledge, skills, and materials, to develop an in-depth understanding of the content, and to show peers and professionals what they have learned and can do.

Instructors who have used portfolios point out that they may require more time from the student and the instructor. Another concern was lack of precision in evaluating portfolios. Since portfolios are individualized, not all students may learn the skills taught in a course. The relative emphasis on process versus content was mentioned. An over-emphasis on the electronic aspects of portfolios was seen as a potential limitation. A final drawback was the quantity of materials in a portfolio and how to display and store these materials.

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Assessing Performance in Instructional Technology: Using the Portfolio

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Few educational reform movements have received the approval and attention of such a wide range of educators as the current trend toward direct assessment of student performance. This attention was foreshadowed by Messick (1994) and reinforced by many of the prominent current theorists and practitioners (for example, see *Educational Leadership*, April 1989, May 1992; *Phi Delta Kappan* May 1989, May 1991). Many groups who are interested in content-specific areas are calling for increased emphasis on assessment of authentic tasks (National Council of Teachers of Mathematics, 1993; Hansen, 1991). The underlying assumption for all groups is that students are better assessed in the context of accomplishing relevant, meaningful tasks rather than decontextualized, artificial exercises. These alternatives to standardized testing have taken on several monikers - the most common of which include:

Performance assessment - a term associated with the nature of the product or performance that is assessed. The performance or product produced must be a valid example of the skill to be assessed. Note that the skill does not have to be accomplished in a real-life context (Meyer, 1992).

Authentic assessment - a term associated with assessments that are situated in the appropriate performance context. These assessments may include performances, observations, exhibitions, and interviews. The key characteristic of this type is the performance context as opposed to the nature of the product (Wiggins, 1993), and the more inclusive term.

Alternative assessment - a term used to indicate the new collection of procedures and techniques that require the student to construct responses to questions as opposed to traditional testing which requires students to select a response to items constructed by the item writer (Ryan & Miyaska, 1996).

This paper addresses one specific method of authentic assessment, portfolio assessment, and its application in two case studies assessing learning of instructional technology. Suggestions for practitioners who wish to use this method are provided at the conclusion of the paper.

Portfolio Assessment

The Portfolio

A portfolio is a " a systematic and organized collection of evidence used by the teacher and student to monitor growth of the student's knowledge, skills, and attitudes" (Vavrus, 1990, p. 48). Flexibility and student ownership are essential elements in portfolio assessment. This does not mean, however, that there is no structure to it. On the contrary, the portfolio must be highly structured for two reasons: The portfolio must provide an intersection of objectives (skill required), instruction (skill learned), and assessment (skill evaluated). Unstructured or ill-formed assessment instruments tend not to reflect the task to be learned, thus failing to provide necessary congruency among the learning elements. All parties interested in the assessment must understand the purpose and components of the portfolio. It is also essential to help students establish a sense of ownership. This can be established by negotiating the portfolio's makeup and determining how scoring of the assessment instrument will be accomplished (Lescher, 1995).

Types of Portfolios

There are two types of portfolios: process portfolios and product portfolios. They differ from one another in the makeup of the body of evidence and the purpose of the assessment instrument. Contrasting the two, one may think of the process portfolio as a record of accomplishment throughout the term (daily homework) while the product portfolio is the final exam (a one time record).

Process portfolios show a student's work along a temporal path with samples taken throughout the period. They provide a rich and dynamic record of the student's changing, growing capabilities and attitudes. This record helps to show the route that the student followed to reach his/her current ability level (Lescher, 1995).

On the other hand, product portfolios attempt to document the very best work produced by the student (Cole, Ryan, & Kick, 1995). The student will not include all their work in this portfolio, but will select only examples of excellence. The student usually will select these examples.

Content of Portfolios

The artifacts that comprise the portfolio assembled by the student must be negotiated between the student and teacher. Possible components include:

- Traditional tests (which may be corrected by the student)
- Samples of in- and out-of-class work assignments
- Reports of experiments
- Laboratory notes
- Teacher observation of in-class performance
- Student logs or journals of in-class learning activities and accomplishment
- Student reflections concerning their feelings about learning activities
- Essays and writing samples
- Video and audio samples of performances

Scoring Rubrics

A rubric, a set of criteria against which the student's work will be judged, is necessary to make a collection of materials and an assessment. According to Ryan & Miyasaka (1996), there are four basic types of scoring rubrics:

1) holistic, which specifies no criteria, but instead uses overall judgment in arriving at the score,
2) modified or focused holistic, which uses holistic scoring but with embedded criteria so that students and instructors can concentrate on critical performance areas,
3) analytic, which involves making judgments of specific, but individual dimensions or characteristics, similar to judging subsections, and
4) modified analytic, which includes analytic scoring with a total score so that an overall grade may be tallied.

Discussion of the Cases

This paper discusses the application of portfolio assessment to two instructional technology courses. These courses address the use of technology in educational settings, both for personal productivity and for instructional use, using the portfolio assessment method of compiling multiple samples of a student's work that are produced at various times throughout the assessment period. Each portfolio is similar in the general products that must be exhibited, but different in the specific content and nature of that product. There are two general cases discussed. Case 1 is very highly structured and leaves the student little choice as to what to include in the portfolio. Case 2 provides the student a broad latitude in assembling the makeup of the portfolio.

Case 1

Instructions to the Student. This course requires the production of specimens of various activities that will be addressed during the quarter. You will be responsible for completing all activities , however, you will be asked to choose, in consultation with the instructor, which activities will be submitted at the conclusion of the course and the weight each graded activity will carry. Table 1 is a list of activities that are grouped into similar enterprises.

Table 1.
Course Requirements, Case 1

Group 1 - Take home examination

One written quiz over the course content.

Group 2 - Information

Electronic communication. Send, receive, forward, reply to, and attach documents.

WWW information processing.

Group 3 - In-class activities

Word processing. Produce a letter to parents concerning student progress, student achievement, or some other school-related theme. It must be produced on multicolored letterhead that you have designed.

Use a spreadsheet to calculate the solution to a science problem.

Use a database to organize a student class list.

Merge the parent letter and the student class list.

Group 4 - Out-of-class activities

Select and evaluate a piece of computer software. Included in the evaluation should be a description of the target group of learners and the instructional objective that is to be taught.

Select, summarize, and evaluate a journal article which describes an application of technology to teaching. Attach a copy of the article to your evaluation. Additionally, attach a list (in APA format) of 4 other articles that you reviewed before selecting this article. Provide your rationale for choosing the article that you evaluated.

Present a 5-10 minute summary and evaluation of the article or the software that was selected using a presentation package.

Group 5 - Group project

In small groups, produce a short HyperStudio stack that includes a color image that has been scanned from a document, a digital photo, and a short segment of digitized audio and video. You must also hand-in the document that was scanned, and the separate files that were used to construct the stack.

Group 6 - Progress

Students will be able to show how they have improved their skills over the period of the course. Included in that activity will be the diversity of projects that were presented for evaluation.

Portfolio contents. The makeup and grading of the portfolio were negotiated, but boundaries were set so that students were required to produce a sample of several types of technologies. The following table illustrates the variety of student portfolio makeup that was allowable. The column Minimum % indicates the required percentage for the whole group. A sample of appropriate weights for the activities for two different students is included in the last two columns. Note that the total of the group minimum equals 90%. Even if an activity were weighted 0%, it was still required to be accomplished.

Table 2.
Portfolio Requirements, Case 1

Activity	Due	Minimum %	Student 1	Student 2
Group 1		20%		
Quiz	Lesson 10		25%	20%
Group 2		15%		
WWW information	Lesson 6		10%	10%
E-mail use	Lesson 5		5%	10%
Group 3		15%		
Word processing	Lesson 8		5%	10%
Spreadsheet	Lesson 9		5%	0%
Database	Lesson 10		5%	5%
Merged document	Lesson 10		5%	5%
Group 4		20%		
Computer software eval	Lesson 7		10%	5%
Article review	Lesson 11		5%	10%
Presentation	Lesson 12		5%	5%
Group 5		10%		
Group project	Lesson 12		10%	10%
Group 6		10%		
Progress	Lesson 12		10%	10%
Total		90%	100%	100%

Rubric. While Table 2 defined the makeup of the portfolio, and gave guidelines for the weighting of each activity, each activity also was graded, so a scoring rubric had to be established to grade each activity.

One that typically was used for production of the materials in Table 2, Groups 1 thru 5 was:

- Errorless - Full Credit
- Few errors - 85% Credit
- Many Errors - 70% Credit
- Not accomplished - 0% Credit

One that was used for the scoring of progress in Table 2, Group 6 was:

- Major - 100% Credit
- Substantial - 85% Credit
- Limited - 70% Credit
- None - 0% Credit

Observations. Case 1 was highly structured. The instructor provided the framework used by students to assemble their portfolio. It was a product portfolio (Table 2, Groups 1 - 5), although there was a small element of progress included (Table 2, Group 6). Modified analytic scoring was used. By design, students were allowed to decide which elements would be most important in each category.

In practice, many students used the default weights (represented by Student 1 in Table 2). Some students chose to weight only one product per category heavily and limited the weight assigned to the rest of the products in that category. These students tended to be the ones who had little prior knowledge. They appeared to adopt a strategy of minimizing their exposure, while students with a more complete background displayed an "I can do that" attitude.

Students also appeared hesitant to enter into any negotiation with the instructor. This class was a class of adult learners (mostly teachers) who typically have accepted a traditional view of the assessment process, and therefore may have been hesitant to suggest a formula that differed from the instructor's stated default.

The material turned in varied in quality and quantity. Because the students had the option of turning in an "electronic portfolio," they found it easier to dump all their work onto disks and submit it as part of their portfolio. Only two students (out of 18) provided an index of products or rationale for their selection. Because of this, the "portfolio" for the majority of the students became much more a collection of performances rather than a systematic, ordered display of accomplishment and progress.

Scoring of the portfolio and the portfolio elements was problematic because the rubric used was not well defined. Both the students and the instructor had difficulty judging what student produced material met the stated criteria. This resulted in lower reliability for the score than would be desirable.

Case 2

Instructions to the Student. Compile a portfolio of your work throughout the quarter. It must include your lab journal. This journal represents your lab notes on how to apply media to teaching. This journal may be derived from your readings, class lecture, or class lab time. The portfolio is intended to document your course learning activities, concentrating on progress made throughout the term. It may include any graded or ungraded exercises that you want to show me and any graded work that was less than perfect that you have corrected.

The activities in Table 3 were graded throughout the course of the term. In practice, this grading method differed little from traditional assignments accomplished and graded throughout the term. Abbreviated requirements for each graded activity are listed in Table 3. Supplemental checklists were distributed during the term in advance of each graded activity so that students would know the specific requirements and scoring of each graded activity.

Table 3.
Course Requirements, Case 2

Take two written tests over the course content.

Word processing. Produce a letter to parents concerning student progress, student achievement, or some other school-related theme. The letter must include the usual components of a business letter & at least 2 paragraphs. It must be produced on a multicolored letterhead template that includes your name and address or the name and address of your school and a graphic object or image.

E-mail. Send, forward , receive, reply to and attach electronic messages.

Select and evaluate a piece of instructional media (filmstrip, slide set, or video). Include in the evaluation the target group of learners and the instructional objective that is to be taught. Use a word processing program for document processing.

Collect relevant information from the Worldwide Web that will be useful in your educational setting.

Produce a framed overhead transparency utilizing computer programs and printer, photocopier, or thermofax machine. This item should support lesson planning for your methods class. Include in the evaluation the target group of learners, the instructional objective that is to be taught, and the method of production. Graphics and text must be integrated in this transparency. You must include any computer printouts and/or layout sheets from which the final product was derived. Use a word processing program for document processing.

Produce an instructional handout, worksheet, or test using computer programs, printer, or photocopier. This item should support lesson planning for your methods class. Include in the evaluation the target group of learners, the instructional objective that is to be taught, and the method of production.

Select and evaluate a piece of computer software. Include in the evaluation the target group of learners and the instructional objective that is to be taught.

Select, summarize, and evaluate a journal article which describes an application of media/technology in teaching . Attach a copy of the article to your evaluation.

Demonstrate to the class the educational use of your transparency, handout, or WWW site.

Present your article, media, or software evaluation to the class.

Compile a portfolio of your work throughout the quarter. It must include your lab journal. This journal represents your lab notes on how to apply media to teaching. It may be derived from your readings, class lecture, or class lab time. The important thing is to document your course learning activities. It will be evaluated for both progress during the quarter and quality of product produced.

Rubric. The same scoring rubric was used for all students.

Table 4.
Scoring Rubric, Case 2

Component	Weight	Criteria
Lab Journal	25%	Complete coverage of material Content
Products	25%	Variety Correctness
Progress	50%	Progress over time Accuracy of corrections

Observations. Case 2 was unstructured. Students had wide latitude over what to include in their portfolios. The only required element was the lab journal. This was intended to be a progress type portfolio, although it also included elements of the product portfolio as well. The rubric used best exemplifies the modified holistic scoring technique. Each student had already been graded on a number of performances (products) throughout the quarter. They had this opportunity to correct their mistakes, show the progress that they had made, and highlight any special features of their experience.

In practice, students were very anxious about the form of the portfolio. These traditional undergraduate students (preservice teachers) have become accustomed to assessments where the teacher asks the question and they respond with an answer. They very much wanted a "model" portfolio they could use as an example. Given the instructor's reluctance to specify the contents of the portfolio, the students tried to cover all the bases with a strategy of handing in everything they could find.

Scoring the portfolio was again problematic because the rubric used was not well-defined. This rubric required the instructor to judge on a continuum the proper accomplishment of the described criteria. This resulted in lower reliability for the score than would be desirable.

Recommendations for Practitioners

Based on the observations found in these cases, the following guidelines are suggested for those who are interested in implementing portfolio assessment strategies. One must remember that each portfolio is different. As such, guides that will help direct portfolio assessment activities may be useful, but strict rules may not be possible. Unless your students are thoroughly familiar with this type assessment method, plan to teach them what a portfolio is and, specifically, what your assessment objectives are. A little time up front will produce marvelous results later on. Plan your assessment as carefully as you plan the rest of your course. Systematically look at your learners and your objectives. This will help you to choose the most appropriate portfolio type and rubric.

The more concrete the rubric anchor behaviors are, the easier the portfolio will be to grade and the fairer the assessment will be. Be sure that the instructions and expectations for the portfolio are clear to the student. These concepts are new to most students, so your intent may not be as intuitive to them as it is in traditional assessments. Help the students to question and think about the assessment by giving some intermediate range goal. It seems that unless forced, many will put off thinking about the portfolio until it is due. Don't make the choices too hard. Especially if this is the first time that students have been involved in using an instrument like this, providing some structure is helpful to the student and results in a better assessment of the student's progress and accomplishments. Require students to provide a rationale for the inclusion of portfolio components. Ask students to write reflections about how they have grown by talking about the various artifacts in their portfolio. This may help students accomplish summarization of the material and skills.

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Technology for Preservice Teachers: "Driver Education" for the Information Superhighway

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In this paper, a professor of education discusses the challenges rapid advances in technology have presented to collegiate departments of education in their preservice-teacher coursework and to classrooms in general. Specifically, use of the Internet's World Wide Web (WWW), the information superhighway, will be presented as one important way to integrate technology and the vast amount of information it makes available. The discussion includes a look at how several segments of the nation view the current and future implementations of technology in American education. Following will be a brief review of the commitment of a small liberal arts college to technology and the corresponding revision in preservice-teacher coursework in its education department. This will include Internet websites which offer innovative and practical possibilities for teaching and learning. In summary, this paper offers "driver education" for traveling the information superhighway to preservice teachers.

Connections: The Internet and the Classroom

In the presidential debate of October 6, 1996, President Clinton stated, "Every classroom in America should be hooked up to the Internet by 2000 (Clinton, October 6, 1996). Clinton was reiterating his commitment to The President's Educational Technology Initiative, described in his State of the Union Address where he said that our schools ...must be connected to the information superhighway, with computers and good software, and well-trained teachers. (Clinton, 1996)." We are working with the telecommunications industry, educators, and parents to connect every classroom and every library in the entire United States by the year 2000." Indeed, to get closer to this goal, President Clinton has proposed an additional $2 billion in federal money be spent this year on instructional technology for elementary, middle, and high schools so that every 12 year old can log on to the Internet (Wagner, 1996). How can the president's goal of making teachers as comfortable with computers as they are with chalkboards (Pearson, 1995) be attained?

Today, reform in education mandates improved teacher training. It is appropriate, then, that President Clinton mentioned well-trained teachers in his technology initiative. How can preservice teachers best be trained technologically? This paper addresses that challenge by looking at one college and its "driver education" for traveling the information superhighway for preservice teachers. It discusses the commitment the college has to graduating technologically literate students and the ways in which the Internet is infused into teacher preparation courses.

Chatham College is a small liberal arts college located in Pittsburgh, Pennsylvania. In a small college, access to information is vital to keep students current with developments in all academic disciplines, and it is imperative that students have equal access to resources and research. The college has recently invested in developing a strong campus network by using fiber optics, Microsoft NT, and a Rolm telephone system, and by placing high-end multimedia in faculty offices and student computer labs. Electronic mail and campus-wide access to the Internet are now available to the entire college community.

For the past twelve years, there has been a college-wide commitment to graduate technologically literate students who must demonstrate proficiency in word processing, spreadsheet, database, and bibliographic searching before completion of the teacher's certification program. Now, the challenge is to take computer proficiency to a higher standard. What is the most effective way to infuse technology into coursework in the teacher education program and to ensure that our preservice teachers will be well trained in technology? What is the best "driver education" for preparing preservice teachers to implement today's technology in their classrooms of tomorrow? How do we empower teachers with the ability to make the best use of technology? If computers are an important innovation that can revolutionize the teaching-learning process, do the teacher certification courses reflect this? Further, are there changes in course assignments, syllabi uses, and content that support this approach? Finally, how are professors of education using technology in their own teaching and research?

Need for Technology Instruction in Preservice Education

According to a 1995 article based on a comprehensive study from the Office of Technology Assessment (OTA), *Teachers and technology: Making the connection*, schools' access to various technologies is rising steadily. The OTA estimated that there are about 5.8 million computers in the classrooms of American schools—about one for every nine students (O'Neil, 1995). The report cited classrooms where teachers were taking advantage of new technologies resulting in innovative, engaging, and varied learning opportunities for students. International research projects, communications with scientists via e-mail, and multimedia research papers were all given as examples.

However, the report pointed out that most teachers are not adequately trained to use various technologies in their classrooms and the picture in preservice programs is not much brighter (O'Neil, 1995, p.11). OTA found that "overall, teacher education programs in the United States do not prepare graduates to use technology as a teaching tool (O'Neil, 1995, p. 11)." The biggest barrier to technology use is time—for training, for trying out technologies, and for exploring uses of technology and discussing the role technology can play in teaching instruction.

In a study conducted by Carnegie Mellon University in conjunction with the Pittsburgh public schools, interviews were conducted, and teachers were surveyed about their use and experiences on the Internet. The educators were positive about the benefits of Internet in the classroom, commenting that it makes students aware that they are a part of a global community and gives them a wide variety of resources to stimulate their thinking. "It does more than boost enthusiasm or expand sources; it fundamentally alters the roles of teachers and students" (Peha, 1995, p. 20). The teacher becomes more of a facilitator, helping students to find and use information. However, two-thirds of the teachers who responded to the questionnaire said that they "survived... [the Internet] without any formal training, relying instead on printed literature and experimentation" (Peha, 1995, p.22). The suggestions offered for overcoming difficulties related to introduction of the Internet into the curriculum included more time for exploration on the Internet, more online support, more step-by-step instruction time, and more collaboration and commitment with other parties involved in Internet activities.

A recent article in *US News and World Report* described six classrooms around the United States that promote learning through technology. The educators in these schools reiterated the need for good teacher training in technology, saying that "training is the most crucial ingredient of an effective computer program and the one that is underfunded the most often" (Wagner, 1996, p. 92).

Adding to the challenge for untrained or undertrained teachers is the incredible speed of the technological advances. Consider what has occurred in less than three decades. In 1969 when the Pentagon tried an experimental system of linking destinations together over an electronic network, Arpanet. By the mid-80s it had grown into a broad network,called the Internet, for educators, researchers and government (Mills, 1996). In 1977, Microsoft was a start-up company (Polsson, 1996); in 1981, the IBM PC, the microcomputer that "legitimized the industry for the rest of the world" was introduced (Polsson, 1996). Then, in 1991, The World Wide Web (WWW) was activated on the Internet (Zakon, 1996).

Very recent technological advances have certainly created a gap between the rapidly changing technology and the increasing need for information technology in teacher training. How do we get onto the information superhighway and know what to do with the information available? How can educators integrate technology so that computer-literate students are skillful, reflective, mindful users of information or as Hyerle (1996) describes them, "infotectives" (p. 16).

This author believes it is incumbent upon professors in teacher training programs to integrate information technology in the coursework for teacher certification. By adding technological assignments via the Internet to our teacher certification courses, preservice teachers can be better prepared to meet the technological challenges present in the classrooms of tomorrow.

The following provides description of courses available at Chatham College (Chatham College Catalogue, 1996-97) that are relevant to a technology-infused curriculum for teacher preparation. The author shares assignments for these courses that integrate information technology via the Internet. This constitutes Driver Education for traveling the information superhighway.

Integration of the Internet into Teacher Preparation Courses

ED 301: Perspectives on Education is a broad-based course which introduces prospective teachers to the profession of teaching and explores social bases of education. Students examine the roles of the teacher and the school both in the past and in contemporary society. An assignment which is particularly applicable for the Internet asks students to evaluate educational reform initiatives. Several websites are helpful:

http://www.ed.gov/pubs/Reform/index.html, where students can access findings from a national study on school-based reform; and **http://k12.cnidr.org:90/resource.cntnts.html**, a site that explores technology and school reform. By accessing the Pennsylvania Department of Education's web site at **http://www.cas.psu.edu/pde.html**, students can find information on many alternatives to traditional education, including home schooling, school choice, school vouchers, charter schools and magnet schools. Students are further able to learn about the position of the Pennsylvania legislature on each of these topics. To track reform initiatives on a national level, students can access information from the US Department of Education by locating the site at **http://www.ed.gov/**.

Ed 303: The Multimedia Classroom blends state-of-art theory and practice and involves students in a shared learning environment integrating technology and the arts. A specific assignment for this course requires students to demonstrate ability to use the computer for research into children's literature, particularly to locate web sites containing information on authors' backgrounds, literary analyses, and the use of children's literature in the elementary classroom. An excellent web site for these purposes is Kay Vandergrift's Reading in Children's Literature, **http://www.scils.rutgers.edu/special/kay/childlit.html**, where lists of children's literature, including publication information, are offered. Other sites that students found helpful are: The On-line Books Page at **http://www.cs.cmu.edu/Web/books.html** and The Children's Literature Web Guide at **http://www.ucalgary.ca/~ca?~dkbrown/index.html**.

ED 308: Communication Skills in Education is a course that guides students as they investigate the interrelationships between listening, speaking, writing, and reading. Students must write a literacy unit. Useful websites for finding age-appropriate children's books include **http://www.ucalgary.ca/~dkbrown/index.html**, where students can find children's literature and information about the authors and **http://www.cs.cmu.edu/Web/books.html**, for books online. Another helpful address for finding educational software is **http://www.edutainment.com.au**. This allows students to consider software they might like to purchase for use in their future classrooms.

ED 312: Elementary School Curriculum explores teaching in specific content areas, including mathematics, science, music, art, social studies, health, and physical education. A major assignment for students in this course is to design a curriculum unit on a topic of their choice. Because students can choose from a wide variety of topics, many students find websites from "the educator's ultimate World Wide Web hotlist" (Dyrli, 1996) especially relevant. Some sites for locating general curricula were Ed Web at **http://edweb.cnidr.org**; World Education Exchange **http://www.hamline.edu/~kjmaier**; and The Schoolhouse at **http://www.nwrel.org/school_house**. Websites that students found helpful for curriculum units in the social studies include Environmental Systems Research Institute at **http://www.esri.com** and Science and the Environment at **http://www.voyagepub.com/publish**, an award-winning magazine that takes its readers globe-trotting to discover the state of the environment around the world. Two excellent websites for social studies include the Library of Congress Web at **http://www.loc.gov** and **http: //www.census.gov**, which gives students information about any city in the United States, answering questions about the ethnicity, age, and number of the people who live there. Another web site applicable to many topics in social studies is Welcome to the White House at **http://www.whitehouse.gov/WH/Welcome-plain.html**.

ED 320: Principles of Secondary Education focuses on the characteristics of the secondary school student and the structure and climate of the high school. The Internet is an excellent resource for many of the students as they complete their research assignments on topics specific to adolescent development or schooling. Websites that students find helpful include **http://education.educ.indiana.edu/cas/adol/risk.html** which covers many topics on issues relating to adolescent development, including health issues (sexuality, alcohol, drugs), developmental issues (ADD and eating disorders), and mental health issues; **http://www.healthwire.com/women/grgirl.htm** which includes issues girls face while growing up, such as low self-esteem, depression, anxiety, etc.; and **http://www.priory.com/journals/adsui2htm** contains a helpful article on suicidal behavior among adolescents. Another web site that students find interesting is **http://educ.indiana.edu/cas/ttforum/ttforum.html**, a site maintained by the Center for Adolescent Studies at Indiana University. This site contains excellent learning resources for secondary students, parents, and educators such as *Teacher Talk*, a newsletter for secondary and preservice teachers.

ED 321: Teaching Methods for Secondary and Adult Level offers students a range of teaching strategies and classroom management techniques in the context of their major fields of specialization. For this course, students are assigned the task of finding lesson plans on the Internet which they adapt for their classrooms. Some sites with particularly strong lesson plans include the AskERIC Virtual Library at **http://ericir.syr.edu** and Columbia Education Center's Mini Lessons at **http://youth.net/cec/cec.html**. A site for environmental science lessons which students find helpful is EE-Link, Environmental Education on the Internet **http://nceet.snre.umich.edu**. Students also enjoy visiting **http://educ.indiana.edu/cas/ttforum/ttforum.html**, a site maintained by the Center for Adolescent Studies at Indiana University. Another web site which preservice teachers find helpful for their own professional development is the 21st Century Teachers Website at **http://www.21ct.org**, a site where information about the technological skills that will be needed by teachers in the next century is disseminated by several key educational associations including the NEA, AFT, and the National PTA.

ED 322: Teaching in a Multicultural Society is designed to help future teachers understand the complexities of teaching in a culturally diverse classroom. Instruction provides preservice teachers with the knowledge, insight, and understanding to work effectively with students from various social classes, religious, ethnic and cultural groups. Individual differences that affect teaching and learning are emphasized; instructional concepts and strategies for multicultural classrooms are offered. In this course students are required to research a particular cultural group and find at least one foreign web site. Students also were able to locate excellent multicultural books for use in classrooms. Helpful sites include the Multicultural Book Review at **http://www.isomedia.com/homes/jmele/homepage.html** which reviews various children's book. A web site that allows classrooms to find partners with shared interests in other parts of the world is the Intercultural E-mail Classroom Connections at **http://www.stolaf.edu/network/iecc/iecc-form.html**. Students have located the web site of the Japanese National Tourist Organization at **http://www.nttjp/japan/TCJ/TC.html** to learn about Japanese culture. Students have also accessed Origami at **http://www.cs.ubc.ca/spider/jwu/origaml.html**. For examples of how to fold paper into origami. Other homepages students visit for intercultural research include China Home Page at **www.ihep.ac.cn/china.html** and Global Show and Tell at **http://emma.manymedia.com:80/show-n-tell/** where projects and accomplishments of children around the world are shown via the Internet. Students researching the Native American cultural group found **http://indy4.fdl.ccmn.us/~isk/** an excellent homepage containing information about culture, art, education, science, history and Native American sources. At this site was information about how students could meet Native American students on the Internet. The site at **http://www.pitt.edu/~mitten/ailabib.htm** offers excellent activities which can be used in the classroom as well as a bibliography and guide for choosing Native American literature.

Conclusion

This paper demonstrates that the Internet is a teaching resource that merits inclusion into teacher preparation courses. If preservice teachers are to become technologically literate and bring technology into their classrooms effectively, it is imperative that preservice teacher education include both depth and breadth of technological access. Specifically, use of the Internet in the preservice-teacher classroom exposes these future teachers to online learning. Websites and examples of Internet-related assignments integrated into specific courses at Chatham College are offered as road maps, or "driver education," for preservice teachers to travel the information superhighway. Connecting classrooms to the Internet is an exciting, innovative method to help our students become active network citizens in a global community by training them to access and explore the World Wide Web and its myriad of resources on the Internet.

The author appreciates dialogue with members of the Chatham College education faculty and preservice teachers related to the integration of technology into their courses.

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Proposed Short Course on the Development of Web Based Training

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The National Cryptologic School (NCS) is the training department of the National Security Agency (NSA). It is responsible for the education and training of NSA's large, geographically diverse, and often highly technical workforce. Its mission includes both highly tailored courses in state of the art technology and all-hands awareness training; as well as the education of its own training staff. Because of the variety in students and material, a wide assortment of delivery techniques are employed. One type of mechanism which has received increasing attention is Computer Based Training (CBT).

Some Advantages

CBT is a particularly interesting technique for NSA because its workforce is predominately computer-literate and has direct access to a centrally-networked computer (i.e. it's on their desk). CBT offers training which is available to the user without dislocation, is in a familiar environment, and is delivered via an existing infrastructure (the network). This infrastructure, with a few additions, can easily be used to aid in the administration of the courses (Arthington, 1996). Currently at NSA, the CBT is primarily commercial off-the-shelf (COTS) leased/purchased courseware, which runs on DOS platforms (or by use of a DOS simulator) and is delivered by use of the Web (actually ftp, but there is a nice Web interface).

Further Advantages of the Web

The possibility exists, however, to make direct use of the Web as the presentation (as well as delivery) mechanism. Courseware in this model would have a number of advantages over ordinary CBT:

1) because there are Web browsers for each of the major computer platforms (e.g. Unix, DOS, Mac) (Barek, 1996), simulators would not be needed to make courseware compatible,
2) courseware could be run in parallel with the application being trained, and
3) courseware could be delivered in page-sized chunks, neither clogging the network, nor overburdening end-user machines.

Yet, all of the benefits of ordinary CBT would still apply.

The Curriculum

The foundation of the education and training curriculum at the NCS is the Instructional System Design (ISD) process. This model has five major phases. Four of the phases follow in a mainly linear order— analysis, design, development, and implementation; they are performed in parallel with the evaluation phase. Consequently, the heart of the curriculum is a sequence of courses directly addressing these phases: Training Needs Assessment (ED-190 or ED-195), Developing Objectives and Tests (ED-170), Instructional Program Development (ED-181 and ED-182) and Training Methods for Instructors (ED-101).

Students may add to this base by selecting specialized electives which address assistive technologies which may be employed (ED-205), the material being taught (e.g. ED-031, ED-103), particular platform techniques (e.g. ED-121, ED-222, ED-218), and the varying types of training (e.g. ED-125, ED-E11). Currently, the only course focused on CBT techniques is the last one listed (ED-E11, Introduction to CBT).

The intention is to extend the curriculum to offer training on a variety of CBT development techniques. The genesis of this proposal was a request of the author to encode his efforts to develop techniques for Web-based development (along with actually developing training in this manner) into a course in this curriculum.

The Web

The Web is actually the hypertext transfer protocol (HTTP), a client-server protocol running on top of the Department of Defense (DoD) protocol suite. The servers are processes running on server machines, which have access to a multiply-linked collection of information pages (the Web metaphor follows from thinking of the links as strands of thread, and the pages as knots); the clients are browsers, which request the information from the servers and present the data and graphics (or sound, movies, etc.) to the user. The protocol is distributed and stateless, which has several interesting consequences for training developed with the technique presented in the proposed course.

Since the protocol is stateless, it doesn't know what page was accessed last (or, in fact, if any page has been accessed). With a great deal of programming expertise, it is possible to create an environment where the user is restricted to the designer's choice of the next page in the training, but this (the construction of such an environment) is not practical to teach, and a tool for providing such an environment is not being developed. This means that the user can move forward and backward with ease, and skip randomly through the material with little experience. Lesson flow models, the ordering of the pages intended by the designer, (Barker, 1996; Dee-Lucas, 1996) will have to be compelling, since the technology will not enforce them.

On the other hand, since the Web provides multiply-linked pages, a wide variety of lesson flows can be implemented. The course will offer tools which facilitate some of the most common techniques for organizing the presentation, but once the student acquires some skill in manipulating HTML (HyperText Markup Language is used to describe the contents of the information pages) many more could be implemented.

Second, because the protocol is distributed, users are not obliged to limit themselves to the server containing the courseware. While this can be seen as a negative (the audience might wander off and never return), it should be viewed as a way of tapping into additional training resources. Students can be directed to other information sources (so the developer does not constantly need to reinvent the wheel), or they can—on their own—search for additional information on a particular topic.

The Course

The course design is intended to be consistent with the various factors identified above. Different learner-style models (Barker, 1996; Dee-Lucas, 1996) will be surveyed and techniques for addressing the major styles will be presented.

Course Description

Title: HTTP/HTTP CBT Authoring

Weeks: 1	Days/Week: 3	Hours/Day: 8
Total hours: 24	Class size: 20	

Objective: The student will be able to organize and present topics (in which they have expertise) as CBT in the form of intranet Web pages (using HTML). The materials produced will be useful as both training materials and desk references.

Evaluation: Graded, Project

Description: This course will have two major parts: using HTML to build course modules and training pages, and creating quizzes using quiz generation tools (Woodcock, 1996).

Student qualifications:

1) ED-E11 (Introduction to CBT)
2) Basic Web Authoring Skills
3) A topic which could be the basis for a CBT

Method of instruction: Platform instruction. This course will involve a significant amount of in-class work on the computer, developing a CBT module.

Course Outline

Day I

0800-0900	Course Introduction
0900-1000	Web Theory, HTML Refresher
1000-1130	Lab 1: Sample Web Class, Page Creation
1130-1230	Lunch
1230-1330	Module Preparation; Objectives, Evaluations (Power, 1996)
1330-1430	Lab 2 (non-computer): Module Structure, Objectives
1430-1600	Lab 3: Develop Module Skeleton

Day II

0800-0930	Lesson Flows, Storyboards
0930-1030	Lab 4 (non-computer): Storyboard Course Module
1030-1130	Page Building Tools
1130-1230	Lunch
1230-1600	Lab 5: Build the Module

Day III

0800-0900	Quiz Builder Concepts: HTML Gateways, Forms
0900-1000	Original Quiz Generator: Use, Building & Maintenance
1000-1130	Lab 6: Create a Quiz
1130-1230	Lunch
1230-1330	Multiple-Choice Quiz Generator & the Database Checker
1330-1530	Lab 7: Create Multiple-Choice Quiz
1530-1600	Course Evaluation and Tearful Goodbyes

Commentary

The proposed course is designed to be the practical application of the skill acquired in the Introduction to CBT course. The students will be encouraged to use this time to implement a course in their area of expertise, using the same network as they have on their desks. The connection between the task and training environment should be very large.

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CIS 100 - Introduction to Computer and Information Science: Appropriate for General Education?

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This paper presents thought-provoking issues of whether or not an introductory Computer and Information Science course should be included in a college or university's general educational requirements. Both sides of the issue are presented in an unbiased fashion. This paper draws no conclusion to the issue, but rather encourages the reader to think about the issue and to apply their thinking to their institution's general education policies and goals.

The faculty and administration at William Woods University have been struggling with this question for the past five years. While most faculty and administration members agree that a computer literacy course is beneficial to students, there is no consensus that such a course should be used to satisfy education requirements. A brief perspective of the course and general education requirements at William Woods University will help in this discussion. CIS 100 - Introduction to Computer and Information Science is an introductory-level computer literacy course. It meets for a full semester and is worth three credit hours. The course description describes the course as: "An introductory course providing comprehensive coverage of a broad range of preliminary computer and information processing concepts, application, issues, concerns and trends" (William Woods University Catalog 1996-1997, page 97).

The method of instruction is primarily lecture-based with computer lab support. This means that the student will, on average, be working on a computer in class once every two weeks. CIS 100 is open to freshman through seniors and has no prerequisite. Traditionally, two sections of twenty-five students have been offered in both the fall and spring semesters. The class enrollment is always full, with additional sections being offered upon occasion at night and during the summer sessions.

General education requirements at William Woods University consist of thirty-two credit hours. These hours are broken down in the following manner:

English Composition	6 hours
Oral Communications	3 hours
Mathematics	3 hours
Fine or Performing Arts	3 hours
Humanities	6 hours
Natural Sciences	7 hours
Behavioral & Social Sciences	3 hours
Freshman Seminar	1 hour

This course work encompasses seven instructional objectives for general education at William Woods University:

1. Written and Oral Communications: The ability to communicate effectively
2. Numeracy: The ability to analyze, interpret and manipulate numbers
3. Critical Thinking: The ability to examine problems logically, to assume and independent perspective, and to conceive pragmatic solutions.
4. Humanities: Knowledge that enables one to comprehend the traditions and values of one's culture and those of others.
5. Aesthetics: Knowledge that enables one to appreciate beauty and refine one's artistic taste.
6. Natural Sciences: Knowledge that enables one to comprehend the physical world as revealed through scientific investigators.
7. Social Sciences: Knowledge that enables one to better understand the behaviors of self and others and the role of the social environment.

The question has been raised by the faculty at William Woods University of "Why should CIS 100 be allowed to satisfy requirements in general education?" Proponents of allowing the course to count as general education often cite the following "facts:"

1. Computer skills are now mandatory in today's workplace. One would be hard pressed to name a profession in which computer skills would not affect the efficiency or outcome of the work being performed. It is stated in the university's mission statement that William Woods is a "profession-orientated university" (William Woods University Catalog 1996-1997, page 5.) This is often interpreted to mean that one of the university's objectives is to prepare students for the work force. A

"professions-orientated university" should take steps to ensure that its graduates are computer literate and ready to continue utilizing computers in their chosen careers. Many feel that requiring CIS 100 - Introduction to Computer Science is a step to fulfilling this objective of delivering skilled graduates to the world of work.
2. The course can be efficiently delivered. With a student population of approximately 600 full-time students, one or two sections of CIS 100 per semester should meet the needs of the students over their tenure at WWU. A lecture-based class can be delivered in an auditorium setting, increasing the number of students served while decreasing the number of sections offered. This suggestion is a cost-cutter over the current way the course is taught.
3. The General Education guidelines can be revised. The CIS 100 course appears to fit with the mission statement and not the seven general education objectives. It would then appear that there is a discrepancy between the seven general education objectives and the university's mission statement. William Woods utilizes a standing Curriculum Committee, whose membership is made up of representatives from the seven academic departments and the academic dean. It is entirely within the jurisdiction of the Curriculum Committee to revise the general education policy at William Woods to reflect changes in the university's mission or academic objectives.

While many faculty feel that including CIS 100 in general education is a good idea, there seem to be just as many who don't. They cite the following to support their view of the issue:

1. CIS 100 does not "fit" into any existing General Education categories. All general education courses "fit" into one of the aforementioned categories of study. While an argument could be made that CIS 100 fits in the Mathematics category, it would certainly be a stretch in logic since the course is literacy, not numeracy based. The same faculty argued that the seven general education objectives should not be amended to pander to any department's desire to have their course(s) included in general education.
2. If the course is beneficial, the students will take it anyway. This is already being borne out by looking at the full enrollments of the course. CIS 100 is already a required course in seven different majors at William Woods University, and subsequently is already required of a large portion of the student population. Opponents of this statement point out that between the 32 hours of general education and a major course of study up to 72 hours, there is precious little room left for students to be taking purely elective courses, and may not have the choice to take the course unless it was required.
3. Students already have computer learned skills in high school. While many students do have a certain exposure to computers in high school, it would be difficult to assume that all students are computer literate upon graduation of high school. Faculty can argue that college-bound students are probably smart enough to gain exposure to computers for their own benefit. Requiring a computer literacy course would be redundant for most of these students with computer exposure and constructing a competency test would be too time-consuming to be worth doing. Therefore, don't require computer literacy course for all students but make it an available option for elective credit.
4. CIS 100 is already required for seven majors on campus. Why should it also count towards general education? If seven of the most popular majors are including CIS 100 in their requirements, does this mean that most students are taking the course anyway? Putting CIS 100 into general education would be a useless gesture and a waste of time.

While this is an issue that will not likely be solved any time soon, it does get faculty thinking about the whole concept of general education - from how it aligns with the university's mission to how to proceed with revising the general education objectives. This feat, in itself, is a worthwhile outcome of debating the merits of having CIS 100 - Introduction to Computer & Information Science included in general education.

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EDUCATIONAL LEADERSHIP

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This is the first year that the SITE Annual has included a section on Educational Leadership. A talented instructional leader is a key ingredient in creating the climate conducive to efforts that attempt to bring about change in classrooms, school districts and university settings. The critical importance of leadership in accomplishing change was described by Prasch (1991) in a presentation concerning changing the preparation of educational administrators. He spoke then of the need for leaders to include the use of emerging technologies in operating new programs. A 1995 National Information Infrastructure (NII) report highlighted some of the leadership challenges that occur when technology is used in schools. They concluded that it will take sustained commitment of leadership at school, district, and other levels of leadership that touch educational settings. The issues raised by Prasch and the NII are mirrored elsewhere in the literature and make a strong case for this new section.

Over the years we have had many sessions at the conference and papers in the Annual that have examined leadership issues in many forms. These have included the impact of the teacher/leader as a change agent, the importance of the principal as instructional leader, and the leadership required to revise and re-vision teacher education programs to better prepare preservice teachers to use technology.

In this section you will see that the authors have approached the concept of leadership thought a variety of lenses. These lenses include looking at Educational Leadership in terms of the prospective administrator, the roles of practitioners in the field, school change and organizational issues, and issues in higher education.

Prospective Leaders

In order to prepare principals to take an leadership role in integrating instructional technology into the curriculum, Roden offers us an outline of an ambitious preservice program. This program concentrates on analytic skills and hands-on practice with computer-based decision making tools. It focuses on both large scale capital and funding concerns, and classroom curricular issues. The rationale is based on a set of core skills that new principals must have when they assume their leadership roles. The course of study includes using technology to incorporate and understand statistical information, understand networks for distributed data and resource access, and incorporate software for curricular improvement.

Kaufman believes that although educational institutions reflect an organization design for learning, they themselves do not reflect the systems-based approach that in an integral part of organizational learning. Her paper describes a Performance-Based Principal's Program that is intended to enable future principals to foster a systems approach. Of additional interest to the reader is the realization that the basis of the work is a carefully crafted technological interface that has been placed over an existing quality curriculum. The design was guided by theories about the learning process and adult development.

Administrators in our K-12 schools frequently complete their educational experiences with little or no preparation in using technology to accomplish their professional activities. In his description of an experimental course, Yan provides a look at one course that was designed to meet their specific needs in this area. Administrators were provided skills and practice in authentic activities, kept journals to document their learning and reflections, and worked together to accomplish tasks. Overall, the course was deemed a success, and may serve as a model for other educational programs.

MacNeil describes the use of an Electronic Meeting System (EMS) for synchronous group problem solving and decision making for prospective administrators. Case studies provide opportunities to identify problems and propose solutions. In this project, one group used the EMS to analyze a complex case, while others were given the same case but directed to use the more traditional model of analysis. Results suggest that more creative solutions were generated, and that more egalitarian models were used. The use of EMS was proposed as a way to allow for more brainstorming, to create a record of the dialogue and postings, and to move beyond simplistic solutions. Some cautions were also given regarding extended time to reach consensus, tendency to digress from goals, loss of accountability, and possible lack of clear direction in using the EMS. Further research using EMS in this area and with this population is suggested.

Practitioner Leaders

Murphy and Gunter begin by acknowledging the importance of the role of the administrator in the use of computers in schools. In addition they provide information on specific guidelines for instructional leaders implementing computer integration. When all of this is said and done the question remains whether or not the teachers themselves feel supported by their administrator. The purpose of this study was to measure and report the amount of perceived administrative support teachers received and what factors impacted their perceptions.

North's paper describes a professional development project for secondary principals and senior teachers in Northern Ireland. Using qualitative methods, North provides insight into a new staff development model of teaching this system with a multimedia CD-ROM, as opposed to the traditional paper based training model. The training project is based on three levels of training, "Show Me", "Let Me Try", and "Tell it to me Again." Video conferencing was used to allow education managers to interact with tutors for a variety of support and testing activities. Results reported include information about the effectiveness, efficiency, and cost effectiveness of using this new program.

Driskell and Cobin describe how principal leadership initiated ongoing support for teachers learning to integrate technology into the curriculum. The designation of a Technology Facilitator helped teachers create lesson plans that included technology experiences and exploration of a variety of useful software. The paper focuses on ideas for others who might want to implement a similar position in their own setting. The collegial collaboration provided in ones own setting is a powerful motivator for teachers to attempt new instructional strategies.

In their paper DiBlasi, Steinle and Hall describe the efforts of the Durango School District to carefully plan for their technology implementation. At first efforts were expended to get the hardware into the schools, but ultimately the need to focus on staff development became clear. The district hired a Technology Coordinator, created a Department of Educational Technology, and began a systematic approach to involve all educators. Using a "train the trainers" model, one educator in each school took responsibility for organizing, training, and supporting others at that school.

Lare describes several instances where teachers were provided unusual access to computers to encourage their involvement in the use of technology in the classroom. The key to the program is making the technology available to the teachers in their own time frame. They were then able to explore, take risks, and see applications for these tools in their own instructional life.

School Change And Organization Issues

It is very easy to assume that technology provides an indisputable and universal benefit. We are reminded of the importance of continuing to examine and question in the paper by Nicholson in this section. She reminds us of the economics surrounding technology and how it can create pockets of inequity throughout the educational system. What is our responsibility, if we believe the first statement of the paragraph, to secure convenient, affordable access for students?

School districts are required to make projections in order to solve complex problems, and now the potential exists for computer systems to assist administrators in this task. In his paper Taylor provides authentic examples of specific activities that intellectual agents (programs that search for information and organize it) might perform to assist internal decision making and problem solving systems for educational administrators. One primary advantage is that intellectual agents will anticipate the questions and issues before humans, and their projections will assist in making thoughtful decisions in areas such as distribution of funds, teacher shortages, and transportation patterns. This paper provides a look into the future of these tools, and creates a framework in which to consider the possibilities that are on the near horizon.

Gunter and Gunter identify significant problems associated with rural economic and educational development. The loss of population and weak tax base make it less likely that students and institutions can join the information age and provide access to global resources. The authors describe one attempt to change this pattern by joining educational and economic interests in rural southeastern Alabama. This project, The Southeast Alabama Network, was designed to bring full access to all schools, health care providers, businesses, and citizens throughout seven rural counties. Significant effort will be spent on training and support organization to encourage thoughtful implementation of this new access.

How can Information Technology provide assistance to educational leaders? Facemyer examines the three types of leaders described by Senge. He provides a series of premises about IT in aiding leaders and their work. IT, in various formats, can be systematically applied to provide each type of leaders with help for the management issues they face.

"What is it that leaders do and how do they do it ?" is a frequently asked question. Swartz provides one person's perspective on the answer to that question. He also tells us about some of the misconceptions that abound and ends by reminding us the importance of all stakeholders being involved if change is going to take place.

Dubenezic provides resources to support those in schools who are leading the way to help teachers integrate the WWW into the curriculum. He includes materials that specifically address content area materials but there is also a focus on professional development among the sites provided. Dubenezic also provides a URL for a site he has developed so that you can access all of the sites described.

Issues In Higher Education

It was difficult to decide where to place this next paper. It most certainly deals with school change and organization issues but does so while examining how higher education plays a role in preparing leaders to participate in this change process. Saito reviews the recent technological development and its influence of education planning. He seeks to illustrate the notion of information literacy and its importance to educational planners. He provides specific ideas on how information literacy can be accomplished.

Davis and her colleagues are examining an important issue in the use of Information Technology. They recognize that IT affects most sectors of our society but ask if we really know what its role is in teaching and learning in higher education. They found little documentation of the few examples of ways in which IT can assist teaching and learning. The research study is still in progress but Davis shares the evidence they have found to date.

Howard and his co-authors have produced an Information Systems course that takes advantage of multimedia and hypermedia. Although the course has been successful in the eyes of the authors and their students many faculty are hesitant to join in and use these tools in their own teaching. This paper describes the process on assessment and discusses the key question of making technology mandatory or optional for teaching and learning.

Kveton and Vesla describes efforts of the Czech Technical University (CTU) to meet the needs of students and educators with respect to Information and Communication Technologies (ICT) as suggested by the European Union. They describe trends in Europe, the current campus wide information system at CTU, and perspectives of the management information system. Efforts also include policies to implement ICT into education, research, and management.

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Training School Leaders to be Technology Leaders: A Modest Proposal

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Evaluation and Systems Solutions

In the American public schools, we have traditionally looked to the principal as the curricular leader. A good principal can lead by example, can motivate teachers and students, and has a clear understanding of the relationship between people, curriculum and the physical spaces of a school. We assume that an effective school leader could walk into most any classroom and muddle through any lesson, performing at least a serviceable job. The major exception to this assumption is educational technology. No principal would ever declare "I don't know much about math", or "I was never much for reading", yet many commonly make this declaration about computers and the role of technology in the classroom. As a result, technology tends to exist in schools outside of the core curriculum, used as an end in itself, rather than a means to support the central teaching mission of the school. Despite spending considerable amounts of money for hardware, networking connections and software, technology in schools tends to be what happens in the computer lab, or a disjointed, haphazard portion of classroom life, seldom connected to or supporting instructional objectives in a meaningful way. Many teachers want to use this technology in a more effective way, but need help and direction in the relationship between technology and the core curriculum.

To address this need, the following program outline was developed. The goal of this program is to train preservice administrators in the skills needed to be highly effective technology leaders in schools. Principals will be able to manage technology both as a large scale capital project and at the classroom level. In addition, principals will be given coursework in analytic skills and hands-on practice with computer-based decision making tools. This paper is an outline for how such a program would be structured. It appears that there is a clear and urgent need for leadership in the technology area, and a program which targeted preservice school administrators would be a positive first step.

Rationale

There is a need for a new breed of school leaders is required who have the skills to:

- Use technology and analytic tools to make policy decisions based on internal and external data.
- Effect site-based management by developing data systems to track, manage and analyze fiscal, academic and demographic data.
- Provide leadership for school-wide implementation of instructional technology, as both a long term capital project and a classroom level teaching system.
- Use large external databases to develop more effective measures of relative school performance.
- Provide quantitative and qualitative data for district and state level constituents.
- Use the proper statistical tools to understand and express student performance data, while appreciating the limitations of quantitative measures of human learning.

Proposed Course of Study

There is a need for school leaders who are able to manage technology and data as a part of their administrative life. At best, many administrators take a few computer courses aimed at enhancing generic skills with software. A program which is tailored to develop a small cadre of administrators who have strong analytic and technical skills would be unique in this area and perhaps in most areas. From where I sit, my bet is that most higher education institutions are not nimble enough to offer a dynamic program which will constantly evolve to provide current material. To this end, the following is a core series of courses, to be taken as a cohort and in order.

1) Applied Statistics for School Leadership

This course would include an overview of the content taught in most Masters level research courses, but with an emphasis on the following:

- Hands-on use of computer software to teach relevant decision making skills using realistic school-based data sets.
- Emphasis on the skills needed to reduce complex data and present the findings effectively to varied constituents.
- Emphasis on interpreting student performance data and communicating results in a balanced and sensible manner.
- Emphasis on working with live fiscal data to make decisions based on various financial assumptions.

2) Distributed Data Systems in School Settings

This course will focus on the planning and implementation of a building or district level technology plan. Topics will include:

- Network typologies and standards.
- Budgeting and capital planning for technology projects.
- Relational database systems for administrative and classroom functions.
- Connectivity to World Wide Web (WWW) and Internet resources.
- Computer security and ethics.
- Staff development and training issues.
- Distance learning technologies.

3) Technology in the Classroom

This course will concentrate on the use of technology at the individual student level and its role in the learning process. The goal of this course will be to prepare administrators to be instructional leaders in this area. Topics include:

- An overview of educational software and multimedia titles.
- An understanding of the relationship between lesson objectives and different types of software.
- Using technology for better assessment.
- Using WWW resources across the curriculum.
- Integrating live data into the inquiry process.
- Technology and the writing process.
- Using technology to simplify classroom grading and administration.
- Developing one's own software with authoring tools and visual programming languages.

4) Planning and Dissemination Project

This will be the final phase of the program. Students will work independently under faculty council to develop and disseminate a project for professional growth. Some possibilities include:

- Analysis of state or federal education statistics to provide policy data for other school practitioners.
- Development of a technology plan in conjunction with an area school district.
- Development of a cohesive series of classroom software programs which support a portion of the New York State curriculum.
- Development of a database system for comprehensive school management and reporting in conjunction with a local school.
- Development of a "Lead Teacher of Technology" training program with a local school district.

This program would fill a need, would generate interest sufficient to allow for competitive admission and would lead to a very robust placement rate. More than that, this type of program would support the use of technology as an integrated part of the core activities of a school, rather than an ancillary activity by involving the key leaders within the school.

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Organizational Learning as a Tool in Meeting the Technological Needs of Teachers

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Schools, like many organizations, are in the midst of unprecedented transitions. Educators at all levels find themselves adapting to a playing field on which the components of their own training may no longer be aligned with current realities. A technological restructuring of the workplace is one such reality. The innovation shared in this paper links technology with beliefs about organizational learning in order to better prepare candidates in a school principal's program to address the needs of adult learners on their teaching staffs.

Guiding Beliefs and Theoretical Foundations

In recent years, Peter Senge's (1990) ideas about learning organizations have successfully aided various institutions in the throes of realignments and transitions. Claiming that the collective disciplines of personal mastery, mental models, team learning, and shared visions contribute to both individual and organizational betterment, Senge points to a systems approach as the distinguishing factor in successful transition efforts.

I contend that although educational institutions reflect an organizational design for learning, schools themselves do not reflect the systems based thinking that is central to organizational learning. The work described here is intended to enable future school principals to foster a systems approach. It reflects my view of administrators as both leaders and learners, and as vital parts of a larger system of parents concerned for the future of their children, of business communities concerned about the competency of future employees, and of politicians concerned about public spending. The broad-based conceptualization of school leadership that frames this work:

1. acknowledges teachers as instructional leaders who will, and indeed who must, play new roles in research, evaluation, and decision-making within today's schools,
2. believes school principals must address the learning needs of their adult staff with the same level of commitment with which they approach improved learning for children and youth, and
3. depends on the craft knowledge of veteran educators aspiring to become school principals for establishing sound interfaces between curricular and pedagogical needs and technological platforms as they share their growing administrative competencies within six core areas of a Performance-Based Principal's Program. These major areas are: curriculum management, instructional supervision, evaluation and research, educational innovation, organizational management, and human relations.

Placing a technological interface over an existing quality curriculum in school administration was shaped not only by my interest in Senge's work, but also by three other guiding theories about the learning process and adult development. One is Zuboff's (1988) distinction between using technology to automate or to informate.

Automating technologies make existing work more efficient. Informating efforts involve stretching people to think differently about the work they do and applying technology to redesign that work. The informating potential of the Internet is reconfiguring our traditional portfolio documentation of administrative competencies while simultaneously enabling the entire cohort group of twenty principal's candidates to expand their knowledge base for guiding more informed decision making.

Traditional theories of learning emphasized programmatic content. A second influence on this work are recent findings in cognitive science (see Perkins and Salomon, 1989) which point out that the experiences encountered in new learning are as influential as the content that is learned. This supports Buchminster Fuller's (in Senge, 1994) argument that if you want to teach people a new way of thinking, you should not waste valuable time trying to teach them at all, but instead provide a means through which new approaches can be utilized. The websites described in the presentation of this paper illustrate how this third assumption, in particular, helped reshape one program in educational leadership.

Preparing for the Changing Nature of Leadership

Lou Gerstner, (1994) CEO of IBM, claims that nothing matters more to America's schools than finding competent principals to lead them. Although the role of the school principal is frequently cited as the key element in school reform, it is not the solitary role of times past. It is a role that demands skills in team building, shared decisions making, and increased technological competency.

The Performance-Based Principal's Program at Indiana University of Pennsylvania (IUP) is nationally recognized by the Association for Supervision and Curriculum Development and the National Association of Secondary School Principals for its design in preparing school principals. Following a five-week summer seminar in School Administration, candidates translate the six core competencies of the curriculum into an context specific Action Plan that details how specific requirements in each category (for example, inclusive practices in Management of Curriculum) will be addressed through their work in the urban and rural settings in which their supervised internships take place.

A student in the seminar in school administration first introduced the possibility of a technological approach to sharing growing competencies and challenges into the IUP Principal's Program. Mr. Alan Johnson created an online electronic page detailing his work in the program's major competency areas. His initial efforts motivated redesigning the program in order to model the informating potential of technology. Use of the Internet thus demonstrated technology as a useful tool in sharing individual accomplishments and problems with fellow students and supervising faculty members during the candidate's supervised internship. This replaced technology being one separate component in the core area of educational innovation. Mr. Johnson's webpage can be accessed at http://ramsesjr.jtwn.k12.pa.us/~anj/iup.html.

Technology, Policy, Power, and Practice

The most recent National Educational Summit pointed to technology as a major element of school reform. But policies emerging from this vision offer little promise for school betterment if computers are used primarily as automating rather than informating instruments. Policy is at best an enabling device (McLaughlin, 1987). Real change is a people dependent process.

As educational leaders endeavor to develop rather than to dictate a readiness for change in school cultures, two messages from contemporary leadership literature seem particularly relevant. These are: 1) an inquiry orientation that moves teaching and administrative roles closer together, and 2) increased attention to the interactive nature of leadership and followership that includes rather than excludes such elements as conflict, confusion, and complexity.

A technological orientation to inquiry expands the role of teachers to program designer and planner and distances instructional tasks from the prepackaged curriculum materials of past decades that were critiqued for their deskilling impact on educators as effective change agents. An inquiry orientation is apparent, for example in principal's candidates' websites that details useful strategies for authentic assessment and inclusion of special needs students in the core area of curricular management. An emphasis on both improved student achievement and teacher empowerment is evident too in student home pages that address improved supervision methods.

An outstanding example of attention to conflict, confusion, and complexity regarding technological decisions is apparent in Al Johnson's website that allows administrators to seek out answers to questions about technology and school finance, questions that may be embarrassing to ask publicly because administrators with high levels of instructional wisdom often have low levels of technological expertise correlating with their age more than other factors. Answers resulting from shared experience to such questions can result in considerable savings for school districts if administrators are committed to asking and to answering questions that matter. Cuban (1992) warns that inquiry which screens out rather than includes elements of uncertainty results in asking only those questions for which we already know how to find the answers and not the questions that matter most in improving our schools.

Sense making rather than generalization is an expected outcome of contemporary information gathering. As leadership roles become reconceptualized beyond one who dictates courses of action based on recent trends to one who gathers and uses the best information possible, it is essential that leadership programs in higher education provide clients with technological access to quality information in addition to traditional text and journal resources. In a commitment to this strategy, IUP's Principal's Program now offers to its principal's candidates an administrative website that fosters quick and useful links through which core competencies can be strengthened. This site can be accessed through IUP's home page at http://www.iup.edu (developed and maintained by Tom Jones, graduate assistant and technical coordinator for the Principal's Program). Mr. Jones can be reached at cymru@twd.net.

Conclusions and Problems

Theories that anchor organizational learning define individuals, their problems, and their achievements as part of a single system. This project resulted from combining this principle with the informating potential of the Internet in preparing leaders for tomorrow's schools. Integrating the technological platform of websites on the Internet permitted the expert knowledge of separate individuals to contribute to the collective wisdom of the entire group. In the process, the involved adults all expanded existing technological competencies in ways that enabled them to model an integration of technology and organizational learning for their future staffs. This process of personal growth and shared knowledge fosters the connections between autonomy and accountability that educators desire and the public demands. It inspires actions that are motivated by aspiration rather than desperation. And it encourages teachers to structure their own professional growth.

A large portion of student time, it must be noted, is consumed by the investment in learning how to develop competency-based portfolios as websites. A large portion of student funds can also be consumed if the candidate invests in the necessary hardware and software to utilize the benefits of this shared technology from home rather than traveling to a university or community location with access to the Internet. We hope that future grant funding will enable our program to supply each candidate with a laptop and online Internet subscription service for the duration of the 12-18 month Principal's Program. Through these continued efforts, we intend to transform one higher education program into a national example of organizational learning.

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DEVELOPING COMPUTER COMPETENCE FOR FUTURE SCHOOL LEADERS

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Many graduate programs in educational leadership require students to take courses in leadership and management, but few of them require students to be technologically competent. Preparation of technology leadership is an important theme in educational leadership programs (Means, 1994; Kearsley, 1990; Picciano, 1994). To meet the increasing needs of developing computer competence for future school leaders, a graduate course in educational technology was offered in the department of school administration and supervision at the University of Texas-Pan American. This paper reports the implementation of the course.

Course Objectives and Contents

The objectives of the course are to help future school leaders become competent in integrating educational technology:

- understanding the nature of educational technology and the various data processing methods used by educational administrators;
- becoming an intelligent consumer of educational technology;
- developing the skills used in the planning for and administering computer technology in schools;
- increasing the likelihood of the future use of educational technology to guide professional practice.

The course covers the following four categories of administrative uses of technology: word-processing, communications, data analysis, and data management. The students also explored Mac School (Bickford, 1993) — a student information system, including (a) finding information, (b) tracking and reporting attendance, (c) generating report cards and transcripts, and (e) creating scheduling system.

Strategies for Learning Activities

On the basis of principles derived from the current research on teaching and learning technology, the following strategies were used as guidelines for classroom learning activities:

- Structure the lessons with adequate introduction and guided practice.
- Lecture as little as possible.
- Introduce interactive computer activities as quickly as possible.
- Provide large blocks of time for extensive hands-on experience.
- Encourage peer interaction and continuous sharing of information.

Course Emphases

Emphasizing Current Issues in Educational Leadership and Technology

This course provided graduate students in educational leadership program an in-depth look at the use of existing technologies in educational administration. Class participants were required to review literature that examined the use of computers and related technologies in the area of educational leadership. Students were required to interview school teachers and administrators on their beliefs and practices in educational technology. Based on their own experiences and interview data, the following issues were discussed in the class

- Educational technology and site-based management.
- Educational technology and educational reform.
- Educational technology and effectiveness of educational leadership.

Emphasizing Step-by-Step Hands-on Exercises

Basic Computer Competency Worksheets were provided to students. Through step-by-step, hands-on exercises, students were able to build competencies in educational technology. They were able to use technologies to perform administrative tasks on day-to-day basis.

Emphasizing Self-reflection

Students were required to keep learning journals. The following questions were used to enhance their reflective thinking:

- What happened this week that worked well? Why?

- What happened this week that did not work as I expected? Why?
- What are some questions I would like to ask my classmates and professor?
- List one specific area that needs work. What can I do to improve in this area?

Students' reflections on these questions were focused on the following categories:

- Reflection on classroom instruction and discussion;
- Reflection on the knowledge and skills learned in class;
- Reflection on strategies of learning educational technology;
- Reflection on anxiety and stress in learning educational technology.

Emphasizing Portfolio Assessment

The course is based primarily on a criterion-referenced portfolio assessment. Portfolios contain collections of students' work over time. The students included their reflection journey, projects, term paper, presentation notes, and anything contained evidence that they have engaged in self-reflection. During the course of developing the portfolio, students might include all work in the portfolio for purposes of reflection, self-evaluation, and revision. However, at the end of the semester, they selected the pieces that best demonstrate their growth and achievement.

Learning Accomplished by the End of the Course

Word Processing

The class participants were able to use word processing programs to compose, revise, correct, combine, rearrange, and to print it in a wide variety of formats. For example, they were able to use a mail merge to write a letter to students' parents.

Communication

The class participants were able to use enormous and growing resources for educational administrators with a mainframe computer—including such applications as electronic mail, Internet, listservs (electronically facilitated discussion forums), Gopher, World Wide Web (WWW) and theTexas Education Network (TENET).

Data Analysis

The class participants used computers to perform data analysis. For example, they used the electronic spreadsheet to analyze a school budget or other quantifiable data, such as enrollment projections, time schedules, or test averages, as well as to translate raw data into bar graphs, pie-graphs, and tables.

Data Management

Class participants were able to build a database to store a brief sample of the school records such as student records, personnel records, inventories of school equipment, financial records, and special management records. For example, they were able to build a database for a school that including student name, age, birthdate, parent's name, address, phone, emergency contact, and doctor' name.

Summary

Overall, students reported that the technology learned in this course has benefits in a variety of areas. Many students have integrated educational technology into their daily administration tasks. Providing the technology is, however, only the first step in moving towards effective educational leadership. Further supports are needed to help our future education leaders to integrate the technology into their educational reform activities.

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Case Study Method and Electronic Meeting System for Principal Preparation

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Both the legal and the business schools have a long and extensive tradition of using cases to prepare future members of their professions. The use of case studies to prepare principals has not nearly so long a tradition (Merseth, 1991). Efforts to improve the preparation of prospective school administrators often include the use of case studies as an instructional strategy. The case study method provides actual situations in which participants can refine problem solving skills. The school reform movement or, as Fullan (1996) terms it, school reculturing, requires that administrators develop skills that can assist them and their staffs in implementing changes that benefit students. A closer alignment between theory and practice in the developmental programs for school administrators has many advocates. Culbertson (1964) pointed out the discontinuity between the study of administration and practice. The results of a 1984-85 national survey of the status of school administration preparation advocates a closer alignment of theory to practice; since then most university programs have changed emphasis. That national survey found that most preparation programs concentrated on procedural issues rather than on ethics and leadership issues. The survey also reported that a shift in priorities was underway and predicted that future preparation programs would focus on improved instruction, field experiences, evaluation procedures, and interagency coordination (Gousha, 1988).

The 1987 report of the National Commission on Educational Administration recommended that preparation programs for school administrators should be more like those in professional schools that emphasize theoretical and clinical knowledge, applied research, and supervised practice. Relevance in professional preparation programs is not unique to the study of educational administration. Schoen (1987) described the rigor of relevance in all professional schools. Criticism of professional training programs has often focused on the remoteness of the academic programs from the problems in the field. The passive nature of most instruction and the failure to present theoretical constructs in ways that are meaningful to students and practitioners continues to be a problem in preparation programs. The use of case studies as an instructional method is directed to solving the problem of teaching theoretical constructs in ways that are meaningful so that future school leaders will be good decision-makers.

Given the significance of good decision-making it is important to minimize poor decisions and poor decision making practices. There have been many times when groups have made bad decisions or when the conditions of information would warrant a different decision than the one made. Educators often tell stories that attest to the befuddled decisions from school boards throughout North America, often related to building design and location problems, personnel selection, or policy choices that would boggle the mind. Case studies used as an instructional method focuses on developing future school leaders as good decision-makers.

Case Studies and Leadership Preparation

Professors who use the case study method to prepare school administrators believe that the use of case studies assist in the development of skills essential for good school leadership. Generally it is thought that through the use of case studies participants acquire analytical skills and the ability to think clearly in ambiguous situations. Synthesizing information and conceptual development are other dimensions of the case study method. Development of mature judgment is also nurtured through the process, as it requires the examination of one's value system and testing that system against the law and others' expectations. Finally, development of communication skills related to listening to others, seeing divergent points of view, speaking and writing clearly, understanding one's self, and the use of imagination and intuition are all considered important aspects in the development of school leaders.

The case study method requires that participants be reflective at each step in the process. Thus, the procedure is not linear but rather dynamic and open to the restatement of the initial problem if necessary. This is essential in that limiting problem solving by following rigid, static steps may result in identifying the wrong problem or supporting problem. Finally, since the method is dynamic, it requires time to use effectively.

Given the previous rationale it would appear that the case study approach to preparing school leaders is a wise one. The ambiguity of the school environment requires that principals have leadership skills that focus on the purpose of school and use flexible approaches to achieve the purpose. But does the case study method meet the needs in preparing candidates for the role of principal?

The answer to those of us who work in preparing future school administrators lies in the observations of the students. More often than not the identification of the problem and the solutions using the traditional case study method have superficial results. Using the case study method means accepting that there are no right solutions, however; some solutions are better than others. Many of the reasons for the inadequate response from using the case study method can be found in the theories of groupthink and escalating commitment (Hellreigel, Slocum, & Woodman, 1992; Janis, 1982). Group dynamics tends to guide the quality of the identification of the problem and the subsequent solutions. There are also disadvantages if there is pressure within the group to conform or if there is a forceful member or dominate clique that ramrod decisions. Strong, vocal, and occasionally, the least knowledgeable people can become the most persuasive in the process. Once a direction has been taken, as inappropriate as it may be, more and more resources, including valuable time, are directed toward the inappropriate result.

An alternative form of meeting environment known as Electronic Meeting Environment (EME) is now possible through the application of information technology that attempts to make meetings more productive. Through the use of this technology future administrators are given the opportunity and the support for issue identification and prioritization procedures, which facilitates achievement of group consensus. Computer-based technologies provide effective tools to drive more productive meetings. These hardware/software combinations, commonly known as electronic meeting systems (EMS) have begun to find their way into a variety of educational environments (Aiken & Riggs, 1993).

Electronic Meeting System (EMS)

EMS endeavors to make meetings avoid groupthink and escalating commitment and also become more productive. EMS technology is designed to improve the productivity of many collaborative planning and decision making processes (RICIS, 1994). Through the use of this technology, group involvement in decision making can be accelerated. The use of EMS for the preparation of school leaders also has several other benefits. The public school principal of today needs to develop skills in group decision-making. Group involvement is a necessary condition for site-based and total quality management. Best and prevailing practice increasingly involves collaborative methods and group consensus building and or including involvement of various interest groups, or representatives, of groups, in educational decision making. Nunamaker, Dennis, Valacich, Vogel, and George (1991) have presented a strategy for understanding EMS processes, focusing on the characteristics of the group to be involved in the process, the tasks to be completed, the context of the organization and culture, and the outcome to be achieved. These items provide a framework for evaluating and understanding this and other examples of EMS and also establish an organization for a research agenda on system use (Spuck, Prater & Palumbo, 1995).

The Process

This study involved students in graduate classes in educational leadership studying the role of the principal. The study used a case as the bases for creating a decision-making situation. The case was about a principal who had recently been assigned to a dysfunctional high school with a mandate to establish a functional and improved school. The principal was an experienced administrator and was able to create a very much improved school environment, however, the principal had continuous difficulty regarding the relationship and the performance of a recalcitrant secretary. The case presented many positive and negative situations and involved many participants. Clearly the case was not unlike situations and dilemmas that educators work with on a daily basis.

The students were familiar with the use of cases and used the following procedure as a guide. Students, in groups of five or six, were encouraged to take a position after reading the case carefully and outlining the key points. Then they were expected to frame the central problem in a sentence or two. Next they identified secondary problems and indicated how these related to the central problem. After identifying supporting problems they found supporting information, looking for internal consistency and being careful about assumptions. The next task was to develop alternative solutions within the context of forces that enable or restrain them, or those that maintain the status quo. Students were then required to evaluate their alternative solutions, subject them to scrutiny, and use a T-account to list advantages and disadvantages. A T-account is a simple chart in the form of a T that allows you to list the advantages and disadvantages in a parallel structure for visual clarity and impact. The process also required that a list of activities, identification of responsible parties, presentation of a time line, and statement of measures of intended outcomes be included. They then select the alternative most likely to solve the problem or bring about the desired change, or suggest a better option. Finally, they were expected to create a plan for implementation, including a method for adjusting.

This case was used in a traditional manner as described above during four different semesters, with groups of five or six students for a total of 24 experiences. On all of these traditional occasions the student groups identified the secretary as the problem for the case. The groups identified some punitive measure from reprimand to firing the secretary as a solution. The class that used the EMS had 39 students. For our purposes, 13 students used the EMS and the other 26 students stayed in the typical configuration. These five groups used the same case and were to follow the guide as stated earlier. The groups were to be used to compare if the resulting identification of the problem would be similar.

For the purposes of this study the EMS used an approach based on the Nominal Group Technique. This approach is a refinement of brainstorming that focuses on generating alternatives and choosing one. This approach is recommended where group members fear criticism. The following steps were used: members silently list their ideas, all ideas are listed on chart with discussion allowed for clarification but no criticism, finally a written vote is taken (Van deVan & Delbecq, 1974). This process encourages members to pool their judgments in order to solve the problem and then determine a satisfactory course of action.

Results

The group of thirteen graduate students identified 61 possibilities as possible problems. The students were asked to vote to narrow the selection down to the top fifteen. The sixty-one possible problems had many similarities, however, an attempt to group them together was not successful. The group was then asked to prioritize the fourteen selections. The sum of the rank ordering and the mean were calculated and the standard deviation from the mean was also provided. The ballot showed that most of the students identified the main problem as the lack of support from the Superintendent but the result was not significant. The significance level is found by the program calculating the consensus threshold using Ventana's coefficient of consensus (VCC). The value of 1.00 represents complete consensus and the value of 0.00 represents no consensus. The VCC = 1.00-((STD / (high Limit - low limit)) * 2). The significance 0.18 showed very little consensus as a result of 0.65 would be considered significant. The lab assistant then narrowed the choices to five and the students voted. This time the VCC was calculated at 0.26 which again showed little significant agreement among the decision makers.

The next step in the process was to generate solutions. Each of the five identified problems were examined for solutions. Problem one created 45 solutions. Problem two-15, problem three-11. problem four-11, problem five-9. After identifying solutions for the problems they were asked to vote again on the critical problem. The students were then directed to predict by brainstorming the advantages and disadvantages of the solutions for the problems. The generated lists of advantages and disadvantages created a great deal of data that needed to be sorted.

The identification of the problem with the EMS system although not significant, focused on the Superintendent and his/her lack of support for the principal in handling the difficulty with the secretary. The other five groups of five or six students identified the problem as being a difficult secretary and the need for the principal to proceed with progressive discipline. The EMS students focused more on the problem of lack of leadership in the organization and the relationship between the principal and the superintendent. It should be noted that although, there is no one correct answer when using the case study approach, because a case reports the author's bias, all details cannot be given and the assumptions that the students make in determining the analysis cannot be controlled. It is worth noting that a different outcome resulted from using the traditional case study method and using EMS, which suggests that there are better analyses and perhaps better solutions than others. It is also worth noting that because the EMS students identified a different problem, the solutions they provided were also very different. The main point is that if they don't have the right problem identified, they are not going to provide useful solutions. Competency as a school administrator requires the ability to think critically and identify the problems that need solutions. The core of school leadership is the ability to make good decisions.

As a follow up, six experienced and successful school administrators were asked to read the case and react by identifying the problem and the solution. The result using EMS more closely followed the analysis of experienced school administrators. The results indicated the need for more study and analysis on the reasons for the different outcomes, and more study as to why the process of using the traditional case study method produced more superficial results, at least in this situation. There are also several advantages to using the EMS over the traditional case study method that make the system a very useful teaching approach when developing decision making skills.

The Advantages of Using EMS

There is an staggering amount of data that is produced and easily sorted using the EMS system. The variety of ideas makes the group's work more focused on solving the problem rather than defending a solution. Olaniran (1994) made the observation that using electronic brainstorming produces significantly more fresh ideas. The use of EMS allows the calculation of the data to be produced by the system and the results are available throughout the meeting as well as in summary at the end of the session. A complete record of the meeting is available for analysis at the end of the meeting. All participants can input their ideas simultaneously. Opportunity for equal participation of all group members is provided. Large groups can work together to effectively provide more information, knowledge and skills to work on the task.

Using the EMS removes a major barrier of members seeing and hearing which ideas are whose. It encourages members of the decision making team to think and create solutions rather than playing the politics of supporting an ally or friend. Nelson & Quick (1994) report that the Boeing Company study of its meetings found that 20 percent of the team members did 80 percent of the talking. Using EMS frees members' participation, and relationships become less important as the focus is on determining a best result. Although time can be considered a liability it can also become an asset using the EMS.

Some ProblemsUsing EMS

Using the EMS can be more time consuming than using the traditional method of working in a group on a case study. The groups not using the EMS were finished with their deliberations much earlier than the EMS student group. The anonymous nature of the meeting can also encourage frivolity and distract others from the task, although some humor does add to the meeting. Another problem with anonymity is that it encourages irresponsibility and the accountability for ones actions can be lost which creates ethical implications. Educational settings, which often require public accountability, cannot be anonymous. Using EMS is and can be fun; hence, there is a need to be careful of the Halo Effect.

Discussion

Issues and problems occurring within the schools are becoming increasingly complex requiring more innovative solutions to problems. Yet the preparation of administrators focuses on developing systematic decision-making skills. These strategies come from the business model. While school leaders engage in some activities that are similar to those found in business, the more critical areas that administrators are required to address deal with individuals, both staff and students. The factors that need to be considered in school decision-making are more complex. Case study methods adopted from law and business schools need to be re-examined as a method of instruction for use in the preparation of school leaders.

As was observed, the case study method is often used in a superficial manner and resulted in identification of problems and solutions that are inappropriate for a school environment. Students tended to look for a right answer and thus were likely to focus on surface problems rather then underlying problems. Thus, the solutions would ultimately not solve the root of the problem and were unsatisfactory for the school setting. Using the case study approach it is necessary to be aware of these limitations.

This EMS approach used with a case study suggested a higher level of decision-making than the traditional case study method. Through the use of this technology future administrators were given the opportunity and the support for issue identification and prioritization procedures, which facilitates achievement of group consensus. Immediate feedback and real time results meant no waiting. The importance of having a complete record of the meeting was a distinct advantage of the EMS. Individual entries, as well as the entire process, were recorded and analyzed. Decisions that require planning and problem solving or reculturing with task assignments can benefit from the EMS.

Just as some decisions are best made by individuals and some by teams or groups, some decisions are better suited to the use of the EMS. Decisions that would tend to be very emotional or those that require expedient action would best be served by the EMS. Decisions that will result in hurt feelings and poor relationships that can cause an organization to become dysfunctional could be best served by the EMS. Decisions that need to be made avoiding the groupthink phenomena can be well served by EMS. Meetings that require new or better solutions that can be best achieved using brainstorming have the advantage of simultaneous input using EMS. The importance of rapid polling on decisions is important for decision making that requires immediate feedback. Future administrators may benefit from experience in this form of decision making and problem solving.

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ADMINISTRATIVE SUPPORT: A KEY COMPONENT OF TECHNOLOGY INTEGRATION

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In their review of the research base of elementary computer instruction, Benjamin, Bryant, and Mack (1990) noted theimportance of the role of the administration as one of the important dimensions of the use of computers in school. The authors recommended guiding principles for administrative involvement in and support of computer instructional use which included administrators: 1) serving as role models for technology use, 2) updating their own skills, 3) visibly supporting staff members in the use of technology, 4) setting high expectations for technology use, and 5) promoting purchases and effective use. Administrators should serve as role models, start small, and encourage teachers to have computers at home (Weal, 1992). Barker (1990) noted that until the faculty and staff members see that their chief administrator feels comfortable talking about and working with the new technologies, it is highly unlikely that they will feel any sense of urgency to learn new skills themselves (p.37). Principals play a critical role in either minimizing or maximizing the acceptance of technology by the teachers (Fisher, Dwyer, & Yocam, 1996). These authors noted that principals must make a commitment to support schoolwide instructional change and the integration of technology by supporting teachers and providing them access to the technology.

Ornstein (1992) presented 16 guidelines for instructional leaders to implement in support of computer integration. Included in these guidelines was the need for school principals to know how to work with computer systems, become involved in instructional decisions surrounding computer use, and encourage teachers to integrate computer instruction in the curriculum (Ornstein, 1992). Waetjen and Bellisimo (1992) encouraged administrators to cooperate with teachers and others to research and observe the impact of computer applications in the schools. Nuccio (1990) noted that the principal s role in the successful integration of computers in the instructional process is just as vital as the principal s role was found to be in the effective teaching research of the 1980's. Zappone (1991) concurred with the emphasis placed on effective leadership in the successful integration of computers by including leadership as one of the key components of computer integration. In spite of the importance of leadership, inadequate support of teachers in the use of computers was listed as one of the prime factors interfering with the effective use of this technology in the schools (Branscum, 1992). In a study of computer instructional use, Murphy (1993) found that administrative support for the use of technology significantly contributed to the amount of use of the computer for instructional purposes by teachers. Strong, positive administrative leadership also was noted as a key variable for the planning and effective use of technology (Roblyer, Edwards, & Harviluk, 1997) with some authors calling for a redefinition of the meaning of educational leadership and the role of the school principal within a technological paradigm (Bennett, 1996, p. 57). Bennett (1996) noted that if principals are to be successful in a technological context, they must use develop six broad categories of tasks: defining/ communicating mission, supporting/supervising teachers, promoting a climate encouraging computer use, managing technology, monitoring student progress, and managing curriculum/instruction. Sergiovanni's (1996) nine responsibilities of leadership (purposing, maintaining harmony with consensus, institutionalizing values, motivating, managing, explaining, enabling, modeling, and supervising) accentuate these essential characteristics of school leaders who support effective integration of technology.

The purpose of this study was to measure and report the amount of perceived administrative support received by teachers for the use of computers and related technology in instruction. Teacher attitudes, accessibility to computers, and training were considered in the interpretation of data regarding administrative support.

Procedure

The subjects of the study were 76 teachers of kindergarten through 12th grade, 44 of whom were also graduate students enrolled in a survey of educational technology course. The group included 13 male teachers. The experience of the teachers ranged from one year to 26 years (25 respondents had 1 to 5 years of experience, 17 respondents had 6 to 10 years of experience, 13 respondents had 11 to 15 years of experience, 11 respondents had 16 to 20 years of experience, and 9 respondents had 20 or more years of experience).

The survey included five sections: General Information, Training, Access and Use, Administrative Support, and Opinions and Beliefs. The General Information section asked for demographic data (position, grade level teaching, gender, years experience), and whether the teachers had a computer at home. The training section queried the teachers about the amount and kind of technology training they had received. The Access and Use section asked the teachers about the availability of/accessibility to computers in the school for instructional purposes. In addition, the teachers were asked to give an average amount of time of usage of the computer by students and the types of instructional usage employed. The Administrative Support section asked the teachers to indicate how supportive they perceived their administration to be about their use of computers and related technology. The last section, Opinions and Beliefs, asked the teachers to respond to 12 general statements about the use of computers in the classroom.

Although the focus of this paper is on the role of the administrator the other sections of the survey will be briefly addressed.

Access to Computers and Related Technology at Home and School

Home Access

Of the respondents, 66 had a computer at home (25 of the teachers not enrolled in the technology course had home computers; 41 of the teachers enrolled in the technology course had home computers). The types of these home computers ranged from older model Apple IIs and IBM 286 systems to Macintosh multimedia systems and pentium based models. Of the teachers surveyed 57 reported owning IBM compatible machines and only 15 owned systems with multimedia capability.

School Access

Access to the computer at school for instructional purposes was reported by 74 of the 78 respondents, however, the kind of access was limited. Availability of older machines including Tandy and Apple II models was reported by 21 respondents. The use of newer models was reported by 40 teachers and 32 of these teachers utilized the multimedia capabilities of these computers for instruction.

Only six of the teachers not enrolled in the technology course had a computer(s) in the classroom. The other 26 of these teachers taught in schools with labs, however one teacher added a specific note that while the school had a lab, her students were not provided access to it. Of the 44 teachers enrolled in the technology course, 18 had only one computer in the classroom, 24 had more than one computer (two to seven computers) available in the classroom, and 13 taught in schools with labs. In some cases teachers reported both lab access and classroom computer availability.

Instructional Use of Computers and Related Technology

When queried about the usage of the available computers, 46 of the teachers reported either drill and practice or rote use. Three of these respondents used the computer for drill only. Thirty-seven used the computer for tutorial or concept development purposes, 36 used the computer for instructional word processing, data base work, spreadsheet work, or graphics, and only 32 teachers mentioned the use of multimedia. Sixty-six percent of the teachers used the computer for drill/practice/rote purposes, 47 percent for tutorial/concept development, 46 percent for word processing/data base/spreadsheet use, and 41 percent for multimedia applications. Some teachers reported more than one type of use.

Reported amounts of technology use ranged from zero to two hours per student per week. Only eight teachers did not indicate use the available computers and 61 of the teachers reported only one-half hour or less of use per student per week.

Technology Training

The reported technology training of the teachers included self-teaching, coursework, and workshops. Twelve of the teachers had no training and most of the respondents enrolled in the technology course (26 of the 44 teachers) had no training prior to the current coursework in which they were enrolled. Forty-two of the teachers reported that they were self-taught, and 48 had attended workshops. Some teachers reported experiencing more than one kind of training.

Attitude of the Teachers

The overall attitude of the respondents was scored as high. Twenty-four of the teachers attitudes fell in the average range and none of the scores fell in the low range for either the group enrolled in the technology course or the group not enrolled in the technology course.

Perceived Administrative Support

Teachers were asked to rate the level of administrative support they believed they were given in terms of computer usage for instructional purposes. Of the 32 teachers not enrolled in the technology course, only four teachers indicated high levels of administrative support, 11 indicated average support, and the majority of the respondents indicated low levels of support. However, of the teachers enrolled in the technology course, only five teachers indicated lower levels of support, 14 indicated average support, and 25 of the respondents indicated high levels of support.

As a group, the surveyed teachers who reported the highest levels of administrative support also reported more and varied use of the technology for instructional purposes, especially for multimedia use and application software (word processing, data bases, spreadsheets). This finding was noted in the analysis of all of the teachers, but was especially evident among the teachers not enrolled in the technology course.

Conclusion

The role of principals and other administrators is critical to the successful implementation of instructional technology planning and use. The leadership role is crucial to the acceptance and adoption of educational technology by teachers (Bowden, 1994). Van Dusen and Worthen (1992) revealed strong leadership as one of the factors that facilitated the implementation of integrated learning systems while an absence of dynamic leadership risked ineffective use. The widespread rush to integrate technology in schools has required school administrators attitudes and actions [to] become more important than ever to the future of education (Bennett, 1996, p.57). In spite of this reliance on the administrative role to encourage improved technology use, many teachers report a lack of support for the integration of the technology in classroom instruction. Instead teachers report minimal levels of support, lack of encouragement, and an absence of advocacy for the use of instructional technology.

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EDUCATION MANAGEMENT IN-SERVICE TRAINING THROUGH MULTIMEDIA CD-ROM SUPPORTED BY VIDEO CONFERENCING

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This paper offers a review of a pilot project in the application of multimedia and communication technology to promote professional development of Northern Ireland secondary school principals and senior teachers in their practice of education management. The development of effective and efficient methods of professional training through the application of the new technologies is widely seen as an achievable goal. The project described below represents the early development of one group's efforts in this domain.

Pilot Project Description

The pilot project is owned and developed by the CLASS (Computerised Local Administration Systems for Schools) organisation and is both strategic and operational in its focus of intended interventions. At the strategic level, it represents a collaborative exercise in utilising an existing professional development infrastructure, including both government agencies and commercial enterprises, to deliver inservice training to four secondary schools using multimedia CD-ROM and supported by tutors using intermediate band communication. At the operational level, four 'technology-ready' secondary schools, who were selected because of their good track records in the use of information technology, agreed to participate in the professional development exercise.

Three of the four schools decided to engage their senior management teams in the training programme, consisting of principal, vice-principals and senior teachers. The other school decided to use the training opportunity to develop their pastoral care team which consisted of two vice-principals, three heads of school and seven heads of year. In total, twenty-eight teachers engaged in the project. Their levels in IT literacy varied from high users to zero users. Approximately 35% of the teachers considered themselves to be nonusers of IT.

The CLASS project's partnership model is reflected in its components, each of which were contributed free of financial charges by the respective public or commercial organisation. SIMS Ltd. provided the knowledge engineering component of a traditional classroom-based training package on Management Information Data Access Systems (MIDAS). This was converted into a beta-release version of an interactive multimedia CD-ROM training module by the Northern Ireland Centre for Learning Resources (NICLR). The multimedia learning system was supported by a CLASS training centre-based human tutor and linked to the pilot schools through an ISDN2 video conferencing facility using Vision Technology VC 8000 system and TeamVISION communication software provided by (BT) British Telecommunication plc., which also provided the ISDN installation and line costs. The hardware was supplied by Fujitsu ICL in the form of five Ergo-Pro X40/ 133-16- 850 Mb computer systems. Coopers and Lybrand gave advice on project management and the Northern Ireland Regional Training Unit (RTU) offered advice on school management issues and evaluation methods. This complex but effective partnership model was managed through a Liaison Group which met under the chairmanship of the Director of CLASS. The CLASS project itself was managed by a senior CLASS officer supported by an assistant and a technical officer.

The pilot project represents a possible early stage in the Department of Education for Northern Ireland's (DENI) current overall strategy of examining ways in which computer-based management information can lead to improvements in the quality of school-based decision-making. The professional development of teachers through effective inservice training is seen as a key activity of this strategy. However, it is increasingly difficult for schools to offer sufficient inservice training to meet these professional development needs. Factors such as high cost of substitute teachers, loss of key staff, distance to training centres and finding suitable training times for economical size groups militate against the provision of traditional classroom-based professional development programmes. The CLASS pilot project represents an initiative that could provide a potential platform for flexible inservice provision, empowering schools to manage their own professional development needs at a time and to a level that meets local requirements and with minimum disruption to pupil learning.

Methodology and Research Focus

This study is located within the qualitative tradition and utilises data obtained through unstructured and semi-structured interviews of key participants, observation of learning situations and planning and development meetings. Data was also collected through self-reporting of teachers who completed a personal training log in which they recorded time spent on each unit, problems encountered and reflections on their experience. The project has been in operation for one year and has included course design, multimedia material production, technical development and initial technical training of the participating teachers. The professional development programme itself was undertaken by the teachers over a thirty day period, although the principals and project managers of the four schools were engaged in training and development programmes with the CLASS team for six months.

Teaching and Learning Models and Strategies

The teaching and learning strategies employed by the CLASS project utilised the technologies of multimedia CD-ROM and video conferencing. In broad terms, the CD-ROM provided a fundamental skills-based training programme in the use of MIDAS, with the teleconferencing technology providing a student progress monitoring facility through a skills test exercise and teacher development through online tutor support.

To place the training programme in context it is necessary to point out that CLASS is a powerful, fully integrated management information system installed in all Northern Ireland schools. The MIDAS component looks across the system's database and modules, providing details on staff and students as well as summary financial information. In each of the project schools MIDAS is hardly used. Indeed, most of the project school staff were unaware of its existence, although CLASS is used extensively by teachers with particular specialist interests such as curriculum planning, examination entries and financial planning. In part, the reasons for this non-use are due to the slowness of response to a query and unfriendliness of the system's MSDOS interface. For example, the average time from logging into the system and extracting say a students' list in MSDOS MIDAS is approximately six minutes. However, CLASS are currently upgrading Northern Ireland's schools with the faster computers and a Windows 95 interface which will address these problems. The staff development training package has been timed to coincide with this upgrade programme.

The MIDAS multimedia CD-ROM was designed to reflect the structure of a learning objectives driven, paper-based classroom training model and organised into five units covering the required skills for data access. From the trainee's perspective, the CD-ROM provides a direct visual representation of MIDAS software. After logging in, they are offered five training units set in a Windows interface.

The learning strategy employed is structured around the three logically developed, integrated approaches of 'Show Me', 'Let Me Try' and 'Tell it to me Again'. Following Units 1 and 2, which demonstrate the structure of MIDAS, describe icons and features of the Windows interface, trainees are 'taught' the functions of MIDAS through a series of simulated school information gathering activities based on simulated practical, school-focused problems.

The 'Show Me' aspect of the learning package offers the user an automatic demonstration of an aspect of MIDAS. In this function, an audio explanation accompanies a moving pointer tracing the pathway required to obtain task related information. The tempo of the pointer is automatically varied according to new-knowledge requirements. The pace of instruction has been designed to ensure that competent trainees do not become bored and each 'Show me' activity is short enough to give 'the unsure' the incentive to try the routine again.

The 'Let Me Try' allows users to perform the task for themselves. However, because the simulated MIDAS is not totally responsive, students cannot fully interact with the data. If a student moves down an incorrect pathway, the software offers an error message requesting an alternative route to try.

The 'Tell it to me Again' function provides the solutions that should have been obtained by the trainee during the learning process, offering reinforcement feedback. At times during the process, students may access the task question, which are frequently lengthy and detailed in their information gathering requirements, through operating a 'pull down' window. Interestingly, only approximately half of the trainees discovered this function, emphasising the invisibility of hidden menus.

In pedagogical terms, the first aspect supports the development of knowledge, the second the acquisition of skills and the third reinforcement feedback or suggested route for further study. The aspiration of the CD-ROM designers to produce a 'low text' - 'high human interaction' visual learning environment has been largely met.

Video conferencing technology was used (a) to provide tutor support for teachers who may encounter difficulties in using the CD-ROM training package; (b) to provide a communication link between trainees and the CLASS project manager; (c) to allow testing of teachers to take place on completion of study programme; (d) to support the CLASS project team in carrying out formative evaluation; (e) to facilitate communication between CLASS support managers of the four schools with a view towards examining school specific practical applications of MIDAS and assisting with development issues once schools started to use the real data of their school; (f) to allow project schools to develop professional networks; (g) to raise project schools' awareness of the potential of intermediate band communication systems and develop necessary skills for their use.

From a trainer's perspective the constructed learning environment, emerging from the coupled video conference tutor support system and the CD-ROM, offers a three element overall pedagogical structure:

(a) Knowledge acquisition is offered through low interactive, high visual, automatic multimedia display of relevant aspects of MIDAS. Here learners move through the MIDAS package at their own pace, repeating or reviewing the essential procedures and gaining knowledge of the structure of MIDAS.
(b) Skills acquisition is achieved by allowing the learners to utilise the acquired knowledge in preset simulated problem solving activities.
(c) Understanding of the system and its value in improving school-based decision-making will be developed through the tutor support programme facilitated through video conferencing.

Some Research Outcomes

The CLASS project is ongoing. The observations which follow are based upon the fulfilment of phase II of the project - the completion of training. The next and, arguably, most important phase will explore how senior and middle education managers have integrated the new knowledge, skills and understanding into their professional practice and made an impact on the quality of educational processes in their schools. Within these boundaries it is possible to offer some observations on efficiency and effectiveness issues about education management professional development facilitated by the educational technology outlined above.

Effectiveness

How one should measure the effectiveness of a professional development project will always be an open question. At this stage in the project it is only possible to assess the achievement of short-term goals which were, broadly, the acquisition of those skills that would allow senior and middle managers to use MIDAS. However, in addition to learnings which occurred as result of the formal curriculum, there were other kinds of learnings taking place that more easily fit the concept of the informal, or hidden, curriculum. Each of these kinds of learnings having an impact on the professional development of education managers and, in turn, on the development of the school organisation.

Formal Learnings

Two major indicators used to assess a project aim of 'helping staff acquire new and relevant skills' were a self-reporting monitoring log and an externally administered, through a video-conference link, competence test of four, unseen, school-focused practical problems. From the data received through the personal logs, which were supported by personal interviews, each person fully completed the multimedia training programme, successfully operated the video conferencing system and successfully completed their competency test questions, although the speed and efficiency of achievement of their answers to test questions varied significantly. The mean time to complete test was 262 minutes with a standard deviation of 86 minutes. The mean number of errors made was 2.07 with a standard deviation of 1.54. The ease with which each participant completed the training programmed and time they spent in training, see below, also varied.

Informal Learnings

There were two main kinds of learnings from the hidden curriculum. Firstly, the experiences of the project impacted positively on the participants' attitudes towards information technology. For the previously nonusers and low-users of IT, the project enabled managers to 'overcome hesitancy'; 'see computers as less threatening'; 'become more confident in using a PC'; 'be familiarized with operating procedures'; 'increase their (professional) status with colleagues'. Secondly, the common experience of engaging in the project further contributed to a sense of corporate identity of the four management groups through, in part, having acquired the same information management skills, ' we now have a more even platform of knowledge'. In part, too, the reflective processes that were an integral part of the project, created opportunities for each team member to contribute to and learn about each others area of school management concerns. There was also evidence that the shared common experience of feeling vulnerable and sharing of solutions to problems encountered, mainly of a technical nature, contributed to the development of interpersonal relationships useful for team-building.

Efficiency

One of the major incentives for the development of independent learning systems is the potential efficiency gains they offer over traditional training patterns. From the schools' and teachers' perspectives there was the major efficiency gain of reduced financial cost of training. Because teachers carried out the training during school time or at home on personal computers, there was no need to attend a training centre and employ substitute staff to cover absented classes at about £100 per day per teacher. However, the average time spent by teachers engaged in the training programme was greater than that anticipated in the traditional training model. The designed time of imparting the skills for MIDAS in a traditional setting is 180 minutes. However, the mean time spent by teachers undertaking the independent learning model was 206 minutes with a large standard deviation of 116 minutes. Although teachers on average spent longer on the training exercises when using the multimedia package, it should not be said that it was a more inefficient mode of delivery.

Rather, we believe, that it reflected the valued nature of individualise learning in that it supported a wide range of learner needs, allowing the 40% of the teachers who required more time to be accommodated whilst allowing the other 44% to complete the training in less than the projected training time. (12% completed in about 180 minutes.) Also, and importantly, there have been no empirical studies undertaken to test teacher skills proficiency using the traditional training model. Nevertheless, this efficiency aspect will be the focus of further study.

Cost-Effectiveness

Measures of cost-effectiveness need to take account of all qualitative outcomes balanced against financial and other costs, and are frequently comparative in nature. With respect to the CLASS project, a full cost-benefit analysis would need to extend beyond the project boundaries for a full appreciation of the involved factors and would be expected to take account of a range of savings that would accrue from large scale strategical developments. There are, however, some clear financial costs and benefits. For example, although capital outlay is high, with multimedia CD-ROM commercial production cost about £40,000, hardware costs (multimedia computers and intermediate band teleconferencing equipment) about £5000 per school site, the training support staff costs are only about 30 minutes per trainee. There are financial savings for the school of about £100 per teacher, although there will be opportunity costs to the school due to teachers engaging in the training programme during school day and utilising a teacher as the school programme manager. Once the investment in capital outlay has been discounted through economies of scale and opportunity costs of teachers engaging in the programme minimized through the careful planning of inservice training by the school so that it occurs at times when teachers have sufficient free space, then there are clear financial benefits to schools and the education system they serve.

Conclusion

There is understandable interest in the economic dimension of professional development programmes. Nevertheless, it is the perceived quality gains that are also of interest. Although this study was not designed directly to compare an independent learning model with traditional training methods, it was of interest to note that each teacher stated that they qualitatively preferred the school-based, independent learning model. There were a number of significant reasons given to substantiate this preference which appeared to fit within the two categories of 'personal' and 'organisational':

Personal

(a) The opportunity to determine one's own time and space for training. This is supported by the wide variation in the times during which the multimedia package was used- from 8.00 am to 10.00 p.m.- and length of time spent using the system - from a total of 85 minutes to 560 minutes. (b) The opportunity to make mistakes in private, thereby reducing personal embarrassment. (c) Easy access to the CD-ROM to support revision when the teacher moved at a later point to using real data. (d) There was a belief that the training increased the professional status of the teacher in the eyes of colleagues. This belief was particularly strong in the cases of previously nonusers of IT.

Organisational

(a) A key benefit of this training model was that it allowed each member of a specific management team to train simultaneously, thereby supporting school-based strategic development: an option not possible in the traditional model. (b) There was an equal distribution of corporate skills, providing a common platform for organisational development. (c) The training activity positively contributed to team-building, particularly in the development of interpersonal relationships. (d) The training method also was perceived as promoting the path of participatory style of management through opening up hitherto specialist areas and promoting discussion of problematical organisational concerns.

Despite the overall enthusiastic teacher support for the CLASS project's use of an independent training model, there were a number of lessons about the design and delivery of this model on a wider basis. Firstly, a technical support system within each school needs to be available. In about 25% of the individual sessions teachers encountered some form of technical difficulty and required support. In 5% of these sessions, where support was not available, the teacher quit, expressing strong feelings of frustration at the loss of time. Secondly, low motivation was experienced in teachers during those periods when the multimedia sessions were low on interactivity and high on information output. High motivation occurred during periods of high interactivity, helpful progress feedback, a sense of discovery and exploring content that had strong practical relevance. Thirdly, the training model needs to be carefully managed at school level with attention paid to auditing of individual progress and ensuring individuals are not experiencing unmanageable conflicts of priorities on their time. For successful school-based development, timing of the introduction of the training programme is crucial.

Phase III of the CLASS project is currently being undertaken by the four schools. The crucial question which now needs to be answered is : "Will the newly acquired individual skills be incorporated and further develop the quality of the school's educational processes?"

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A Key to Technology Integration into the Classroom: The Campus Facilitator

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One of the many important responsibilities of a campus administrator is the development and articulation of a shared vision for technology integration on a school campus. With the constant thrust for schools to do everything possible to encourage technology infusion, the campus administrator must make decisions based on the needs of teachers and staff on that campus to make technology reasonably accessible and applicable. Providing a campus facilitator to orchestrate the use of technology on the campus is one essential way to effect technology access and application among the entire staff.

Training teachers to use and apply technology is an ongoing process for each campus in the nation. School districts create many different scenarios for technology training which include inservice days during the school year, staff development during the summer, release days while teacher's classrooms are covered by substitute teachers during the school year and offering after school training sessions. Some districts employ a director of technology to oversee the technology plan for the entire district, the big picture. Many school districts have technology trainers who help train teachers to use specific software for the classrooms or for general computer literacy. The district technology trainers generally respond to K-12 teachers, librarians, administrators and support staff. Linda Roberts, project director of the Office of Technology Assessment (OTA) commented in a landmark study called *Power On!*, "that despite good intentions, the best information, and the hopes of planners, schools have at most established demonstration centers for what might be. The school districts have demonstrations of what is possible, but if you go into a typical school, you will see that teachers in the classrooms are hardly using computers at all. School districts are good at innovation, but fall down in implementation" (OTA, 1988). OTA's 1995 study, *Teachers and Technology*, found the barriers to teachers actually integrating technology into the curriculum had not come down. According to that study a majority of teachers reported feeling inadequately trained to use technology resources, particularly computer-based technologies. Also, although some schools have made progress in helping teachers to use basic technological tools they still struggle with curriculum integration, which is central if technology is to become a truly effective educational resource (OTA, 1995). Other research points out that new teachers are not ready to use technology in the classroom and must be trained along with the veteran teachers on campuses. Collis (1994) concluded that the majority of teacher education makes little or no reference to computer related technology, and much computer related teacher education is stimulated and delivered by persons without an academic background in teacher education.

After all the training workshops and inservice opportunities offered by a school district, the teachers are faced *in the trenches* with trying to use technology on their specific campus with the curriculum that is to be taught. Now THAT is what the whole integration process of technology is about. The variables are many: grade, subject, computer platform, software, accessibility and more. If technology is to be integrated in to the classroom, teachers need constant support.

The creation of the *Site Specific Technology Facilitator* role or the *Local School Technology Coordinator* role is one answer to the problems that face a campus administrator when encouraging technology integration on his/her campus. Job descriptions for the

"facilitator" will vary depending on the campus or school district but generally the idea is to encourage the use of technology in the classrooms and to do lots of *hand holding* while the teachers try to implement each specific detail for using computers for instruction, research or project-based applications. The facilitator's main job is to *lure* teachers into technology integrated lessons. Explaining lesson plans for teachers and creating ways in which technology can be integrated into the lesson for that subject (many times changing the classroom environment from the traditional one to a more project-based collaborative learning situation), gathering the software and hardware available for use by the teacher and helping her/him understand the roles that technology can play in extending the lesson is all part of the *hand-holding*. There is something to be said about taking the teachable moment and going with it, especially with reluctant users. A teacher should understand that being an expert in the use of technology is **not** required. Students in the classrooms of the near 21st century are ready and anxious to use technology. Once teachers see how *alive* the classroom becomes during the technology integrated lessons they rarely go back to the non-technology traditional classroom.

Suggestions for the Campus Facilitator

After several years of experience we (a building principal and facilitator) would like to offer some suggestions about facilitation.

1. Focus first on the teachers who are easiest to encourage. Ask them to allow you to look over their lesson plans and make suggestions where the available campus technology can be used. In many instances scanners, digital cameras, modems or other computer hardware can be brought into the classroom for the lesson. Knowing the possibilities will allow the non-technology using teacher creative about how to use technology to extend the lessons.
2. Be available for teachers so that the lesson/lessons will be successful. A computer supported lesson may have some problems, but the campus facilitator can troubleshoot on the spot and make adjustments to help teachers avoid problems in the future.
3. Some traditional lessons may need to be revised to better utilize technology. Helping the teacher revise the lessons by brainstorming how to set the challenge for the lesson, deciding the goals and objectives of the lesson, identifying the learning strategies to be used, deciding how students will construct their knowledge (what resources are available), what will be the performance criteria, who will access the work and how, and how will students communicate their results are all important steps in revising a lesson plan. Encouraging the teacher to give constant feedback is very important for all student involved.
4. Teachers who have used technology in their classrooms will be advocates for those who are not yet even considering the concept. It's contagious.
5. Campus facilitators should encourage teachers who have used technology successfully in their curriculum to present their successful technology-based subject-specific lessons to other teachers and to become mentors for these teachers.
6. Campus facilitators can provide listings of campus hardware and software, peripherals that can be used on the campus such as laser disc players, digital cameras, video cameras, VCRs, video digitizers, and so on.
7. Time is generally a problem and timing will always be an issue. Planning the lessons takes time. All the hours that are not instructional hours on the campus are used. Before school, lunch, conference periods, planning periods or after school times are all used to by facilitators to help and encourage teachers to use the technology on the campus.
8. Posting technology conference dates and workshop dates is helpful.
9. Writing a few paragraphs about teachers who are using technology on the campus in the principal's weekly campus bulletin gives a positive spin on technology integration. A campus technology newsletter would help and encourage teachers to use technology.
10. Some schools do not have open labs or available computers for each student. The campus facilitator should be able to help the teachers in a one computer classroom develop workable concepts for instruction, and help others learn how to use a handful of computers in a collaborative learning situation.
11. Connecting the teachers on the campus with teachers on other campuses in the school district or other school districts who are using technology is exciting and should be encouraged. This can be via telecommunications or meetings teachers must already attend.
12. A mobile technology station can be set up for the campus. This station could consist of a large monitor, computer, laser disc, VCR, LCD panel, overhead projector or any combination of equipment. This station can be used by the students and teachers in many ways.
13. Faculty meetings is a time to make quick announcements about new technology or up coming technology training.
14. Helping the teachers understand the power of telecommunications and how to access available modems on the campus to use e-mail or the Internet is a vital part of technology training. Use of the World Wide Web is one the most misunderstood resources and one that can be used in so many creative ways.
15. Encouraging teachers to use technology to support instruction, assessment, curriculum development, communication, collaboration, research, text and multimedia production, resource access and classroom management is the overall thrust of the campus facilitator.

The role of a computer facilitator is best performed by a person with a love for technology and a keen interest in integrating it into the curriculum. Teachers have a huge amount of work to do each day: planning, increased paperwork, dealing with students with special needs and meeting curriculum requirements just to mention a few. Even the most dedicated teachers find it hard to find the time to plan lessons using technology. A campus facilitator who is given the time by the principal to help teachers use available technology on their campus provides a jump start for the teachers.

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STAFF DEVELOPMENT—ON TIME, ON TARGET

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No, we didn't pass the four million dollar technology bond issue, but we had a district technology plan. Now what? Durango School District is located in rural southwestern Colorado with a population of 12,000 in the city and 30,000 in LaPlata County. There are 4,500 students in 1 high school, 2 middle schools, and 7 elementary schools. In 1991 our new Superintendent was concerned that there was no comprehensive plan for technology in the school district. Requests coming from the schools were as varied as the educational philosophies of each school. Later that year he accepted an invitation from IBM Corporation to conduct a study of Durango's technology needs and facilitate the development of a district technology plan. A technology study team composed of administrators and teachers was formed. Input was gathered from teachers, support staff, administrators, students, parents, and community members. A five year technology implementation plan was developed and presented to the Superintendent and Board of Education for approval in April, 1992.

When we developed our technology plan we established guidelines to produce the completed plan. The guidelines have been revised over the past three years but the basic concepts are still in place. The major areas included in the plan are; the technology team, assessment, visions, what is available, funding, acquisition, staff development, implementation and evaluation. The complete outline is included in the appendix.

New Position- New Directions

The new position of District Technology Director was filled with a teacher on special assignment in the Fall, 1992. Also during the Fall the district held a bond election to finance a new elementary school, middle school, and to implement technology. The building bonds passed, but the technology portion failed. Although the technology bond failed, the Board of Education and Superintendent remained committed to placing technology into the hands of our students, but at a much slower rate. The Board reprioritized the capital reserve funds and allocated $500,000 to begin implementation of the plan. The district technology committee submitted recommendations to the Superintendent on how to begin putting computers into the schools. They were approved and the computers were ordered.

Technology and Software

Since 1992 we have received over $2.5 million and installed local area Novel networks into 7 elementary schools, two middle schools and one high school. There are five computers in every fourth and fifth grade classroom with a mini-lab of 15 computers in the media centers. There is a variety of instructional software available to students including IBM courseware, Jostens's Learning Corporation, Edunetic's, and other third party programs. At the middle schools there are two large computer labs with 25 computers in each and a variety of configurations for 50 other workstations with Computer Curriculum Corporation and IBM courseware. Each middle school has a technology lab with 15 modules. At the high school there are four computer labs with 25 computers each for word processing, curriculum courseware, business, multimedia and science technology. There is also a technology lab. All libraries in the district are automated using McGraw Hill's Columbia software. The district office was networked in Fall, 1996. We are in the process of putting Internet networks into the middle schools and high school, upgrading existing workstations, and putting a plan together for a science impact energy grant that we received for the elementary schools.

Now We Have It, How Do We Use It?

From 1992-1995 the District Technology Director was the only person in the educational technology department. Duties included selecting, purchasing and assisting in set up of the networks, maintenance, public relations and staff development. The first year the fifth grade teachers had computers placed in their classrooms. Teachers received training from the coordinator and some vendors. The next year technology was placed in the sixth grades and those teachers were trained. After that technology purchases escalated dramatically. The high school received very little in the way of staff development. Follow-up training was haphazard.

In 1995 the District Technology Director believed that the time had come for the Board of Education and Superintendent to increase the staff of the technology department. The number of computers had grown, maintenance was overwhelming and staff development was not happening. Support was beginning to wane.

That fall one halftime district trainer was approved by the Board of Education. This person was responsible for training the elementary and middle school teachers on the networked courseware. New users received one day of release time for training and after school inservices were offered. The District Technology Coordinator was responsible for training high school and middle school teachers on the newest networks. Interest and skill levels began improving. As training increased, the demand for even more grew dramatically. Graduate technology classes were offered through a state college and a new plan for training was developed.

Technology Staff Development

Staff development must be well-organized and ongoing, and it must address a full range of needs. It must be an integral part of your plan and your budget. While the focus of this section will be primarily on the teaching staff, system-wide implementation of technology requires the effective training of other employees as well. Administrators will need to know the pros and cons of various technologies, how to determine whether desired learning outcomes have been reached, and how to use technology to run their buildings. Office support staff must learn how technology can help with their day-to-day tasks of running the school. Library personnel must learn not only how technology can assist in their work, but also how to help students and teachers tap into the larger bank of resources that will be available to them.

Over the past year we have discovered that staff development implies more than training — it also refers to professional growth. Teachers must not only know how to use various technologies, but also must clearly understand how technology changes the learning process. Staff development must not only teach specific skills but also develop teaching strategies and explore the impact that technology will have on teaching methods.

Experience has shown that many factors make planning and carrying out staff development programs difficult, including shortages of time, money, motivation, and capacity to provide for ongoing technical assistance within the schools. These issues must be recognized and addressed as part of your Technology Plan.

Vicki E. Hancock, Assistant Director of the Education and Technology Resources Center at the Association for Supervision and Curriculum Development (ASCD), suggests that any staff development consider including the following:

1. Teachers should have plenty of opportunity to reflect — to read, think, and talk — about the benefits and limitations of technology.
2. For lasting impact, staff development should be ongoing and systematic, not simply a series of one-shots.
3. Large workshops should be supplemented by peer coaching and modeling, so that teachers can benefit from each other's expertise.
4. Staff technology training should be based on the actual curriculum for which teachers are responsible.
5. Staff development sessions must provide hands-on, exploratory experiences with technology — not abstract theory, but actual 'messing around' with machines.(Hancock , 1993, p. 7)

Schedule specific times for teacher technology training in the school calendar throughout each year. Earmark some of these times for training in specific skills that will be needed to progress along the implementation timeline. But leave some of the training dates open to allow for training in areas that develop as the program progresses. Designate some of the sessions for system-wide training and some for individual classroom applications. Remember that training must be ongoing throughout the year, so be generous in your time allotments.

It is essential that there is an ongoing commitment to staff development. Businesses match every hardware or software dollar invested in technology with a matching dollar for training, while educators spend five percent of their technology budgets on training. For our 1996-97 budget the Durango School District has allocated 14% of its technology budget for Technology Staff Development. We feel that for every $1 spent on hardware, schools should budget $ .25 for staff development.

Whatever level of investment you choose, the effectiveness of your technology implementation will be in direct proportion to the effectiveness and thoroughness of the training you provide. Access to technology is not enough — we must learn how to use it and incorporate it effectively.

Areas of Training and Staff Development

All training must include hands-on computer time, both during and after the workshops, to allow trainees to become familiar with the actual applications. Make sure that training is also followed with staff exploration and planning time for the integration of this new material into the classroom.

Remember to include professional and clerical personnel from your school system. Invite some of your stakeholders to participate as well. The training can be broken down into 10 categories.

1. Introductory training — a basic course to familiarize both teachers and administrators with the general capabilities of technology; an important initial offering
2. Computer ethics instruction — all technology users must be made aware of the do's and don'ts of accessing and copying software programs and files

3. Technology-specific training — system-wide coursework in the use of CD-ROM, computer graphics, networking, e-mail, databases, multimedia, etc.
4. Subject/grade level training — workshops to explore applications (software programs, online communications, CD-ROMs, etc.) that are available for specific subject areas or grade levels
5. Software courses — to expand the use of technology through exploration of HyperStudio, PageMaker, Windows, and other products.
6. Curriculum writing courses — to provide opportunity for teachers to come together and develop curriculum materials that integrate technology into their classrooms
7. Classroom management strategies — to learn use of the computer in record-keeping, document production, etc.
8. Technology as an assessment tool — to explore the use of technology in authentic and portfolio assessment .
9. Internet — introductory use of the computer to get staff their drivers license to get started on the information highway.
10. Process training — seminars and discussion groups focusing on the ways in which technology is changing the educational environment, the role of the teacher, how teachers modify classroom techniques, and the ramifications of this.

As you identify the components of your staff training program, you may want to consider recommending that your school system include a required level of technical competence as a condition of employment for future staff hiring. This will allow you to maintain a common level of knowledge and ability on which to base staff training. We are in the process of developing this segment of our Technology Staff Development to make teachers more accountable.

Provide for Ongoing Support and Feedback

While formal staff training is an absolute necessity, an additional component is also necessary if teachers are to become comfortable with technology — they must have access to "someone down the hall" for answers when things go wrong or for new ideas when they are ready for them. This is where our T3 program enters the picture. This will be addressed by one of our T3 individuals later.

The best way to provide this support is for your system to hire a minimum of one person as a Technology Specialist, or Technology Director. It will be this person's responsibility to troubleshoot problems, provide information, and act as a catalyst for further implementations. The Technology Specialist can also coordinate maintenance, upgrade software, and manage the network.

In addition, each building should have a person (teacher or administrator) to serve as a resource to help staff with basic questions when the Technology Specialist is in another building. Make sure that the staff knows this person's identity and the extent of the support that he/she can provide. These individuals take on an even more important role if your system does not have a Technology Specialist.

A third way to provide ongoing staff support is through developing a resource bank of people at local universities or businesses who would be willing to give some time to your school system to assist with staff development issues. Try to arrange for a volunteer to be in your building on a regularly scheduled basis. If this is not possible, make specific arrangements with them ahead of time, so that you can let them know when needs arise. These types of ongoing support are vital. They provide the hand-holding, person-to-person process that will help teachers to be successful with technology.

As you begin implementing technology, you will want to establish a vehicle for monitoring the effectiveness of the training and support in each building. A system-wide team of teachers with representatives from each building can be helpful in this process. These teachers can also help to identify training needs as they arise in individual buildings. As Hancock said, "Initially, teachers are inclined to use the computer to reinforce things they're already doing. Later on, they begin to adapt their instruction to the computer. Finally, they begin to explore the capacities of the new machine" (1993, p. 13).

In our Durango School District a half time staff training position was created in 1995. Our desire was to develop a training program based on the staffs needs. Each school district staff member completed a skills needs assessment to determine which classes should be offered. Upon completion of the surveys classes were developed. The goal was to provide technology staff training in the areas of the following:

- Basic Computers and Windows Operation
- Word Processing- Microsoft Works and Microsoft Word
- Spreadsheets
- Library Automation
- Basics of Network Operation, IBM ICLAS, Schoolview, Internet, Multimedia
- Hyperstudio
- PowerPoint
- Integrating Technology into the Classroom

The school district contracted with Adams State College to provide graduate credit for all of the classes offered. Attendee's can receive graduate credit for a minimum charge of $35.00 per credit hour. Our desire was to provide sophisticated training to the staff so that they understand what technology can do and understand its potential. All courses emphasize hands-on experience and demonstrate the "WHY" of technology in the classroom. When we develop a class we always ask:

- Where are you going?
- How are you going to get there?
- How will you know when you arrive?

Our staff development program was developed with the idea of the teacher must change into a facilitator. Our philosophy adopted the approach of moving from the old "Sage on the Stage" to the newer "Guide On The Side." We try to also remember the "Goof on the Roof."

In March of 1996, the Director of Technology and staff trainer developed a new program for the district called T3 (Train-The-Trainer). Durango's T3 program was developed using the basic structure of Train-The-Trainer that has been written about in numerous educational publications by Joyce and Showers. The concept was to have a trainer at each elementary school, two trainers at each middle school and 6 trainers at the high school. The program was presented to the school board and explained that in lieu of being paid for the time each trainer would be provided a IBM Thinkpad with CD-ROM , sound card, modem, network card and an Internet account. The trainers attend the classes offered by the district Staff Development Trainer and the Director of Technology. The T3 individuals in turn train the teachers at each individual school. This puts a Technology Specialists in each school.

We are currently working on a variety of projects to encourage teachers to become involved in using technology. This includes creating "plain English" instruction manuals, developing a staff computer purchase program in which the teachers and the district each pay half, and a program in which a teacher can Earn a Computer by completing a prescribed instruction and training program. We are also designing Computer Cruises and Computer Train Tours for staff training and encouraging the development of a business partnership with businesses in Durango.

Obsolescence Plan

The Technology Plan for the district was adopted and implemented in 1992. At the time of adoption who would have thought that equipment would be obsolete in such a short time span. Technology changes so rapidly each week it is very difficult to keep up.

In 1995 the Director of Technology developed a Obsolescence Plan. The plan was unique in that it did not state a time frame to replace equipment. It was based on software needs and curriculum implementation needs. There is a part of the plan that does phase out old equipment after five years. But the unique part of the plan is that as software needs change, more memory or larger hard disks are needed, money is in the budget to do it.

From the Trainer's Perspective

Technology has arrived at the Durango school district. Buildings have been networked. Labs are stocked with multimedia machines, scanners, and the latest in scientific probeware. The labs at the middle schools and high school have been made ready for the Internet. Small cells of energized teachers have begun work on attacking the enormous learning curve that accompanies technology, yet more still needs to be done.

The Train the Trainer (T3) program was instituted to help teachers throughout the district to overcome the inertia and trepidation that can impede learning how to use and integrate these powerful tools. It is no longer acceptable for just the building techies to implement computers into their teaching. More teachers need to enter into the world of computers and begin adapting them into their practice.

The program was set up to get at least one technology trainer in each of the ten schools in the district. This person is responsible for training teachers and support staff in the use of software and hardware in the building. Trainers conduct inservice programs and then provide follow-up help. They also help put out minor technical fires to take some of the burden off the district technology troubleshooter.

As a group, the trainers are a very diverse lot. Few of them would be classified as the building computer nerds. They came into the program with a wide range of expertise, but share a strong desire to build upon their existing knowledge and learn new technologies. They have agreed to share their expertise with colleagues and students as they take on new learning. Trainers are also dedicated to make the existing building technology available to all students, teachers, and support staff.

Initially, a survey was conducted at each building to find out the needs of the staff. The results indicated that staff wanted to learn more about management tools such as data bases, spreadsheets and electronic gradebooks. They were also eager to explore multimedia CD-ROM's and authoring tools like Hyperstudio. The most emphatic response however, centered around learning how to use the Internet in the classroom.

A training schedule was set up for the year, and one hour training sessions were scheduled once or twice a month after school. This approach has worked well at some schools, but other strategies have been tried as well. Some trainers have found it more effective to work with small groups or one-on-one. They have ferreted out snatches of time at breaks, during planning times, or before or after school. This individualized sort of training has been very effective because it usually focuses on a specific technology issue that the teacher has brought to the trainer. As the teacher moves forward with their use of the new technology, the building trainer is available to provide support and serve as a sounding board for the technology related details. One-on-one training was most effective during my computer infancy while struggling with word processing and gradebook software.

It is important to develop information literate students that are able to access and utilize all the tools at their disposal. Students are certainly not afraid to use whatever we provide them in the way of computer equipment. Before we prepare students for the 21st century, we must prepare teachers to facilitate their learning. It is clear that staff development is directly tied to student effectiveness in using technology. Our training program is developing teacher proficiency in two ways. First, it helps teachers better manage students by making them more proficient at using word processors, data bases and gradebook programs. Additionally, teachers are going beyond using the computer for simple drill and practice. Now they are adapting and inventing new uses for technology in their curriculum. The computer is a major factor in building a student's knowledge of the world of the world around them. Our task is to make teachers aware of these tools and their potential usefulness to themselves and their students.

Our final comment is a statement found on the Internet. We could not locate the author but we feel that it really gets to the heart of the staff development issue. "Technology minus training equals junk."

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Appendix

Technology Plan Guidelines

A. The Technology Team
1. Identify your stakeholders
2. Choose your Technology Team
3. Provide a base of knowledge for all team members
4. Define your task
5. Resources for getting started

B. Assessing Where You Are
1. Where are you technologically?
2. Where are you educationally?
3. What does the State mandate in the field of technology?

C. Formulating a Vision
1. Develop a vision statement
2. Communicate your vision statement to your community

D. Exploring the Available Technology
1. Multimedia technology
2. Connecting computers in networks
3. Online communications
4. Telecommunications

E. Exploring the Possibilities of Technology
1. Technology and the curriculum
2. Art
3. English/Language Arts
4. English as a Second Language (ESL)
5. Foreign Languages
6. Goal and Skill Objectives for Computer Skills (also called Scope and Sequence)
7. Mathematics
8. Music
9. Science
10. Social Studies
11. Special Education
12. Student Performance Assessment
13. Vocational Education
14. Technology and resource management (libraries/ media centers)
15. Technology and school administration
16. Facility design and system configuration

F. Developing a Technology Plan
1. Set specific goals and objectives
2. Identify your equipment needs
3. Develop a timeline
4. Develop a budget
5. Identify internal and external influences on your plan
6. Gain approval of your plan
7. Consider equity issues
8. Involve your community in the plan
9. A Checklist for your plan

G. Funding and Acquisition
1. Raise funds through grant proposals
2. Corporate donations of equipment and services
3. Local fundraising efforts
4. Off-price purchasing
5. Partnerships with outside organizations
6. Things to watch for

H. Staff Development
1. General areas of training and staff development
2. Determine your areas of need
3. Select appropriate training models
4. Provide for ongoing support and feedback
5. Support staff home use of technology

I. The Implementation Process
1. Begin the implementation with a pilot program
2. Build on your successes
3. Arrange for ongoing support for staff and teachers
4. Bolster your accomplishments with a public relations program

J. Evaluation and Continuation
1. Find out how you are doing
2. Keep things current
3. Keep the momentum going

K. Emerging Technologies and Issues
1. Keep your eye on new areas of technology
2. Track the progress of important Initiatives

L. Extending the Use of Technology Beyond School Walls
1. Choose compatible home hardware and software
2. Make the home-school connection

3. After-school programs
4. Adult programs
5. Special programs

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The Key to Technological Innovation: The Teacher

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In the innovative examples cited in this paper, efforts at technological innovation centered on the teacher. School officials devised ways in which teachers could personally use innovative technologies at home. Situations were created whereby teachers were not only instructed how to use the computers and other innovative technologies, they were also provided with the means to experiment and explore at their leisure. In these programs, as teachers became comfortable with the machines, and experienced first hand the practical applications, the use of the innovative technology as an instructional tool almost became inevitable. As evidenced by these examples, the key to technological innovation in the schools may be the teacher.

The Development of Instructional Technology

Computers and related technology have been in schools for close to twenty-five years. Each year, the administrative applications of the computer are becoming routine in school life. Student records are kept on computers, and business offices would be lost without them. As in the business world, there is a strong suspicion that computers and related technologies have made the school's central office more cost effective and efficient.

The use of computer related technology in the classroom has been far less extensive than in the central office. There are exceptions, and the literature abounds with isolated cases where innovative administrators, teachers and students are effectively using technology to enhance learning (Wagner, 1996). Yet despite the impressive proliferation of computer software for instruction in K-12 schools, there has been a relatively small volume of significant data showing the overall advantages of this type of instruction (Adams, 1989). Some studies do, in fact, uncover advantages (Bracey, 1988). Others are less conclusive. Ognibene (1989) suggest that this current plateau might be due to a number of factors including the inherent conservatism of schools and teachers, the difficulty of integrating technology in the classroom, and the resistance of teachers to practices that present a perceived threat to good interpersonal relationships with students. So, as an instructional tool, computer related technologies have received mixed reviews in the research literature. The enticing instructional potential of the computer has yet to be realized in most schools.

Technology and Teacher Training

Although computers are not quite ready to be thrown in the educational technology scrap heap, there is perhaps a danger that unless a new direction is found, the use of computer related technologies as effective instructional devices will continue to bypass many schools. Teachers, since they are the primary instructors in schools, have always been the key to educational innovation. It would make sense, therefore, that teachers would also be the key to technological innovation. It would follow that if teachers actively use computer related technologies, then there is a strong chance that the use of computers would become a more integral part of instruction. This almost common sense notion has led to countless numbers of inservice programs which attempt to tackle the issue of teacher training and support with respect to the use of computers (Barker, 1994). Just about every teacher in the United States has attended a computer workshop or at least felt that this is something s/he should do someday. Usually these programs, lasting a few days, familiarize the teachers with computers and available software (Brennan, 1991; Outen, 1994; Zeitz, 1995).

Despite all these good intentions, and despite the impressive short term gains as reported in the literature, few studies can be cited which point to effective training techniques which impact a teacher's use of the computer on a more long term basis (Ingram, 1992). Teachers return to the routine of school life and rarely have the time to practice what was taught. Often, computer related technologies might not be available just when a teacher is free. Most school schedules are not set up to be conducive to teachers extending instructional skills. Therefore, the one or two days a year when teachers are asked to broaden their horizons rarely pays off with a significant chance in how teachers use technology.

As might be expected, it is difficult to promote the use of the computer in the classroom when teachers themselves do not understand how to use the technology, or have the time to learn on their own. Therefore, since most teachers do not teach computer classes or have access to equipment, the advantages of the technology which are so apparent to more frequent users in those isolated cases is not made available to many of the students. In short, despite all the hardware and all the efforts at training, there is still something missing which has inhibited efforts to effectively use the computer as an instructional tool.

Unique Programs in Teacher Training

Yet there are situations which have taken a different approach to teacher training. Not surprisingly, they are off the "plateau" and are exploring areas of computer use which very few schools consider. Although the details of these novel programs vary, they generally attempt to get computers and similar technologies into the homes of the teachers on a permanent basis.

The Lake Washington School District in Kirkland, Washington, had land for sale in 1987. Some of the money generated from the sale was used to offer a unique computer program to teachers over the summer. For two weeks, teachers would learn about computers and how they can be used as tools in the classroom and at home. At the end of the course, instead of being paid in cash, teachers took the computers home and used them as they saw fit. The result of this offer was that 98% of the faculty participated in the program (983 teachers) at a cost of 1.6 million dollars. The following year, computer use in the classroom increased dramatically, as might be expected, and teachers were anxious to receive additional training and equipment.

In the Catasauqua School District, Catasauqua, Pennsylvania, a similar program was instituted although the goals were far more modest. Beginning in 1989, the program included extensive training on the computer. At the conclusion of the course, teachers took the computer home in lieu of pay. To date, over 30% (35) of the faculty have participated in the program. The total cost has been $25,000. Again, as might be expected, it is the faculty who have participated in this program which have most often requested software, have reserved computer labs, and have conducted inservices in neighboring districts on technology uses. Not all the teachers participating in this program were oriented towards using technology in the classroom. Many were anxious and worried. However, those inflicted with technology anxiety have made significant strides since they have assumed ownership of their own machines.

Strategies for Implementing Programs

As cited in these two examples, a program such as this can be inclusive or piecemeal, depending on the district's financial and political situation. There are several guidelines that are helpful as educators ponder the possibilities of unique technology training programs.

Work with the Board

In both cases cited, the school board was very supportive, initially. As financial burdens stretched the resources of one of the districts, the board reluctantly decided that this type of program was a luxury which would be misinterpreted by the public. Unfortunately, this mind set may be typical in many districts since the board could have difficulty seeing the connection between permanent and effective technological innovation and having computers purchased for teachers to use in their home. At least a year should be spent preparing the school board for this program. It is also a wise idea to fully explain the program to the business office and school solicitor. Inevitably, you will need their support when working to convince the board, and they will help you answer the important questions concerning whether the technology received should be counted as taxable income.

Inform the Public and Other Constituencies

This type of program is not something to hide from the public. The more is it advertised and promoted in a positive way, the more likely the board will support the program in the future. And it is best not to look at a program of this kind as a one shot summer inservice. Plans should be established to make this an option for ongoing teacher training into the future. In addition, if all teachers cannot be accommodated the first year, it is wise to establish a procedure whereby all feel that a fair selection system has been used. A committee composed of teachers that would be responsible for selecting applicants, might work best.

Build in Accountability

One district "lent" the computers to teachers who would return them upon retirement. In this plan it is important to make sure there are the necessary legal forms which guarantee the return of all equipment. Require frequent reports the first year, documenting how the computers are being used at home. Invite several teachers to attend board meetings and report on changes in their instructional strategies.

Consider Options for Funding

One district simply gave the computers to teachers instead of payment for extra summer work. Another district "lent" the computer to the teacher for as long as the teacher worked in the district. Many districts are now offering interest free loans whereby teachers can borrow money for the express purpose of purchasing computer related technology.

Build in a Training Component

This is a critical phase in the development of this program because it not only provides the foundation for future use of the technology, it also puts the teachers in touch with other teachers in the district or building who will be experiencing similar anxieties during and after the training period. Organizing the training with district or building people is also a good idea, since this also targets and individual within the organization who can answer the many questions which will arise from all participants in the future.

Be Accommodating

It would be best to have one type of machine available for all participants. Yet many teachers might apply for this program who already have technology at home and are looking for enhancements. They should not be denied this opportunity simply because they have already taken the incentive to explore innovative technology at home. In addition, most districts have a great variety of educational technology available throughout the organization. It is best to work with each participant, prior to the training, in order to determine what best suits that individual teacher's needs.

Spread the Word to Other Districts

After the first year, teachers should be encouraged to spread the word both within their training class, through organized meetings, or in other districts at inservice workshops. Teachers talking to teachers about innovative use of instructional technologies is perhaps the most powerful, and effective, message available.

How the Program can Influence Instruction in the Classroom

Technological innovation, as evidenced by the significant isolated cases we often hear about in popular literature, is often spearheaded by innovative teachers and administrators (Wagner, 1996). These individuals frequently have access to computer related technologies at home, and have no doubt experimented with their instructional ideas on their own time.

Yet if we are to expand these cases of technological innovation outside of the isolated cases, we must establish a process whereby all teachers in a building or district have the option of learning about technology on their own time. All the inservice and training will inevitably fail unless teachers have the chance to practice, on a daily basis, what they learn.

The key to the unique programs cited above is that teachers can use the computer whenever they wish. The training is important. But the critical component is the fact that teachers have access to the machine on their own time. They are then able to explore, take risks, and see applications which would elude them during the day. As might be expected, in districts taking this approach, the use of effective, innovative technology has dramatically increased. Computers are used in music and English classes. Teachers are more willing to experiment with math problem solving software. The Internet is becoming a routine research option. Science teachers regularly use interface devices. School newspapers are published on computers. In short, the intuitive advantages of innovative technologies in all its forms is taking hold in these districts. And teachers are leading the way.

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Inconspicuous Inequities: The Myth of Universal Access

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The technophiles are hopelessly naive (or self-deceiving) in their understanding of social problems. They are unaware of (or choose to ignore) the fact that when large changes, even seemingly beneficial ones, are introduced into a society, they lead to along sequence of other changes, most of which are difficult to predict .... In fact, ever since the industrial revolution technology has been creating new problems for society far more rapidly than it has been solving old ones (in Sale, 1995, p. 308). The author of those words has given America much to ponder over the past few years, although unfortunately it wasn't his prose but his performance that captured our attention. The sixteen bombings executed by Theodore Kaczynski , accused of being the Unabomber, clearly mark him as the most deranged among the neo-Luddites. Kirkpatrick Sale argues, however, that contrary to dismissing his idea that the industrial system in which we live is "a social, psychological and environmental disaster for the human race," we should put it at the forefront of the American political agenda (p. 305). Sale goes on to say that Kaczynski's treatise is not irrational, nor is there anything "wild-eyed or rabble-rousing" about it. While we may find the method by which he aired his grievance objectionable, the grievance itself sounds familiar.

Industrial Society and Its Future

Kaczynski's creed, is consistent with a growing body of work in the Luddistic tradition that questions the widely held belief that technology constitutes an indisputable and universal benefit. While some of that work admittedly lapses into diatribe, most raises legitimate questions for we who consider ourselves technology advocates; questions which, as their authors point out, have been ignored in the stampede to integrate technology into virtually every nook and cranny of American society. Some of these concerns are social, some academic, some economic or political, and others combinations of these. One of the more troubling is the widespread perception that electronic technologies have the capacity to radically democratize public education by increasing access, an argument which requires some examination.

There are some preliminary questions to consider, the answers to which will provide the basis for confronting the issue of universal access. Specifically, those questions concern what our expectations are for the technology and whether, at least at this point, those expectations are realistic.

HyperExpectations

Donella Meadows, an adjunct professor of environmental studies at Dartmouth, in a recent commentary offered a means of distinguishing between the sane and the insane. In a discussion of the futility of focusing on the disposal of toxic waste as opposed to reducing its production, she drew the analogy of a leaky faucet. The insane, she said, go immediately for the mops and buckets. The sane, however, turn off the faucets first. While she offered the analogy in the context of environmental concerns, the same may be said for any context wherein we fail to consider the source(s) of our anxieties or problems.

Like Meadows' insane, we've been frantically mopping, trying to stem the tide of user-friendly software, CD-ROMs, high-speed modems, a veritable deluge of unrecognizable acronyms, search mechanisms cleverly disguised as comic book characters, navigational tools that mimic rodents or worms, and enough World Wide Web locations to ensure information overload for even the most casual user. Buckets in hand we continue to bail, too busy begging the question to wonder if anyone's turned off the faucets long enough for us to assess what's happening. The context of mental competence may be extreme, but the question remains: What do we plan to do with the flow of information? In the rush to determine how to integrate the latest technology into America's schools, we've had little time to consider what, in the broad sense, we want it to do.

What's the answer? To put it in its most reductionist terms, we expect technology to halt our purported economic decline by rescuing an education system perceived to be on the skids. We expect it to restore our economic hegemony and stem the now-infamous tide of mediocrity believed to be engulfing our public schools. Democrats and Republicans, politicians and business leaders alike accept this solution as an article of faith. In this theology, our digital deliverance is at hand:

> Those who preach the faith include educators who believe computers will enable us to teach and learn more effectively; researchers in artificial intelligence who talk excitedly about machines that 'think'; politicians who herald the arrival of the high-tech industry as economic and political salvation; and, of course, computer companies that promote a glowing image of a smoothly functioning universe. The media have seized that image with gusto, generating books, articles, and stories about the miraculous and utopian nature of this brand-new cultural superstar (Brod, 1984, p. 3).

Public figures like Senator Bob Kerrey of Nebraska and filmmaker George Lucas argue that "access to information will be the currency of power and knowledge" in the Information Age, and that failure to provide universal access to the Internet will render America's students unable to compete or even function efficiently in the global marketplace ("Access," 1995). Amita Goyal of Virginia Commonwealth University and Alka Harriger of Purdue University agree that in order to produce employees suitable for today's workforce, institutions of higher learning bear the responsibility to "prepare students to master the skills to be able to compete for the best jobs in the competitive information technology field" (1995, p. 63).

Much of the anxiety over students' performance and preparation is thus inextricably linked to their ability to function in a highly competitive, technology-intensive economic environment, a proposition that many find arguable. That America's students are consistently outperformed by their foreign counterparts, for example, is a favorite theme of IBM CEO Louis Gerstner who alludes to national outrage over our students' finishing "at or near the bottom" on international tests of math and science. His remedy is predictable: "We need to recognize that our public schools are low-tech institutions in a high-tech society. The same [technological] forces that have brought cataclysmic change to every facet of business can improve the way we teach students and teachers (1995, p. 4).

Since the rationale for equipping the nation's classrooms with computers relies on the characterization of public schools as inferior, Gerstner and others who share his view (Finn, 1993; Innerst, 1995; Ravitch, 1995) find it necessary to ignore reports to the contrary. And while an increasing number of scholars have emerged to defend public education (Berliner & Biddle, 1996; Bracey, 1995; Rose, 1996), the perception of incompetence persists, as does the conviction that employment in a nontechnical field is a thing of the past. The October 11, 1996 edition of *USA Today* featured a letter from President Clinton and Vice President Gore saying that by 2000, "60 percent of all jobs will require advanced technological skills" (in Bracey, 1996, p. 136). There is no subsequent description, however, of what precisely those advanced jobs and skills are, and attempts by researcher and author Gerald Bracey to solicit either a definition or a citation for the figures were unsuccessful. Both, however, are contradicted by the US Department of Labor's *Employment Outlook 1994-2005* (1995), which predicts that the majority of jobs requiring a college education will not be high-tech jobs, and that the occupations that will account for the largest numbers of jobs will be low-skilled. The *Outlook* further reports that among the skilled jobs available, most will feature a degree of specificity that will require extensive on-the-job training regardless of the employee's education credentials (1995).

What accounts for our tenacious faith in the power of technology to transform, even in the absence of a demonstrated need for transformation? Perhaps one of the problems with encouraging a more cautious view of the promise of emerging technologies is the historic equation of technology with progress. In this familiar scenario, technology propels economic growth and a corresponding improvement in the human condition, thus explaining its description as "the handmaiden of democracy" (in Gillespie and Roberts, 1989, p. 7). When we express anxiety about that vision, wondering whether it's more problematic than it seems, we are assured by those in the vanguard that there's no reason for concern. Microsoft's Bill Gates, for instance, is confident that "although 'dislocations' will occur (meaning: you're fired), the net result of these disruptions will be a more empowered, better educated, wealthier populace" (Levy, 1995a, p. 56). What's missing in that formula, however, is an understanding of technology's inevitable locus in contemporary social, economic and political contexts.

CyberRealities

Technology has, as Andrew Gillespie and Kevin Roberts recognize, "an inherent 'bias' ... it can never be neutral or independent of society's broader social and political biases" (1989, p. 9). Myron Tuman agrees, suggesting that technology in and of itself cannot make ours a healthier society absent its embodiment in institutions of social reform. What happens again and again, he says, is this: "[I]n the absence of such institutions, just the opposite happens ... those in the best positions to use the technology do so for their own narrow interests while society as a whole suffers" (1992, p. 133). To the list of technology's potential outcomes then, we may add its capacity to reinforce the status quo by further stratifying a society already clearly divided between the haves and the have-nots. Tuman refers to the latter as members of a new global underclass, arguing that the same patterns of inequality associated with print literacy persist (p. 4).

Suneel Ratan observes that if there were any doubt that the computer has become firmly entrenched as a member of the American family, it has been dispelled: "For the first time ever, consumers in 1994 bought $8 billion worth of PCs — just a smidgen away from the $8.3 billion they spent on TVs (1995, p. 17). In America's poorer areas, however, families sharing a home with a computer are fewer and farther between. Computer Intelligence InfoCorp reports a distressing but predictable disparity between PC-equipped households and their less digitally blessed neighbors, pointing out that 70 percent of households without personal computers have annual incomes of less than $40,000, while 63 percent of the PC-equipped homes have incomes above that figure (Ruby, 1996).

Stephen Levy, writing in Newsweek's final 1995 issue, cites Vanderbilt University business professor Donna Hoffman's description of the predominantly upper class clientele of the Internet: "[T]here's no controversy about what online users look like .... They're demographically attractive — upscale, overeducated people" (1995b, p. 27). While it is no surprise that the higher the income level of the family, the more likely they are to have access to the latest in virtually everything, the disparity is more apparent with computers than just about any other item. What are the cost estimates? Bill Gates suggests that, depending on architecture and equipment, the cost to connect one information appliance (e.g., a television or personal computer) to the "information highway" is approximately $1,200 (1995, p. 61). Andrew Kohut of the Times Mirror Center for the People and the Press points out the difference is even more pronounced when the education level of the respondents is factored in. Among college graduates with children, 49 percent of the households surveyed had a PC, compared with only 17 percent of the homes in which the parents had only a high school diploma (in Furger, 1995). At the individual user level, 65 percent of those online have college degrees, while only 20 percent of the general population does; and an astonishing 93 percent report some college attendance (Ruby, 1996).

These social circumstances are, of course, reflected in the education arena. Trends identified in the eighties (Becker, 1986; Becker & Sterling, 1987) that confirmed that wealthier school districts tend to have equipment and access unavailable to poorer ones continue in the mid-nineties, with schools in the suburbs having twice as many computers per student as their urban counterparts (Ratan, p. 17). A two-year study by Janet Ward Schofield of the University of Pittsburgh (1995) reveals further cause for concern. As gifted students have special educational opportunities designed only for them (e.g., field trips, guest lecturers, etc.), these academically advanced students also have more access to computers than do their peers, a situation Schofield says "is likely to widen the already marked gap in achievement between students from more and less affluent backgrounds" (p. 216). At the school under study, college-bound students, regardless of the track they're in, have the option of enrolling in a computer science course. Schofield notes that this opportunity is only theoretically open to non-college-bound students, most of whom take general math courses, since Algebra I is an "informal screen" through which students who wish to enroll must pass (p. 215).

Kohut, pointing out the obvious, says, "If the road to equality is access to information technology, then there are some real roadblocks in place" (in Furger, 1995). Among the roadblocks is the finding of a survey conducted by the American Association of State Colleges and Universities that reports that more than two-thirds of 250 participating institutions either have or are considering a computer-competence requirement for students ("Colleges Target," 1995, p. 6). While the survey isn't clear on whether the competence is to be an entrance or exit requirement, obstacles remain for those students who haven't had the technological advantages of their wealthier counterparts.

While the computer-on-every-desk vision is perhaps impractical, there are some creative solutions that can at least help mitigate the technology gap. Ratan reports, for example, that the information technology industry clings to its faith in market forces, arguing that competition will drive prices down making equipment, software and access more affordable (1995, p. 17). Although interpreted by industry-watchers as a stalling tactic to avoid government regulation, many agree the scenario is plausible. Those constantly on the prowl for the latest gadgets or upgrades could create a vigorous secondhand market wherein discarded equipment or programs/software can be made available to the less advantaged. Ratan sees it as a sort of used-car market for high tech, although eventual obsolescence is a matter for some concern (1995, p. 18).

Additionally, a number of advocates for wider access are focusing on efforts to place equipment and access to networks and online services in public locations, such as libraries or community centers. They're also pursuing attempts to find ways to make presently-equipped facilities open to the public at convenient hours. A number of public schools, for instance, might be willing to keep their doors open in the evenings and on weekends if they could afford to pay staff and utility costs. All of these efforts are commendable, feasible and deserve our support.

What is not helpful are initiatives in several states, mine among them, which have a striking Wildean technology-for-technology's-sake character. During the 1995 regular session, for example, the West Virginia Legislature passed Senate Bill 547 which has among its goals a provision that computer usage will be integrated "into all [higher education] coursework," and that all full-time college or university freshmen "will own or lease a computer" (pp. 78-79). Faculty's academic freedom considerations aside, requiring students to own or lease a computer creates more problems than it solves. The speed at which technological advances occur will render the machine obsolete by the time the student graduates, and lease-to-own schemes are notoriously expensive. Combine only those two problems and the result is a student who not only pays more for a computer than it's worth, but who upon graduation finds her purchase is only marginally useful at best.[1] Families who can afford the latest technology will continue to buy it, much as they continue to buy other kinds of goods and services. Attempting to mitigate the economic disparity between these and their less comfortable neighbors by ensnaring the latter in dubious lease/purchase schemes, however, is misguided. It is precisely this kind of techno-infatuation that Cuban (1986) advised against, recalling that at one time people held absurdly exaggerated expectations for classroom use of film strips, overhead projectors and television. In terms of both cost and efficiency, it makes more sense to concentrate our efforts to assist the technologically disadvantaged on public access than on private ownership.

There's no universal panacea for closing the information gap, but we should neither be deceived by the inconspicuousness of the have-nots nor misled by the persistent utopianism of billionaire technophiles who are clearly out of touch with reality. Gates' pronouncement that computing is now "astonishingly inexpensive" is not only naive but irresponsible (in Levy, 1995a, p. 60). If we intend to used advanced technology in a constructive fashion, if its implementation in our classrooms reflects a commitment to unleashing its considerable potential, then we owe it to our students to do everything we can to secure convenient, affordable access for them.

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[1]Former Silicon Valley workers Lenny Siegel and John Markoff, in *The High Cost of High Tech,* explain the motive of the technology industry's interest in computerized classrooms: "To most manufacturers, the schools are primarily a vehicle for building a consumer market for personal computers. Though school sales are significant ... the home market is five times as large and it is much more profitable" (1985, p. 80).

Internal vs. External Intellectual Agents in the Management Information System of Schools

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In the past year a great deal has been written about the future of personal and corporate intellectual agents. Depending upon the degree of speculation involved, these agents live in the information world of the Internet and represent the interests of their owners and creators. In their simplest form, they search for information and for connections among information that are known to be of interest to the person or organization they represent. They then serve the distillation of their work to their masters upon demand. What was purely speculative a year ago is in practice today. New companies such as AutoNomy in Cambridge, MA., are in the forefront of offering authoring programs that can generate such intellectual agents. But the speculation stays ahead of the practice. Other theorists and futurists assign far more intelligence to the intellectual agent of the near future than searching, filtering, and sorting, and claim that it is within reason to suppose that such agents could soon embrace a heuristic that allowed them to be self-adjusting, capable of self-improvement, and facile at organizing other agents. Thus, the agents could be self-structured in an *ad hoc* hierarchy to accomplish more sophisticated goals and complete more complex tasks, enlisting and dismissing subordinate agents as quickly as is required to fulfill the demands of the superior agents.

Given the current state of artificial intelligence and the enormous economic base behind the Internet, what appears to be a mere fantasy today is likely to metamorphose into an improved and implemented version tomorrow. With apparent intelligence and access to unfathomable interconnectivity, the intellectual agents of tomorrow, and the real and virtual organizations that employ them, will be as dominant in the information space as computers are in today's physical office.

Internal Connectivity as a Prerequisite

For schools and school administrators one of the primary limitations to the entire notion of external intellectual agents working within the Internet, is that there are no existing links between such possibilities and the *internal* activities of the school. The databases of schools tend to be disconnected or nonexistent. Thus, without any *intra*connectivity the best an external agent can do is deliver information to a human agent at the boundary of the school. (*Boundary* is used within this paper in the systems analysis sense: the interface between the school and the external world, that is, between whatever is defined as school and what is not school.) The mechanism for the use of intellectual agents when there is no intraconnectivity would probably be in the form of one or more school employees enlisting intellectual agents for their own interests or amusement. The intellectual agents would not be able to inform school practice except through the intermediation of the interested human agent.

Worse still, without any *intra*connectivity there can be no automatic seeking of information that might be useful to the internal decision-making processes of the school. Every need within the school would first have to be appreciated by a human agent. That agent would then have to have the ability, interest, time and persistence to take the need to the boundary of the school and translate the need to the intellectual agent. If the present low ratio of technological utilization to technological availability within schools is any indication, the intellectual agent would rarely be employed.

A solid *management information system* (MIS) always exploits the relevant internal information sources, processes that information through the lens of appropriate models, formulates the rudiments of decision support, and then informs that support with external information if it is needed. Thus, intraconnectivity is a prerequisite to the systematic and intelligent use of external agents.

This same MIS process is witnessed in industrial organizations with expert decision support systems, and thus they are well-positioned to exploit the benefits of sophisticated external intellectual agents. By contrast, schools and most local governmental agencies are not similarly prepared internally and yet *they are often determined to purchase equipment and participate in the outward-looking part of the electronic information revolution*. The problem is as old as the fields of systems analysis, database design, and intraorganizational cooperation and sharing. Schools present a clear case where the new technology depends upon the successful implementation of the old — where the organization must be functionally sophisticated before it can responsibly exploit new opportunities.

Intraconnectivity and the Internal Agent

There are rarely any models within the school management information system to support decision making, such as Markov models for personnel policy evaluation, binary programming models for redistricting, cohort survival models for enrollment forecasting, and queuing models for the management of CAI and its resources. Instead, human agents query the internal database system sporadically for specific purposes, without any decision support model in mind, and only when there is an appreciated need. Many of the real needs are never felt or understood and, consequently, are not informed by whatever information base may exist.

Notwithstanding these historic constraints to the advancement of computer assisted decision making, decision science and its underlying computer hardware technology are on the edge of a breakthrough that could substantially improve the rate of adoption and the utility of the tools for educational administrators. More specifically, the capacity of microcomputers to solve full-sized realistic management problems is now available and inexpensive, as are robust computer programs designed to handle such problems without fully involving their users in the underlying technical complications. Once intraconnectivity is appreciated and implemented, decision support models can "live within the bowels" of the information system, constantly updating themselves and yielding information that the educational manager needs but may not have the prerequisite skills or awareness to ask for.

Consider an example recently studied by a doctoral student at North Carolina State University. (Winters, Taylor & Williams, 1996). Working within an industrial education environment, she built a Markov model based on how trainees moved through the skill levels of a certain Computer Assisted Instruction (CAI) module. There were perhaps eight skill levels, seven of which were needed for certification. Every so many minutes, a snapshot was taken within the CAI system. The snapshot updated the Markov matrix (probability of moving from any one skill level to any other). After enough persons had been through the CAI module, several analytical possibilities emerged. The instructor could make optimal interventions, because he would know who was functioning at or below any given percentile in terms of past (normative) performance. He could also tell, based on the first passage time analysis within the model, how long it would be before some given percentage of the total group would reach mastery. Or, put differently, he could tell how much longer the present group would have to work before 80% of his machines would be available to a new group.

So far, the above illustration relies heavily on the human agent, but let us suppose that the instructor or CAI systems manager were not required to make any of the inquiries suggested above. Instead, a Markov system was automatically created and updated for every CAI module as it was installed. Further, an electronic alarm would tell the instructor (on the instructor's screen) that the person at machine 14 was well outside the band of normative performance and needed help. And, let us suppose that every half-hour a forecast for the group and a forecast for the future availability of the resource (the computer room, in this case) was made and a suggested schedule for the next group was produced. These auto-reporting mechanisms could occur without the CAI manager knowing any of the underlying technology or without him even knowing that he should seek such information.

Given sufficient intraconnectivity, the information generated by the Markov model would flow to all other decisions that might be affected by its activities — the records of the students involved, the teacher who was next in line for using the facility, the manager who purchases equipment (based, in part, on the backlog of demands on existing equipment), the curriculum department which prepares or purchases the CAI modules, and so on. All of these possibilities depend upon intraconnectivity among databases within the school — a technical problem that was long ago resolved through various forms of open database connectivity, enterprise computing, and local area networking. And, these possibilities likewise depend upon inexpensive and reliable software for the decision support models — again, a requirement that was long ago resolved by STORM (Emmons, Flowers, Chandrashekhar, & Mathur, 1992) , LINDO, (Schrage, 1991), various spreadsheet add-ins, and numerous other popular solvers.

Consider one more illustration based on an entirely different management problem. In many cities in the United States, there is, either voluntarily or as a result of court intervention, an effort to racially balance the enrollments within public schools. This is done by creating attendance boundaries that capture, for each school, a certain proportion of children from each pertinent race. The goal is to have the balance within each school similar to the balance within the overall system. Some students and their parents resist such assignments by changing their place of residence. Thus, flight and other demographic phenomena require that attendance lines be periodically changed. The danger is that one or more schools will get out of balance before administrators are aware of what is happening. If the system is under a court degree, such imbalance can cause considerable economic and political problems, as well as a sudden disruption in the educational program of children who must change schools with little notice.

Now, let us suppose that the transportation information system is GIS-based and thus can convert addresses to X-Y coordinates as well as performing many routing and scheduling functions, and let us suppose that the student information system (which includes race and address) were sufficiently linked to each other and to a forecasting model. The model could then make forecasts based on small areas within the system's perimeter, monitoring and projecting numbers of students and their racial composition. As those small areas change demographically, a forecast for the schools to which those areas are currently assigned could likewise be forecast and could yield warnings that certain schools would, within one year, be outside a preset tolerable balance. A binary linear program could then annually find the optimal assignment of areas to schools, balancing race and minimizing distance. In April or May of each year, the system would automatically report recommended changes in boundaries for the coming fall. If the changes were approved, the system would notify parents and cause a recomputation of bus routes and schedules. The underlying technology would not need to be understood by the user, nor would the user have to ask all the right questions in order to receive the recommendation.

Other Examples

There are countless examples of how intraconnectivity could support internal decision-making systems and can be of great value to school administrators. As these examples are offered, they will sound more like methods than agents. We will return to this distinction later, but for the time being, keep in mind that an agent is often no more than an automated method. A very brief description of several possibilities follows:

Merit pay systems could employ linear programming to make an optimal distribution of funds. In such a system, the objective would be to maximize the amount of salary money awarded to each teacher for performance on each merit compensation variable, subject to all the constraints of the employing institution and the agreement between the employer and employees. Such variables might include teaching performance, professional development activities, school citizenship, extra duties. The constraints would include merit money available, and limits on the amount of merit pay that can be obtained by any one teacher. Records of the teacher's performance and participation factors would be stored annually in the employees' personnel file, and would be accessed by the merit pay system. Likewise, the policies of the school board affecting the budget and other constraints would be filed in the policy parameters database and could be accessed by the merit pay system. Little or no administrative intervention would be required to generate merit pay amounts, post them to the payroll department, and print notices to individual faculty regarding their merit pay for the upcoming year.

Systems for the analysis of impending teacher shortages could use Markov analysis, a tool that is ideally designed to help analysts understand the current and predicted behavior of systems that change over time. In terms of the teacher shortage problem, those states might include: a) being enrolled in a teacher training program in a particular field, b) being a first year teacher in that field, c) continuing beyond the first year, d) taking an unpaid leave from teaching, and so on. By tracking the movement of individuals once every year with respect to these states, an overall understanding of the way teachers move through career paths can be determined. This determination yields answers to many policy questions (such as whether certain incentives actually pay off in terms of teacher longevity) and, as a corollary, allow the school manager to gauge impending shortages. (See, for example, Taylor, 1990) Again, with sufficient interconnectivity, the information needed for such a model can be captured from standard personnel records.

General scheduling problems (rooms, teachers, courses, times of day) can, if the scale is small enough, use binary programming, or for large scale scheduling problems, some sort of matrix/conflict system. In any case, much of the work commonly associated with the use of these methods could be automated within the MIS so that annual or semiannual schedule-building would not be daunting.

The use of nonlinear programming for finding the optimal locations for new schools in growing school systems was impractical until recently. Now, however, the presence of powerful nonlinear solvers for PCs has made the use of this tool very cost efficient (See, for example, Brooke, Kendrick & Meerhaus, 1991). By drawing on information that is already available in the transportation and student management information systems, new facilities can be properly sized and located, substantially reducing long-term transportation costs. This is especially true when such problems are constrained by racial or other social balance requirements as in the United States. The data for such solutions already exists in school systems that have a GIS-based transportation management system and a student information management system.

There are many policy analysis issues that can best be studied by integrating available information, rather than by experimentation or trial and error. For example, it is impractical to determine the outcome of certain facility or transportation policies by experimentation — no school system can build multiple structures or set up multiple transportation networks just to see which works best.

Likewise, it may be immoral to study other policies by experimentation. Can a system in good conscience try several different personnel management policies (such as retirement rules) just to see which works best? By simulating the physical or social environment on the computer, many such policies can be tested, or their outcome predicted, without dire consequence. In other cases, instead of simulations (which may be too exacting for the soft issues involved) the systematic recording of the consequences of prior policies, especially in the areas of curriculum and student management, may prevent making the same mistakes in cycles just a little longer than the length of the institution's memory. Whether by simulation or archiving, the use of the computer and its potential for saving, sharing, and assembling information can reduce the risks of policy formulation.

All of these cases illustrate the work of internal intellectual agents — small programs or procedures that live within the MIS and invoke certain automated procedures in a richly interconnected, internal information space. The methods become agents by way of gaining independence, or rather, by way of not depending upon human agents for each inauguration or for connections with input information and output activities. In the examples above, the *linear programming method* became the basis for an *intellectual agent* that took care of the annual merit pay calculation and implementation. Likewise, the Markov method became an intellectual agent that routinely evaluated the possibility of personnel shortages, and so on.

The External Agent

Virtual organizations are very different than the traditional organizations we know so well. The structures of virtual organizations are more fluid and their existence, in many cases, are short-lived and time-bound. Their sizes will expand and contract rapidly according to the complexity of their goals and the ease with which they acquire and process the contents of the information space.

Traditional organizations tend to have narrowband links to the information space and currently favor using such links to reach through the information space to other traditional organizations or persons (e.g., e-mail, ftp, search and download). Thus, in present practice, the information space is used by traditional organizations more for its communications capability than for its capacity to embrace abstract information. By contrast, the virtual organization is native to the information space and is served by equally abstract intellectual agents. These agents can search, filter, and sort information, and can be scripted to achieve goals by adaptively assuming roles and taking actions including the enlistment and dismissal of other agents.

In human terms, the practical success of the virtual organization depends in large part on its relevance to the physical world, which, in turn, depends on the intellectual agent and its ability to use the translation protocols that move raw data and processed information across the barrier between the physical space of traditional organizations and the information space of virtual organizations.

The intellectual agent will gradually take on the persona of its creator as it works and relates to other agents within the information space. However, the degree to which the agent is successful at representing its creator will change as the technology improves and as the interconnectedness of the information space deepens. A few years ago, the agent was limited to clever answering machines and paging, today to home pages and search engines, tomorrow to personalized logic driven filters and sorters, and, soon enough, to capabilities that are sufficiently heuristic and self-organizing to defy reverse engineering. When that time comes, our agents will have a kind of intelligence that is superior to ours with respect to the information space, much like computers today have certain processing capabilities that cannot be rivaled by any human being. Persons and traditional organizations will, nevertheless, have their own specialized intelligences and intuitions that are well-adapted to surviving in the physical world.

Some intellectual agents will call on and direct the activity of others (much like a subroutine is called in a computer program). The experience of these agents (that is, a log of their success in achieving their goals and a mapping of those evaluations onto the strategies attempted) will be used to improve their capabilities. Because this is largely a data management problem, the agents should quickly become facile at independent self-improvement. Due to the heuristic, self-learning, adaptive nature of these agents, it is possible that some will take on a "personality" of their own, and behave in ways that are not consonant with the goals of their creator. Computer viruses, for example, can start as harmless pranks but end up being extremely proficient and destructive intellectual agents.

The External Agent and the MIS of Schools

The relevance of the fully-developed intellectual agent serving schools is still rather obscure due to the undeveloped nature of the education information infrastructure as explained early in this paper. However, there are a three observations that can be made with confidence.

The first is that individual teachers and administrators who are network-savvy can already enjoy the benefits of available primitive agents. Particular topics for academic research, administrative problem-solving, or policy development can be given to intellectual agents with the demand that the net be periodically searched for new items and placed in the human agent's mailbox. Although this does not reach to the high level of informing the MIS of schools, it does start to build an internal appreciation for the coming benefits of intellectual agents.

The second observation is that intellectual agents can be set to the task of monitoring and saving information about the emergence of agent-generating programs, so that as the capabilities of intellectual agents expand, school MIS managers will be aware of the possibilities and will start to tie their vision of the future to the emerging technology.

The third observation is that one of the most important products of education is information and information-processing — and this is true at the learning-teaching level, the teaching-supervision level, the supervision-administrative level, and the administrative-governance level. The more an institution is tied to the processing of information — as opposed, for example, to manufacturing a physical product — the more easily it can model itself within the information space as a virtual organization. It is within the parallel virtual organization that the intellectual agents work (setting merit pay, forecasting, scheduling, allocating resources, and so on) and it is at the boundary between the virtual and traditional organization that this work is exposed. The transformation of this abstraction into management decisions and physical actions may remain in the domain of the traditional organization and its human agents unless such decisions and actions are delegated to the virtual organization and accommodated by the boundary translation protocol. In any case, schools are ideal candidates for a high level of cooperation between traditional and virtual realities due to the paramount role of information within schools.

First things first. As interesting as all these new developments may be, the first group of tasks for schools is to get the information they already have organized and interconnected, making use of the best principles of MIS. The second group of tasks is to develop strong internal intellectual agents within the MIS to inform the management and teaching functions of schools, making use of the best methods for decision support. Then, the final group of tasks is to make full use of the external abstract world of information by building a virtual model of the school within that world; a model which mimics the traditional organization and shows it the most goal-directed practices.

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Improving Education by Combining Educational and Economic Development Resources

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As communities enter the 21st century, the continued prosperity of their citizens will depend upon economic stability and growth. Economic stability and growth will be defined by the ability of a region's education system to graduate students with the required basic and technical skills needed for employment and life long learning. In 1991, President Bush set the stage for his America Goals 2000 strategy by stating that, "Building a world-class work force must be a national priority. Improving America's capacity to educate and train workers is critical to the future of this county." President Bush also stated, "Think about every problem, every challenge we face. The solution to each starts with education" (Blount & Kearn, 1991, p. 1). In testimony before the Senate Committee on Commerce, Science, and Transportation, on May 25, 1994, the United States Secretary of Education stressed that how the United States implements technology into educational reform will define the success or failure of the United States (Riley, 1994).

Background

Many areas in the United States are experiencing a critical shortage of skilled workers. Due to the lack of skilled workers, development of workplace skills and related training is currently a major preoccupation of businesses and industries (Wagner & Venezky, 1995). This critical shortage of skilled workers throughout the United States has become so serious that many rural American communities and some entire rural regions are seriously at-risk of becoming ghost towns of the 21st century. Without an educational system providing skilled workers for a region's businesses and industries, the entire infrastructure of a region begins to break down.

Global communications is quickly transforming American society in dramatic ways. Since the advent of the railroads during the 19th century, no single technological revolution has had such a profound change on the everyday aspects of American society. Unfortunately, this latest technological revolution caused by global communications is not equally impacting urban and rural regions.

Many rural areas are suffering a double threat to economic stability and a basic quality of life. First, educational institutions are not graduating students with the required basic and technology skills to fill the desperately needed entry-level positions in businesses and industries. Second, skilled workers in many rural areas, especially in financially plagued states, are out-migrating by the thousands for higher paying jobs in other states and metropolitan areas. This out-migration causes an erosion of a region's tax base and correspondingly limits the amount of funds a region can budget for education. Rural areas are finding it more and more difficult to provide funding for educational resources that are found in many urban areas. Unfortunately, many rural school districts must rely on local taxes to fund technological and other educational improvements (DeYoung & Lawrence, 1995). The decreased tax base caused by out-migration provides less funding for educational improvements that could produce skilled workers so desperately needed by local businesses.

Historically, educators and economic developers have not collaborated their efforts to jointly solve regional educational problems. In many communities, especially rural areas, few mechanisms exists for economic developers and K-12 educators to share ideas and cooperatively solve educational problems that dramatically impact business and industry. In addition, educational institutions, both K-12 and post-secondary, often do not have direct personal knowledge of the needs of local businesses and industries. At the same time, many business leaders lack an understanding of financial and other problems associated with education. In some regions, educators and business leaders do not actively communicate with each other. Business leaders rarely visit school classrooms or meet regularly with educational leaders to a gain first hand knowledge of the multitude of problems facing educators. In addition, very few school administrators, teachers, and university professors regularly visit regional businesses to gain an understanding of the problems businesses are experiencing when hiring their graduating students.

Due to many reasons, including under-funding, public scrutiny, and the increasing threat of lawsuits, educating K-12 students has become a very complex social issue. Administrators of K-12 school districts are finding it more and more difficult to graduate students who possess the required basic skills and technology competency necessary to enter the workforce or to be able to succeed at institutions of higher education. At the same time, economic development professionals in many communities are continuing to use the same economic growth efforts and techniques that they have always used. Unfortunately, without sufficient skilled workers to fill the employment needs of their communities, economic development efforts are no longer reaping any short term or long term benefits. In the words of President Bush, "Think about every problem, every challenge we face. The solution to each starts with education" (Blount & Keam, 1991, p. 1). Economic developers and business leaders in economically depressed regions need to redirect their economic growth efforts in a new direction to be successful.

To assist K-12 education, economic developers and educators must work together to provide leadership in the acquisition of technology and the integration of technology in the classroom. Integration of technology into K-12 education requires an extensive commitment of funding, human resources, and technical expertise. Due to these significant impact factors, many school districts, especially under funded rural school districts, simply cannot integrate technology alone.

Computing and telecommunication improvements are occurring at an incredible pace. The dramatic technological advancements that have occurred since Toffler described the Information Age in his 1980 book, *The Third Wave*, have been dramatic. When the microprocessor was invented in 1969, it could process approximately 60,000 instructions per second (Shelly, Cashman, Waggoner, & Waggoner, 1995). Today's Pentium Pro microprocessors can process up to 300 million instructions per second. By the turn of the century, Intel has predicted their microprocessor will process two billion instructions per second. Intel projects that by 2010, Intel microprocessors will be capable of processing one trillion instructions per second. As technology has progressed, there is no doubt that K-12 school administrators are not only overwhelmed by technology advancements, but also how to fund and integrate current and emerging technologies into individual classroom curriculums.

Today initiatives that combine educational and economic development resources are needed to improve the quality of graduating students. Many of the serious problems facing education could be solved by combining the independent efforts of educators and economic developers. Most, if not all, communities in America have numerous economic planning and development agencies with talented professionals dedicated to community planning, assisting existing businesses and industries, and attracting new business and industries. Most communities receive economic planning and development assistance from various federal, state, and local sources. In Alabama for example, in addition to numerous federal and local agencies, Alabama's counties are served by 12 nonprofit state mandated regional planning commissions. These 12 planning commissions assist their communities and citizens with economic planning, technical assistance, program resource development, and services that will improve the overall economic stability and growth.

Economic Problems Impacting Rural Alabama

At the 1995 Annual Meeting of the Southern Growth Policies Board, Southern governors and industry leaders expressed concerns that, "... without substantial improvement, the South's public schools may prove to be the region's Achille's heel" (Southern Growth Update, 1995, p. 2). Economic growth in rural Alabama is becoming virtually nonexistent, and economic stability is challenged by a significant lack of skilled workers. Economic stability and growth in many rural areas of Alabama are dramatically impacted by decades of under-funding of public education. Neal Travis, President of Bell-South in Alabama recently stated, "Only one of about 10 job applicants screened is found to be qualified for entry level employment." Bobby Dees, Director of Adult Education in Alabama, recently stated, "...over 450,000 Alabama adults are functionally illiterate and thirty percent of Alabamians annually lose their jobs because they are deficient academically and cannot be trained" (Smith, 1995, p. 1).

Global communications is transforming American society in dramatic ways. Unfortunately, the lack of global communications in rural areas like Southeast Alabama is particularly profound. Students must have access to the Global Information Highway and basic technology skills to be employable in the future. Over the past few years many states have educational technology in K-12 education. Alabama began funding $75 per teacher for all educational technology for the 1995/1996 school year. However, most rural schools in Alabama average 15-25 teachers which results in each school receiving between $1,125 and $1,875 for educational technology for the entire school year. It is not surprising that a number of rural high schools in Alabama are still teaching typing on typewriters instead of using computers.

Unfortunately, because of an increasing lack of technology, the education gap between many regions in Alabama and the rest of the nation is increasing at an alarming rate. Many young people graduating from rural high schools in Alabama are doomed to join the "lost generation" of American youth who simple do not posses the required basic and technology skills necessary to become productive employees or succeed in higher education.

The Solution: The Southeast Alabama Network Project

In an effort to prevent many of Alabama's communities from becoming economic ghost towns of the 21st Century, economic developers in Southeast Alabama believed what was needed was a new and joint approach to help solve several of the region's education problems. The Southeast Alabama Regional Planning and Development Commission, in conjunction with regional educators, set out to establish a leadership bridge between education and business.

A grass roots partnership was formed between the Southeast Alabama Regional Planning and Development Commission, K-12 education, post-secondary education, county commissions, local Chambers of Commerce, other economic development agencies, business leaders, and concerned citizens from seven counties in Southeast Alabama. Hundreds of professionals combined their efforts to first identify the primary education problem in Southeast Alabama and then design a plan, complete with funding sources, to aggressively attack the problem. Identification of the primary educational problem in Southeast Alabama was easy, high school graduates were not graduating with the necessary basic and technological skills to be employable in today's technology based job market or succeed in higher education.

The partnership's solution to the identified education problem is a project called the Southeast Alabama Network. The Southeast Alabama Network is a cost-effective, nonprotein network project that will provide local Internet connectivity to all K-12 schools, institutions of higher education, health care providers, businesses, and citizens in seven Southeast Alabama counties. The network will provide free connectivity for all K-12 schools, libraries, and underprivileged citizens in Southeast Alabama, the population of which was estimated in 1995 to be 281,141 with 50,627 students enrolled in 109 K-12 public schools.

The infrastructure of the Southeast Alabama Network is designed to provide all students, teachers, and citizens with a computer/modem access to the network by dialing a local number. Alabama students and citizens who do not own a computer will be provided free access at many locations throughout the local communities, including K-12 public schools, institutions of higher education, libraries, housing areas, and other locations. The project will be managed by an Advisory Board of Directors made up of economic developers, educators, and business professionals from all seven counties and will be operated under the nonprotein status of the Southeast Alabama Regional Planning and Development Commission.

The most important service the Southeast Alabama Network will provide is user defined global information access. Hundreds of icons and home pages, and thousands of hyperlinks will be defined by regional users. Numerous User Working Groups will be organized to define regional needs in specific areas; such as, education, medical, agriculture, and many others. The Internet is a heavily traveled global highway, unfortunately it also has many off ramps to sites that contain adult information that should not be available in K-12 schools; parents and teachers must take control and monitor the sites that students have access to (Black, 1996). The K-12 Education User's Group will help assure that administrators, teachers, and parents maintain an active role in what students view on the Internet.

An extensive training plan has been designed to train educators and citizens. Regional post secondary institutions will play a key role in the network project by providing training for the region's current and future workforce. Throughout the United States, many failures to integrate and use technology have been reported. The variable most indicated as leading to failure has been a lack of training. The Southeast Alabama Network's training plan will ensure success of the project by providing training throughout the life of the project.

The Southeast Alabama Network project is designed as a model project that could easily be adopted by other regions. The Southeast Alabama Network project is the result of a joint effort of educators and economic developers to work together to solve regional problems. Economic developers, business and civic leaders, and concerned citizens must progress past the era of complaining about public education and get involved in educational improvement initiatives. The Southeast Alabama Network project is an example of how economic developers and educators got together to improve a region's workforce. Many joint initiatives between economic developers and educators could be organized in other communities for the purpose of graduating students who possess the skills necessary for employment and life long learning. By combining talents, funding, and other resources of economic development agencies and education, many initiatives could be designed to begin solving many of the problems facing K-12 and post-secondary education.

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Administering Formal Structures Supporting Senge's Three Levels of Leadership

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This paper addresses the systematic application of Information Technologies (IT) to the management of the three types of educational leadership described in Senge's chapter: *Leading learning organizations: The bold, the powerful and the invisible* in *Leader of the Future* (Hesselbein, Goldsmite, & Beckhard, 1996). In that chapter, Senge describes three types of leader: the *executive* leader, working above the workers (Deans, Provosts, and Superintendents); the *line* leader, working with the workers (Chairs, and Principals); and the 'leader, (untitled worker/peers who demonstrate leadership from within organizations) working among and between everyone in an organization. The application of IT to these different leaders can benefit these leaders and organizations. This paper combines the theoretical elements of leadership and technology with empirical evidence derived from management of a Virtual University initiative conducted at a large land-grant university in the Pacific Northwest.

This paper will articulate the premises of IT and its ability to aid educational leaders, describe three types of IT enhanced leadership and the technological support best suited to each, and then forward a hypothesis, called Virtual Leadership which outlines the use of IT in leadership.

The Premises

In promoting or offering a hypothesis about IT and leadership it is necessary to provide the premises describing the utility, or the set of assumptions about the utility, of IT in aiding leaders and their work. This is an important step in light of recent evidence that, just because the work situation is technologically enhanced, it may not be better, or more efficient. It is important to understand that this is not a blanket endorsement of IT and its ability to help workers. It is a specific claim surrounding the application of IT toward specific ends and in specific situations to assist leaders and leadership activity.

Premise One: *Information Technology (IT) can positively change the mechanisms of leadership in educational systems.*

We should first begin with a description of what IT means. In this context IT most often refers to three main features of the technological environment: (1) Computers and their networks as telecomputing communication systems, (2) computers as groupware and groupwork aids, lastly and least (3) computers as personal productivity aids. The extent to which each of these roles is used by different levels of leaders is variable. There are some patterns of use but no firm trends or rule bound uses to which each type of leader uses these technologies.

In the first context, the role of telecomputing is obvious within any framework of leadership. Whether it is using the Internet or an Intranet as in Gardner's storytelling (Gardner, 1995) or Burns' transformational leadership (Burns, 1978), IT and its use as a communication system clearly has great positive potential. Through an Intranet, or the Internet, the power of reaching millions of people quickly and sharing data or software is clear. In one day Microsoft provided a million copies of its browser over the World Wide Web (WWW). This is clear evidence of the power of a coordinated set of messages combined with a leadership strategy designed to move huge amounts of information (in this case software) quickly and efficiently. Compare this to the communication opportunity posed by a popular sports event such as the Superbowl, with an estimated 20-30 million viewers, who are assumed to see 30% of the commercials, and of whom about 20% remember them. In that scenario, less than 2 million viewers get the message, and fewer yet take actions based on the information presented in this medium. This set of diminishing returns of broadcasting and consumerism compared with the focused application of narrowcasting (Lick, 1965), to distribute products and services highlights an efficiency of message and delivery. In the Microsoft example, few extraneous messages are received, little extraneous effort is applied to consumers, and there is still great potential for mass distribution, provided of course the deliverable needed is online. A more recent example occurred during the presidential campaign where Web sites were a strategic element of each campaign. This is a clear illustration of the potential of a leader's use of IT for telecommunications.

In the second context, the use of IT a coordinator of groupwork is evidenced by several researchers as we begin to see the formation of world wide virtual teams (Geber, 1995). As leaders begin to use IT for coordinating groupwork it becomes clear that a vast potential for distributed teamwork exists. As Premise One is formulated we need to see only evidence for the positive possibilities. It may be here that IT excels at assisting leaders at all ranks.

The third context, placed last, is personal productivity. The capacity of IT to assist leaders in this area exists but is limited in its impact on followers. It cannot be omitted however, because of the obvious impact on followers if all types if IT are not part of a leader's perceived repertoire of techniques. As a role model, the leader's stance on the use of IT in personal productivity modes should be made clear.

In summary, Premise One states that Information Technology may advantageously change the patterns, modes, or arrangements of a leader's work (Sproull & Kiesler, 1991). At a fundamental level, the mechanisms of leaders' work may changed by It's presence on the educational canvas.

Premise Two: *Different uses of IT are appropriate for different types of leaders.*

The correct placement of leaders and the IT applications they deploy are critical to the messages they promote as leaders and the work they do in relation to the organization. The day to day maintenance of a listserv serving the organizations operational needs might not be a suitable use of an *executive* leader's time. While an *executive* leader could easily and reasonable facilitate a listserv of peer executive leaders he would, in this context, be working as a *network* leader. The creation and management of a generative problem solving/strategy generation Web site might not be an appropriate *network* leader function; this work might be seen as disruptive rather than constructive.

These exemplify the negative possibilities. Several positive examples exist and will be described in the Development and Description section. There, IT uses of different types of leaders will be described and contrasted.

Premise Three: *While the conscious use of specific IT strategies benefits different types of leader in different ways, the patterns of use can be defined, described and facilitated.*

The systematic application of IT to leadership strategies in these three different arenas constitutes a new hypothesis that is to be developed into a theory of leadership.

A brief overview of the hypothesis that will be developed in the third section, IT Leadership Hypothesis (a theory of IT facilitated leadership) is provided here in the form of a model building on Senge's three types of leadership.

Development and Description of IT Use

Executive Leaders

Technological management of different workers, let alone different types of leaders, is a challenge. Some simple technological solutions exist for managing the complex communication strategies of *executive* leaders: e-mailing lists, anonymous suggestion e-mailboxes, technological eDelphi™ techniques as well as typical listservs. I will explore these and their use in relation to the *executive* leader, focusing on creating structures (data gathering and decision making systems, strategic planning procedures and local area broadcast techniques) aimed at aiding communication and discussion making.

If we agree that key *executive* leaders' (such as Deans, Provosts, and Superintendents) roles include data collection, group problem solving, vision setting (strategic planning), intra-agency vision dissemination, and inter-agency communication; then it is clear that IT can provide several specific types of assistance for a leader engaged in these activities. Several examples of this assistance are provided here.

Table 1.
Leadership Types and Integrated IT Uses.

IT Use\ Types	Executive	Line	Network
Typical Needs	Data collection,problem solving, creative vision setting (strategic planning) and intra-agency vision dissemination, & inter-agency communication	Interactive consensus-building, group coordination, & traditional intra-agency communication	Local, supportive diverse goal activities & grass-roots idea generation
Typical IT Used	Data collection systems (eDelphi™, and online surveys), Groupware (Lotus Notes, Sequel shared document environments), &Internet based communications.	Program and exec vision description through WWW "broadcast", shared documents, and group calendaring as well as review online worker products.	Project based WWW page coordination, informal communications, team coordination through "Project home pages" and revisable drafts and reports.

Data Collection. Data collection for executive leaders can be problematic. Opinions summoned from followers are subject to yesism (workers agreeing too soon with perceived management positions), groupthink (opinions reflecting group norms rather than personal stances or data derived positions) and simple recalcitrance. Extracting useful opinions about the work followers do or opinions they have can be facilitated successfully by several types of IT. Internet based automated survey techniques are useful when inventorying skills, or equipment. Internet deployed eDelphi™ techniques can be important agenda setting tools. Focus groups convened on listservs or as threaded discussions can provide insights to the prevailing attitudes of a faculty as well as garner useful input about recasting executive agendas.

Group problem solving. Shared document environments can provide useful settings for the generation and refinement of organizational stances. Often the meeting time used to collect ideas and develop strategies is inadequate, and often viable strategies such as shared document creation or cycled editing are useful alternatives to real-time meetings. There are several commercial programs that are designed to collect ideas and coordinate projects. Generative approaches to the use of computer models and simulations can provide valuable stimulus to groups examining problems. In situations where groups and committees are created to solve problems, specific software programs, Internet pages and groupware can help in a leader's attempt to facilitate and guide a team working on a specific problem solving task.

Vision setting (Strategic planning). IT's use in strategic planning could incorporate several of the techniques described above. IT aided focus groups, Internet deployed surveys, and carefully targeted e-mailings could create the foundation of data collection for any strategic planning project. The creation of organizational mailing lists and the project or issue specific listservs could become critical features of any strategic initiative.

Intra-agency vision dissemination. After strategic planning or in relation to ongoing changing organizational position or stances, intra organizational communications through WWW page postings, or targeted e-mailings should form the basis of ongoing use of IT for critical communications. Without direct paper-less initiatives, IT can become an accountable and reliable form of communication. In times when faculty snail-mail boxes are cluttered with junk mail and are often unvisited or at least unpurged, e-mail has vastly higher reliability in many settings. As receipt capabilities are incorporated into e-mail systems, it becomes harder and harder for faculty and students to claim they didn't receive a memo. This e-mail use, coupled with an appropriate Web presence, can form a stable and reliable form of communications infrastructure.

Interagency communication. An *executive* leaders work is more often interagency than intra-agency. Often in order to coordinate interagency cooperation the Internet or the WWW is a simple way to begin shared document interaction across agencies and platforms. Partnerships are easier to start and maintain as documents are served at common sites. Progress and announcements are easily shared when the interagency group share an Internet "home".

These solutions are brief glimpses into the opportunities available through Information Technology and its application to aiding *executive* leaders' goals. In no case are these untried ideas or principles. Rather they are viable applications. The extent to which these techniques work depends often of organizational expectations and leader's consistency of application and vision. In settings where e-mail and Internet are not directly assumed parts of the organizational expectations, these IT based solutions may not be profitable. But even in the less than successful IT applications, there are often hints that behavior and organizational expectations are shifting to incorporate and expect participants to engage in these IT uses as followers. As that happens the *executive* leaders will see that their use of IT can be easier and more profitable.

Line Leaders

For managing the tasks of **line** leaders a more generative set of technological solutions exists. Group-shared collaborative document generation systems, Web based form-processed Webpage generation and locally hosted Web Centers form the foundation of systems that enhance the **line** leader's effectiveness and productivity. While line leaders tasks serve a set of clients they in turn inform the practices, management and decision making of their executives. In this way, with the correct systems, they lead the organization into new techniques and strategies. The systemic administration of technologies that aid this type of leader are critical to educational organizations' successes.

If we agree that key **line** leaders' (such as chairs, and principals) roles include interactive consensus-building, group coordination, and traditional intra-agency communication, then it is clear that IT can provide several specific types of aid for a leader engaged in these activities. The following are some examples of successful applications of IT toward these issues.

Interactive consensus-building. The development and maintenance of WWW Homepages depicting the mission of organizational subunits has been an impressive tool in several consensus building processes. Without the use of specialized software, simply the online presence of documents representing the unit's work and mission as well as documents describing specific initiatives seems to galvanize groups into a discussion of their shared circumstance. Beyond the general aid that online documents can provide toward consensus building, there are several commercially available IT techniques that can foster interactive consensus building throughout the development of shared documents through Lotus Notes, or across a Sequel server.

Group coordination. The simple coordination of shared documents through regular postings on the Internet makes these updates available to all involved workers, any time and from anywhere. Group calendaring through WebEvent shareware or MeetingMaker™ are also important techniques for managing committees or teams.

Traditional intra-agency communication. The traditional intra-agency communication of yearly reports, or committee updates or budget reviews can be posted on the Internet (limited addressing on the server limits the document distribution to local participants if necessary) for ease and speed. Often in meetings (convened in rooms with browsers) brief updates can be accomplished by a brief visit to an up-to-date online document. The rapid inspection of figures, graphs of readings of short narratives can provide critical and timely updates in cross organizational communications.

Network Leaders

The technological and social systems used to enhance the leadership capacity of *network* leaders is complex. The systems supporting the effectiveness of network leaders is typically personal and/or social but there are trends toward shifting to technologically enhanced social structures for *network* leaders. Managing these technological structures to aid *network* leaders is the most challenging of the proposed formal structures, because by their very nature they defy formalizing. Despite that caveat, there are tips and approaches that work well to enhance the effectiveness of this type of leader.

If we agree that key *network* leaders' (such as untitled worker or peers who demonstrate leadership from within organizations) roles include local, supportive diverse goal activities, maintenance of informal communications systems, and grass-roots idea generation, then it is clear that IT can provide several specific types of aid for a leader engaged in these activities.

Again, the use of e-mail, Internet pages and listservs can provide support for various initiatives (specific goal activity, informal communication and grassroots idea generation) of a *network* leader. The formal use of e-mail lists by a network leader can often produce large swings in opinion and knowledge. Often the informal relationships that emerge to identify or facilitate an internal *network* leader are IT related. Often we are faced with an executive decision which requires us to turn to and rely on a network leader for implementation. Often there is embedded in our organizations an expert who is often more directly reachable by IT methods than by traditional face to face methods. Conversely, the *network* leader often prefers, through tradition or experience, to address individuals or groups via IT.

This is in no way an exhaustive list or a detailed description of the specifics of the formal structures that support the three types of leaders. These glimpses provide an overview and brief descriptions of the types of formal structures that have been found to work well in some specific settings.

IT Leadership Hypothesis (A Theory of IT Facilitated Leadership)

This attempt at a brief formal description of the features of an IT enhanced theory of leadership. It builds on the construction of three types of described by Senge (1996), incorporates the six features of Gardner's (1995) descriptions of leaders and is combined with the spectrum of IT use described by Brown (1996). It is also influenced by my interpretation of IT's impact on characteristics of leaders.

Gardner's six features of leadership are Story, Audience, Organization, Embodiment, Indirect versus Direct modes, and Expertise. Story & Audience and are features of a leaders sphere of influence. Story generally only applies to *executive* leaders in this construction. Story has very little application to *line* or *network* leaders. Organization, Embodiment, Direct and Indirect modes, and Expertise are features common to all types of leader. Embodiment is the degree to which the leaders are consistent and is identified with the messages they portray. Direct and indirect modes of leadership describe the extent to which a leaders influence is within his or her area of expertise. For example, Dr. Martin Luther King's influence was through his civic activism. His original area of leadership was church related, yet his major influence on America was not through his original organizational constituency, therefore his leadership path was indirect. Einstein and Feynman are examples of leaders whose influence was also indirect. Statesmen and politicians are typically viewed as direct leaders in that their chosen path is associated with their influences. Jimmy Carter holds a Ph.D. in atomic physics and did not gain influence indirectly through his expertise in physics, thus his was direct leadership, while Ronald Regan might be described as having come indirectly to power through proficiency in acting thus his leadership might have been described as indirect. Due to this distinction I equate the elements of Expertise with Indirect leaders while I equate the element of Organization with Direct leaders. I recognize that this distinction is an oversimplification.

Originally proposed as a description of instructional uses of Information Technology, the PIG mode described by Brown (1996) outlines escalating uses of multimedia as three points of use along a continuum: Presentation, Interaction, and Generation--or PIG. The first is demonstrated through Presentational use of IT on the World Wide

Web as a broad or narrowcast medium. Presentation uses include direct e-mail and top-down shared document environments. Interactive use of IT includes prepared WWW interactive forms, shared document environments as well as conventional e-mail use. Interactive forms if IT use are more than simple data collection or forms submission. Interactive IT uses include creation and production of working documents, mission statements and project outcomes or solutions. Closely related to Interaction, IT use that generates ideas, products or solutions is Generative. Generative use if IT includes collaborative shared document systems applied toward problem solving, or interactive decision making systems.

The following matrix outlines the relationships between different types of leaders, their use of or attention to, Gardner's six features of leadership (in italics), and the correlating levels or relative importance of the different types of IT use (P, I , or G).

This model is offered in the same spirit as Gardner did in his work *Leading Minds* (1995, p 297). He says, "I fully expect that studies of other leaders - direct or indirect, or a Monnet-like amalgam of these two species - will undermine certain generalizations and give rise to many others. Thus scholarship advances. Rather than fearing such refutations or modifications, I welcome them."

I offer my outline of the interaction between types of leaders, IT uses and six features of leadership as a theoretical framework for exploring the complex interaction of IT and leadership. This work is presented, not as an answer, but as a framework for asking a question, a question about leadership in a time when the symbiosis between man and IT is becoming more and more evident.

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Table 2.
Overview of IT Leadership Hypothesis and the predominate use of IT types across the PIG Continuum

Leaders	Executive	Line	Network
Indirect/ Expertise	G with minor I	I	P with minor I
Direct/ Organization	G & P for Inter-Agency"Story"	I & G	P through G
Features	P with *Audience & Embodiment* through P	I with *Audience & Embodiment* through I	G with *Audience & Embodiment* through G

Note: P = Presentational IT use, I = Interactive IT use, and G = Generative IT use.)

How Administrator James Wears Technological Hats to the Giant Peach Schoolhouse

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Ask any child, "Who is responsible for those Chrysler ads, "Either Lead, Follow or get out of the Way, " and he might answer "James from the *Giant Peach* story." Ask any adult and he will probably answer, "Lee Iococca." Iococca is one of a growing number of charismatic, messianic CEO's who, some claim, are motivated by a desire to create a fame or glory niche through a revolution they cause in their respective industries. Such charismatic leaders, others claim, are *born with* the skills to lead. They maintain that such skills are neither taught in the schools, nor caught on the job. In a true sense, James came to the Giant Peach with all the skills necessary to lead the menagerie of animals within this "time-bomb" peach to safety.

Many maintain however that leadership can be *taught*, that there are certain steps or elements or stages which, if put into practice, will insure that a business or school will be successful. The very successful Harvard Business school has a tight curriculum based on case study which it believes prepares leaders of tomorrow. If they thought that the scenario of James delivering the Giant Peach to safe port was replicable in business, they might use his as a case for discussion. However if teaching leadership is necessary to it would be difficult to explain how James used the many skills of the menagerie, and in the end was honored with the large monument in Manhattan.

Many maintain that leadership is *caught* on the job; that great Presidents would have been mediocre if the situation or crisis had not confronted them in office. The potential leader can walk a journey between hands on control or shared control; between taking credit and giving credit for success; between blaming others for failure, or assuming responsibility for failure himself.

Whether leadership is innate, taught or caught, Suters (1992) maintains it is critical to know what leadership is, and it is just as critical to know when you are leading and when you are not. When you are leading you are not producing results, but supporting others who are.

What Leaders Do, and How They Do It

In his book, *the Unnatural Act of Management*, Suters (1992) claims there are two main functions of leadership, planning *objectives*, and their execution, and planning *strategies*, the organization of resources, staffing, communicating, monitoring and enveloping associates. Suters then describes how the leader in business accomplish their work by quoting a plaque which illustrates the vision of Lao-Tzu:

> As for the best leaders, the people do not notice their existence. The next best, the people honor and praise. The next, the people fear, and the next, the people hate... When the leader's work is done, the people say, 'We did it ourselves.' (p. 59)

Assessing Leadership

There are many sources for leadership, motivations for a leader, many functions of leadership, and many ways of assessing success. The old school claims you can assess the effectiveness of a leader by how well his followers enthusiastically *pursue a goal* to success, while believing that they did it themselves.

The Gameplayers' Needs

When the Harvard Business school investigated major quality manufacturers in the auto industry in the United States they found four elements which were benchmarks. And all of these elements focused on the *workers*:

> Many experts believe that it is rooted in their sensitive organizational behavior management policies. Nissan and Honda workers are made to feel that they are important, that they have a say in how things are done, that their skill and attention to product quality is the key to their company's success, and that if the company prospers, everyone will share the profits. (Kelly & Kelly, 1986, p. 52)

Harvard discovered that leaders of quality industry are concerned about their product, but also pay attention to the needs of a major game player in their industry, the worker. If the needs of the workers in the schools, the faculty and staff are to be realized Glasser (1992) suggests *lead* management rather than *boss* management:

> The crucial difference between boss managers and lead managers is mainly in how they understand motivation. Bosses refuse to accept that they cannot "motivate" the workers with what they believe will cause the workers pain or give them pleasure, especially when they also believe that what they are asking is good for the workers. Following this belief, bosses constantly look for new sanctions or rewards to "make" the workers work. Leaders, on the other hand, know that they cannot make the workers work hard if the work is seen as unsatisfying or they are seen as unconcerned about the workers needs. (Glasser, 1992, p. 43)

But what about the workers in the schools? In so much of the reform in today's schools, the *teacher* is the focus of the problem. In many areas of the country, teachers were tested at great expense. The assumption was that if we remove our problem teachers, the schools will become great. These gameplayers were considered the culprits.

Since that initial testing a computer revolution has occurred. Society has seen the need for providing technology to the schools, a need for tying all schools to the "Information Superhighway." Savvy administrators who are not sure what the equipment should do, have furnished schools with a great deal of equipment and provided little training, and more often than not blame the teacher for failing to use the equipment effectively.

Douglas McGregor (1960) in *The Human Side of Enterprise* explained one myth behind this attack on teachers. What McGregor concluded from a study of management programs was Theory X "the average human being has an inherent dislike of work and will avoid it if he can." His Theory Y maintains that the average worker finds work "as natural as play or rest." McGregor maintains that General Mills success was based on the second vision of workers. When applied to schools, Theory X develops programs to weed out those average "lazy" teachers. Theory Y finds ways to support and enhance the work of all teachers who find their work as play. The focus in the above approaches is on one gameplayer, the worker.

Applying the Harvard benchmarks to teachers can we say that they are made to feel important, have a say in how things are done, see their skill and attention to quality as a key to school success, and feel that if the school succeeds they will share the rewards?

In a *Place Called School* (1984), U.C.L.A.'s John Goodlad found that parents as well as teachers and students considered the most important goal of the schools intellectual, although they also concurred with teachers and students in considering personal, vocational and social goals as very important. He concluded:

> Our data thus show no withering in goal commitments by the parent group we sampled, and indeed I do not know of serious studies that come up with a narrow list of parental expectations for schools. When it comes to education, it appears that most parents want their children to have it all. (p.39)

Often parents in schools are neglected as game players. The needs of parents in those schools are frequently not recognized. Applying the Harvard benchmarks to parents can we say that they are made to feel important, have a say in how things are done, see their skill and attention to quality as a key to school success, and feel that if the school succeeds they will share the rewards?

And if the needs of parents are unimportant, in the non quality schools the *needs of students* are also neglected.

> For the less advantaged, boss-management both at home and in school is a double disaster: First, such students have learned fewer need-satisfying behaviors than children from advantaged homes, and they come to school both less willing and less able to do the work. They are, therefore , more easily frustrated. This means that almost from the start they do not do as well in school, even though they are inherently just as capable as the advantaged students who do better. (Glasser, 1992, p. 50.)

And yet, even those students who have learned need-satisfying behaviors find it very difficult to survive in a school in which authority protects its *territory* and is threatened by children who can think for themselves.

Applying the Harvard benchmarks to students can we say that they are made to feel important, have a say in how things are done, see their skill and attention to quality as a key to school success, and feel that if the school succeeds they will share the rewards?

In the above approaches schools are fragmented. Focusing on one gameplayer has been the problem of the schools in the past. Odiome (1990) speaks of the trustee theory of management which involves concern for *all the gameplayers* in industry, workers, stockholders, consumers, suppliers and managers.

In the schools the local community has come to expect a quality product in intellectual growth of children. And this intellectual growth is measured in only one area, ability to score well on standardized tests. But who are the game players in the schools? As in industry gameplayers are the workers, teachers and staff; stockholders and consumers are the local community, suppliers are the community and the parents or guardians in particular. The product is growth in children and not just the intellectual growth measurable on a standardized test; the product is growth in children but also in *all of the gameplayers.* And the managers are those leaders in the schools who are expected to serve as trustees of it all. In the end applying the Harvard benchmarks to all the gameplayers can we say that *all the gameplayers* are made to feel important, have a say in how things are done, see their skill and attention to quality as a key to school success, and feel that if the school succeeds they will share the rewards?

The Our Team Good Guys Bad Guys Myth

In a recent work on leadership, *Leading with Soul: an Uncommon Journey of Spirit* (1995), the authors list a group of misconceptions of leadership. The major common denominator in all of these is an adversarial relationship, or a dichotomy between opposites. The authors criticize those who claim leadership is waging war, championing a cause, changing history, or following recipes. They criticize the expanded *dichotomies* of male-female, work-play, career-family, thinking-feeling. The authors add that we make too much of heroes, and that rather we should begin with ourselves (soul) but not by ourselves (spirit).

Few will deny that many schools stand in an adversarial relationship with parents, students and teachers. The task of the school leader is to turn this relationship around. The wise principal will think of the many opportunities to bring parents, students, teachers, staff, parents, the school board and the community, all of which are good guys, together. The implementation of technology can be the vehicle for bringing all the gameplayers together through communal planning. When all the gameplayers see their own needs addressed through a collaborative vision with shared ownership for its realization.

The Our Team Winning or Our Team Losing Myth

The *Good-Guys Bad Guys myth* is destructive in planning and implementing vision. In addition the *Our Team-Their Team* myth can also be a major obstacle to success. The school reform lobbies, and newspaper journalists have set school against school, and district against district in comparing ability to do well on tests. A magnificent plan and collaborative strategies can be undermined by a need to do well on state tests, a very limited measurement of success, indeed. The great leader, like James in the Giant Peach, knows the importance of his local community and all its gameplayers. Unconcerned about who gets the credit for the success he will do what he can to fulfill the needs of the teachers, students, parents and communities. A great leader knows that his online people, the teachers are closest to the needs of students. Teachers, the on- line workers, intuitively know what works, what is needed to fulfill the needs of their students, parents and communities.

If we set dreams and visions and goals together, and see that we all win by doing our best, we needn't ask about winning and losing. If we could see that the only losing is when we fail to realize the greatness in all of the gameplayers, we would be better motivated. Norman Lear (1984), the successful director of leading network shows has this to say about how we teach our children:

> We have been raising generations of children to think that there is nothing between winning and losing. The notion that life has everything to do with succeeding at the level of doing one's best is lost to these kids. If we really believe that we are on the planet for the long term, we will encourage our youth to understand that not everyone catches the brass ring on the carousel of life. The rest of us better enjoy the ride for its own sake, or life has no meaning at all. (p.E 23)

The Goal Line Myth

So often in planning we limit our dreams, and visions and goals to short term objectives. We are too often satisfied with minimal results. The secret is to involve all the gameplayers in owning a wide vision, developed by themselves, and the realization of that vision through strategies developed by themselves.

The vision must be *wide*. The wise leader will provide opportunities for all the gameplayers to share in a wide vision, a vision wider than some technologies and wider than some needs of some constituents. Some, in dealing with technologies, would limit the vision to their favorite technologies and to some gameplayers. Others would limit the vision to the five computer competencies; from word processing, to desk top publishing, to presentation software, to multimedia, to network surfing, and would limit the needs to those of students. I suggest including all Media possibilities from the early technologies such as overheads, slide projectors and filmstrip projectors, and from the five computer technologies to the range of distance learning possibilities. I suggest addressing the needs of the students, teachers, staff, parents, and all the gameplayers in the community. Each of the gameplayers can choose the technology they wish to use and identify the need it will address. A community with minimal resources as well as a community with great resources can plan the same dreams. And to the extent all the gameplayers are involved in the decisions, to that extent they will do what it takes to realize them.

Many of the gameplayers in the community have felt isolated from and unrecognized by the community. In *The Cry for Myth* , Rollo May (1991) describes the contemporary American as one who like the salesman, Willy, in *Death of a Salesman*, does not know who he is. He is caught up with the business of being a number one salesman and forgets *who he is* as a person:

> The endeavor to find the myth of our identity is shown in the way we, like Willy, sell ourselves- our work, our ideas, our efforts, even as it involves, as with Willy, a shine on our shoes and a smile on our face. And we may find one way or another when our myths let us down, that 'we never knew who we were.'(p. 44)

We may see that the only goal in life is to sell ourselves. This involvement by the community can enable all of us gameplayers to find our very selves through working with others in the community. We may be limited to a goal which takes us nowhere. Or we may allow our dreams to take us everywhere . In his chapter, "Dreams are Goals with Wings, " Kriegel and Patler (1991) sees goal planning and achieving as important but limiting:

> The key to sustained performance is finding something larger than a goal, something bigger to shoot for. Something that moves you. A dream you can chase. A vision that inspires... when *we* have a dream and pursue it, nothing is impossible. *We* tap into power, personal resources, and creativity that we never thought we had. *We* can accomplish what had previously considered impossible. In the process *we* discover that the biggest limit is our mind telling us what our limits are. (p. 35,7)

All the Way Home

Doesn't "This little piggy went to market" end with "This little piggy had roast beef and cried *wee, wee, wee* all the way home"? Both the planning of vision and the implementation of the strategies will enable *us as a team* to transform a school and a community. The presence in the community of all the gameplayers will insure that some 'mythtakes' are seen for what they are: limited vision.

Mythtakes:

Administrators alone should get the credit or the blame for success or failure.

The vision and curriculum of the school are the responsibility of administrators alone.

The business of the schools is limited to the teaching of children.

The curriculum should focus on intellectual growth alone.

The old ways of teaching worked in the past, why not now?

The classrooms environment has little to do with learning.

The only valid technology for use in schools is computer technology.

The job of the schools is not to entertain children.

Staff training is unimportant; parent education is unimportant.

Available money determines the vision of the schools.

Teaching moves from education to entertainment as the video screen moves beyond 25".

Teachers and children need competencies in technology; parents do not.

A Mission for Tomorrow

General George Marshall, whom President Truman called America's greatest general, once said that there is so much we can accomplish if we are unconcerned about who gets the credit. He added that when constituents devote all their efforts to accomplishing one goal "all will go well with America, but just as soon as ulterior purpose or motive creeps in, then the trouble starts and will gather momentum like a snowball." (Bland, 1986, p. 616)

If we are to make the schools exciting environments for learning for the whole community we must plan together with objectives, goals and dreams; we must involve all the gameplayers. James provided reactive crisis leadership by involving different insects and animals in salvaging the large peach. However, today's administrator needs to act proactively, engaging the whole community if the Giant Peach School House is to celebrate powerful learning opportunities!

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An Analytical Review Of Web Sites Related To The Planning, Administration And Management Of Technological Innovations In Education

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This paper will identify and examine specific Internet sites that allow school technology leaders and other educators to quickly and easily locate the information they need related to the effective implementation of technology in schools. The sites have been placed into categories for ease of use. These categories include Lists of Web Resources Created for Technology Coordinators and School Library/Media Specialists, Internet Directories and Indexes on Technology and Schools, Specific Sites Related to Technology and School Restructuring / Reform, Specific Sites Related to Telecommunications and the Integration of Technology into the School Curriculum and Other Interesting Web Sites Related to Educational Technology. The first two categories include what can be considered gateway sites, that is web pages that identify or lead to other web sites. The remaining sections tend to link to sites containing more specific information.

The web pages described here can be accessed by connecting to this paper online at the following URL, which will be regularly updated: http://www.emI.jmu.edu/ TEIR/SITE97.html. A related paper by the writer, *Finding the Best Web Sites for Educators*, can be accessed using the URL: http://www.jmu.edu/ TEIR /Web96.html. URLs for all reviewed sites will be found at the end of this paper.

Lists of Web Resources Created for Technology Coordinators and School Library/Media Specialists

The following resources provide an efficient way of identifying a variety of web sites related to the effective and ongoing implementation of technology in schools.

The *Resource Page for Technology Coordinators* is an excellent site and is indispensable for school technology personnel. Because it is easy to use, contains links to all types of information, and is frequently updated, the *Resource Page for Technology Coordinators* is one of the best for every day use. It allows users to sign a register which enables other technology coordinators to contact them through e-mail.

When an in-depth exploration of a topic or issue is required, The Technology *Coordinators Home Page* provides an extensive bibliography of both print and online resources related to the job and responsibilities of the School Technology Coordinator. This site is well organized, comprehensive and one of the most descriptive on educational technology. This is evident in the section on *Educational Management Resources and Issues*, an area of interest to school administrators. Overall, The site complements the above web page as it includes references to many print documents and links to additional web sites.

Librarians Information Online Network (LION) is invaluable as an informative and comprehensive resource. Among the many sections related to educational technology, those on Automation for School Libraries , Internet Mailing Lists and Newsgroups for School Librarians, and Publishers and Library-Related Vendors are especially useful. The *School Librarian Web Pages* by Peter Milbury, and *School Library Hotspots* are two other helpful lists that complement the LION site.

General Internet Directories and Indexes

Several Internet directories and indexes provide listings of both general and specific categories on various areas of educational technology. They provide the searcher with a gateway for identifying useful information and can be especially helpful for persons unfamiliar with the field. Most of these directories and indexes are updated on a continuing or frequent basis and thus will be very current.

The *Yahoo Directory* , one of the first to be developed, still remains an excellent and comprehensive of available directories. The Education directory contains two categories of special interest to school technology personnel; Distance Learning, and Instructional Technology. The

Computers and Internet Directory includes catalogs on the Internet, Multimedia, and Personal Computers.

While not as inclusive as the Yahoo Directory, several sub-directories of the *Magellan Directory* contain useful information on educational technology, including Computing, Education, and the Internet. For interesting web sites in the latter section examine the categories of Cyberspace Issues and Fun and Funky. What makes this directory so helpful and unique are the reviews and ratings. The reviews can be accessed by clicking on the word, 'review'. The ratings are explained at the top of the directory by going to 'About Magellan'.

The *A2Z Directory* includes the 10% most popular sites on different subjects maintained by Lycos. It's subcategories are easy to use and provide many relevant documents arranged alphabetically. The 'Find Related Sites' option is especially helpful. Subject areas of interest to educational technology users include Computers, Education, and the Internet.

The *Argus Directory on Education* contains over 90 up-to-date hypertext directories on specific aspects of education that are maintained by individual librarians and educators. It has a worldwide emphasis and many directories are rated according to how helpful and comprehensive their listings are. One area that relates to educational technology is a comprehensive section on Distance Education. Under the Distance Learning heading are links to information on Project Based Education, Tele-collaboration, and Telecommunication. Within the Education section links to information on Teleconferencing, Research, Grants, Funding, Educational Resources, Educational Technology as well as Electronic Classrooms, Multimedia, Distance Education can be found.

The *U.S. Department of Education* web page provides extensive information not found elsewhere on the Internet. Sections that contain a lot of documents and sites related to educational technology include The Secretary's Initiatives, Publications and Products, and Other Sites. The latter includes a subsection on Federal Government Educational and Library Resources that links to such sites as the *Regional Technology in Education Consortia.* The South Central Consortium contains several interesting programs, including *TrackStar,* which allows the user to use and create interactive Internet-based learning materials in all subject areas.

The *WWW Virtual Library on Education* , the *WWW Virtual Library on Educational Technology*, and the *Education World Index* are selective collections of web sites on various aspects of education and technology. They are useful to the searcher who seeks general ideas of what is available on this topic. The category on Education and the Internet includes useful sites related to teaching with the Internet.

From the *Search the Internet with the Internet Sleuth* selecting *Computers* links the user to magazine and software databases that are not as easily found in other directories. In addition to the general *Computers* link there are links specifically for information on graphics, Mac, PC, and Unix among others. The site is also interesting for the controls that are used in the various search capabilities.

The *Technology Resources* section of *the Education Place Directory*, sponsored by the Houghton Mifflin Company, contains a very detailed listing of sites and provides an excellent introduction to and overview of many specific issues and concerns of interest to school technology leaders. These include Funding and Grant Information, Acceptable Use Policies, and Technology Plans (including assessment and staff development). There are also sections on Educational Technology-related Conferences (limited), Commercial resources, Online Journals and Magazines related to educational technology, Using the Internet, and a Glossary of Internet Terms.

Specific Sites Related to Technology and School Restructuring / Reform

EdWeb is a hypertext book that provides an interesting and flexible way to examine the many issues related to educational reform and information technology. It contains links to other resources and is a work-in-progress. A good place to begin.

Computers as Tutors: Solving the Crisis in Education is a more traditional book on this subject. It explores what we need to do to make computers the effective learning tools that they can be when used effectively by educators.

This list from the *Armadillo WWW server* has links to major documents from the past decade and current web sites that relate to technology and school reform.

Technology and Education Reform is a research project sponsored by the US Department of Education that examines nine school sites where school staff are active participants in using technology to promote educational reforms.

Constructivist issues are addressed well at two particular sites. The *Institute for Learning Technologies (ILT)* sponsors an interesting variety of large scale projects related to using technology and constructivist learning theories to achieve effective educational reforms. The *Instructional Technology Connections* page from the University of Colorado at Denver provides an extensive review of teaching, learning and the use of technology from a constructivist perspective. Links are offered to many interesting articles and curriculum resources.

Specific Sites Related to Telecommunications and the Integration of Technology into the School Curriculum

Classroom Connect and the *Global Schoolhouse* provide extensive resources to help educators locate and share experiences, curriculum ideas, and teaching materials related to using the Internet with students. Both are must-see sites. While you are at the Global Schoolhouse, examine the set of excellent articles on telecommunications in the classroom.

For specific ideas and activities on how students and teachers can use telecommunications see *Jill's Page for Educators!* created by Jill Tucker. The section on *Lesson Plans* and *Student Work* are valuable. They contain many exciting and practical uses of the Internet. The *Student Work* area includes examples of curriculum-based, student created html documents.

The *Web66* site also provides much needed information for educators to use the Internet for classroom activities and to link to other schools. Many ideas and resources are provided. A highly rated site.

The *Institute for the Transfer of Technology to Education* is a program of the National School Boards Association to promote the effective use of technology in public schools.

ICONnect, is sponsored by the American Association of School Librarians and provides several resources to help schools get connected to and effectively use the Internet for learning.

The *National School Network* Is a partnership of schools, museums small businesses, network service providers and others who are assisting schools in creating state-of-the-art applications for networking in education.

The *Center for Children and Technology* investigates the important roles that technology has in supporting and sustaining qualitative change in the nation's schools. It is a primary source for obtaining current research reports on educational technology in K-12 schools.

Teaching with Electronic Technology contains many links to higher education sites that provide information about conferences, publications, and general discussions of teaching with electronic technology.

Telecom Information Resources is a great site to visit with its over 2,000 links to information sources on the technical, economic, public policy and social aspects of telecommunications.

Other Interesting Web Sites Related to Educational Technology

Alliance for Technology Access provides information on Assistive Technologies.

Legal Copyright Issues Related to Web Site Management - contains many helpful and current articles on all aspects of copyright use and the Internet

My Keepers Page - Great quotes about education and technology

Your Own Web Guide by Electronic Learning Corp. is an interactive hypertext tutorial all about the different aspects of the World Wide Web. A great resource to use with persons new to the WWW.

Technology Planning Tools (from SCR-TEC) contains a variety of useful online tools and resources to help with integrating technology into schools - including decision aids, cost-modeling tools and computer lab layouts.

Valuable professional reading is provided on several sites. *From Now On - The Educational Technology Journal* contains lots of topics of interest to school technology leaders. You can subscribe for free. *Librarians On the Leading Edge - Librarians as Pilots, Information Mediators, Infotects and Curators* is a challenging article that examines the emerging roles of the school media specialist in the age of technology and the Internet. *Opening Minds With a New Set of Keys* is a thoughtful article that presents a brief, interesting, and easy to understand rationale for effectively using technology in schools

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Center for Children and Technology: http://www.edc.org/CCT/ccthome/

Classroom Connect: http://www.classroom.net/

Computers as Tutors: Solving the Crisis in Education: http://www.cris.com/~Faben1/

EdWeb: http://edweb.cnidr.org:90/

Education World: http://www.education-world.com

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Lesson Plans: http://trms.k12.ga.net/~jtucker/lessons/lessplan.html

Librarians Information Online Network (LION): http://www.libertynet.org/~lion/lion.html

Librarians On the Leading Edge - Librarians as Pilots, Information Mediators, Infotects and Curators: http://www.pacificrim.net/~mckenzie/nov96/thanks.html#Librarians

Magellan Directory: http://www.mckinley.com/browse_bd.cgi

National School Network: http://www.wam.umd.edu/~mlhall/teaching.html

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Opening Minds With a New Set of Keys: http://minot.com/~nansen/links/tech/opening_minds.html

Regional Technology in Education Consortia: http://www.rtec.org/

Resource Page for Technology Coordinators: http://cybergate.com/~blesig/hoffman/tech/tech_coord.html#12

School Librarian Web Pages: http://wombat.cusd.chico.k12.ca.us/~pmilbury/lib.html

School Library Hotspots: http://www.mbnet.mb.ca/~mstimson/text/hotspots.html

Student Work: http://trms.k12.ga.net/~jtucker/stwork/studwork.html

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WWW Virtual Library on Education: http://www.csu.edu.au/education/library.html

WWW Virtual Library on Educational Technology: *http://tecfa.unige.ch/*info-edu-comp.html

Web66: http://Web66.coled.umn.edu/

Yahoo: http://www.yahoo.com

Your Own Web Guide: http://scholastic.com/EL/guide/index.html

Send comments and suggestions for additional web sites to: dubenecw@jmu.edu

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INFORMATION LITERACY: KEY PLANNING TASKS FOR EDUCATIONAL PLANNERS

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UNESCO (1976) defines "literacy" as the ability "to read with understanding and to write simple messages related to his (or her) everyday life, and sometimes to do simple calculations" (p.62). While a debates continues as to the criteria for "understanding" and "simple", the term is often borrowed in other concepts such as "computer literacy" and "information literacy". Various international communities have attempted to identify essential competencies that constitute these concepts as they play increasingly an important role for the human development. This paper reviews the recent technological development and its influence on educational planning, and seeks to illustrate the notion of information literacy that is particularly of importance to the educational planners.

Evolution of "Single-Computing" in Education

The history of computer-based networking goes back to the 1950s when the first submarine cable was installed in the USA for the purpose of exchanging information. Since then, communication satellites have been put into orbit (1960s), and electronic mail, computer conferencing, and bulletin board systems have become available (1970s). These computer-based information exchange services have improved and expanded dramatically throughout the 1980s until it is now said that the online population of computer network users is exceeding 40 million people.

While all of these communication systems have taken full advantage of the latest information technologies, the field of education has, sadly, been adopting them very slowly. In broad terms, we may discern three main phases in which computer-based information technology has reached into the world of education in the following manner.

1. The 1970s were characterized by the computer as subject matter (that is, computer studies were concerned with teaching about computers as used by computer scientists);
2. The 1980s were characterized by the computer as an instructor of a specific subject (that is, computers were used as non-interactive drill and task masters for Computer-Assisted Instruction); and
3. The 1990s were characterized by the computer as an interactive all-purpose problem-solving tool (that is, among other things, the computer moved into interactive areas such as simulation, projection, and many forms of complex analysis).

The above evolution focused on users operating their computers in a "stand-alone" or individual learning environment.

The Emergence of "Networked-User Computing" in Education

The networking capability of the computer has been recognized recently as an effective strategy for establishing collaborative learning environments for mass education (see Figure 1). This movement from single-user skills (developed mostly through courses in "computer literacy") to networked-user skills (requiring knowledge and techniques beyond basic computer literacy, which may be described in broad terms as "information literacy") can clearly affect not only students and teachers, but also the world of educational planning. These trends have major implications for training programmes in any institutions in developing and industrialized countries specializing in educational planning and inevitably call for a general rethinking of not only their working style but also their curriculum content.

Many planning institutions in the world have successfully moved from computer literacy to information literacy by adopting the mixed use of interactive delivery systems. For example, network communication is used for the delivery of instruction, provision of support, exchanging views, etc. These institutions have identified some important networking tools in order to access information, share and disseminate knowledge, and learn collaboratively. These tools include: 1) sending and receiving e-mail messages with instructors, other trainees, and outside experts; 2) joining and using the news groups (or a bulletin board system) to share messages asynchronously at a public place; 3) participating in computer conferencing to communicate synchronously (real-time) in a virtual classroom or seminar; 4) navigating in the World-Wide Web environment to browse and access to inter-linked network of information; and 5) searching for and retrieving information on databases using research tools (Price, 1996).

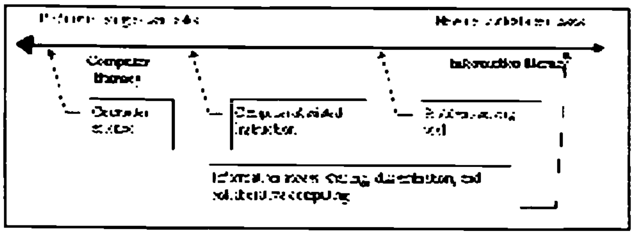

Figure 1. From computer literacy to information literacy.

Trends in Educational Planning

In the world of educational planning, an obvious major contribution of this trend of improved availability of relatively low-cost interactive technology has been the possibility to address one of the high-priority planning issues in many countries regarding the management of information systems. The rise of management of information systems is based on several trends on educational systems seen in the international community, especially in developing countries (Chapman, 1990):

1. Educational systems have been expanding rapidly in size and coverage;
2. Educational programmes have become more complex with manifold goals/objectives;
3. Pressure for more efficient use of resources has increased due to constrained financial support; and
4. Accountability requirement for the donor community has been increased.

Therefore, in many countries, having more and better information has been considered indispensable for sound decision-making in educational policies and practices.

New Role of Educational Planners

The UNESCO-IIEP Workshop on "Issues and Practices in Planning the Quality of Education", took place in Paris in November 1989. One of the most important ideas to emerge from that workshop was that all educational planners at different levels are required to manage different kinds of information in order to support sound decision-making in educational policies and practices (Ross & Mählck, 1990). This notion encourages the rethinking of the new role of educational planners as a "link agent" dealing with information between policymakers and the researchers. That is, the educational planners are now expected to: 1) be sensitive to the general concerns of policy makers; 2) operationalize these concerns into researchable questions; 3) build and manage information systems; 4) analyze and interpret educational information; and 5) provide policy options to address the policy concerns and to support the informed decision-making.

With this new role of educational planners, it is becoming increasingly important that planning institutes ensure that essential information literacy skills required for policy dialogue are taught in their educational planning curriculum. These important tasks might be considered to make up the concept of Educational Management of Information Systems (EMIS).

Framework for Educational Management of Information Systems

Figure 2 shows a conceptual framework for educational management of information systems. The system as a whole can be understood as a process of assuring informed decision-making on educational policy. At each stage, educational planners have an important role (Saito & DiasDaGraça, 1996).

Stage 1: Educational Management of Information Systems (EMIS) Context

At the first stage, educational planners can try to be sensitive toward general policy concerns that are considered high priority issues. Then they can transform these general concerns into either specific research questions or concrete daily planning inquiries.

Stage 2: Operationalization

Educational planners will break down the research questions into separate components to prepare "operationalized questions", and will identify necessary indicators in order to respond to the policy concerns.

Stage 3: Data Format and Source(s)

Planners will identify the level of aggregation for data and the format of data that are required in order to address the policy concerns. Some data may be available in paper format, other in electronic format. They will also decide whether data should be collected using a sample survey or population census.

Stage 4: Data Collection

If no data are available, data collection instruments are designed, and subsequently field data collection exercise will be conducted. If data are available on electronic form already, the data collection exercise will be done through "data retrieval" from diskettes, CD-ROMs, or online.

Stage 5: Database Building

If the field data collection is undertook, or if data are found on paper format, this is the stage to put them in the format that can be "read" by the computer. Planners can define the structure of the file with necessary variables, and enter/clean data.

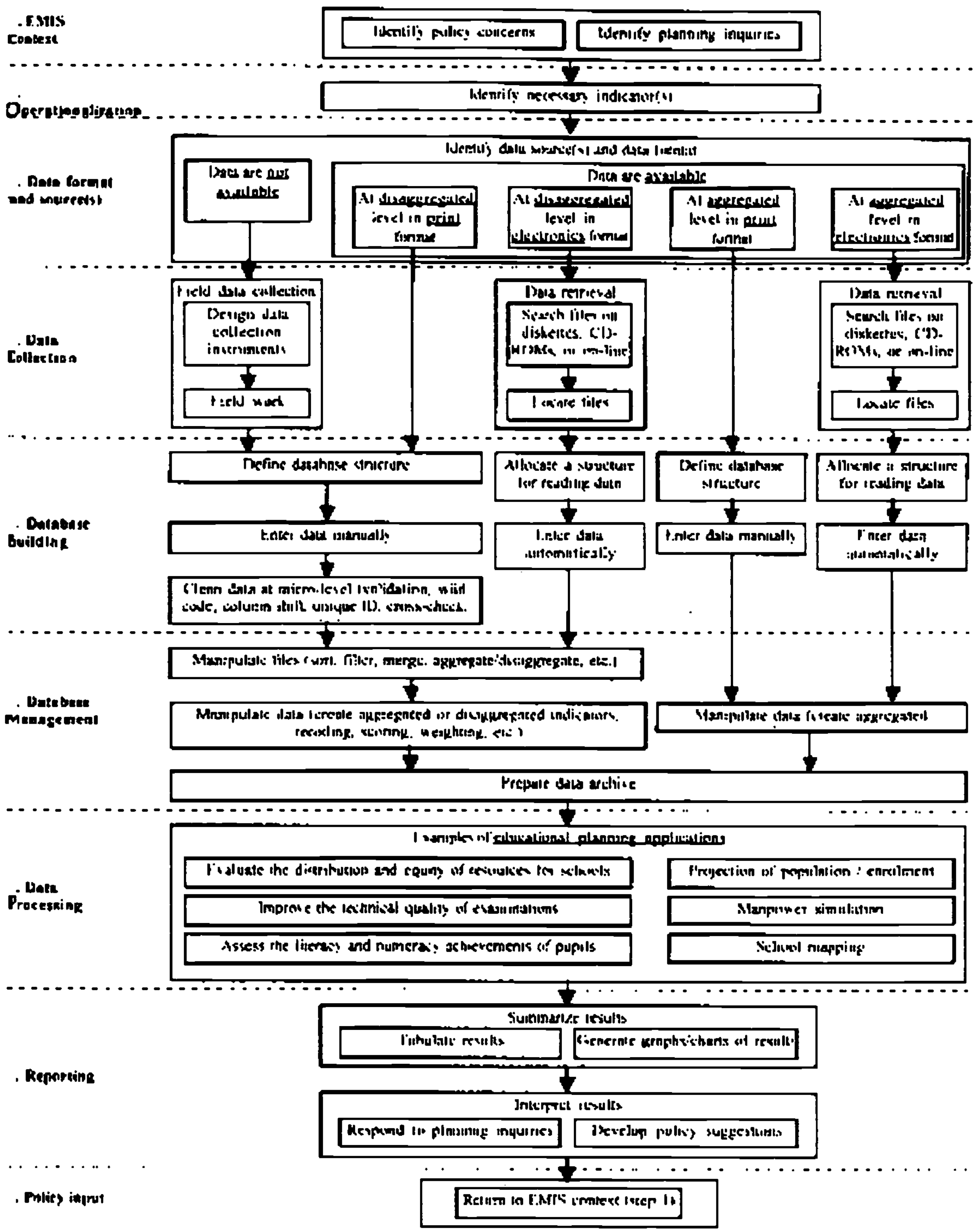

Figure 2: Conceptual Framework of EMIS

Table 1.
Objectives included in different levels of curriculum

Objectives	1	2	3
Module 1. EMIS Context			
a. Identify educational policy concerns that are considered by decision-makers to be high-priority issues.	✓	✓	✓
b. Identify specific planning inquiries and/or research questions that would help address the policy issues.	✓	✓	✓
Module 2. Operationalization			
a. Break down the research question into separate components and prepare operationalized questions dealing with which indicators, criteria, and detailed definition.	✓	✓	✓
b. Identify necessary indicators in tabulated form that are required to respond to the policy concerns, research questions, planning inquiries, or operationalized questions.	✓	✓	✓
Module 3. Data Format and Source(s)			
a. Decide the data level by assessing whether a given study calls for data at pupil, teacher, and/or school levels (the dis-aggregated levels) or district, region, and/or national levels (the aggregated levels).		✓	✓
b. Identify the format (for example, print or electronic media) of the data that are available.			✓
c. Decide whether data should be collected using a sample survey or population census by taking into account the size of the country and the financial constraints.			✓
Module 4. Data Collection			
a. Design data collection instruments (questionnairesand/or tests) for each source of data.			✓
b. Identify the important steps involved in undertaking field data collection such as printing instruments, arranging transport, informing schools, administering tests/questionnaires, training data collectors, etc.			✓
c. Retrieve aggregated or dis-aggregated data that are available on-line, CD-ROM or diskette.			✓
Module 5. Database Building			
a. Define database structure by identifying essential files, their unit of analysis, and their hierarchical relationships.	✓	✓	✓
b. Define database structure by identifying the information elements on fields that form the building blocks of a database.	✓	✓	✓
c. Define database structure by identifying the different attributes (name, type, length, etc.) of variables.	✓	✓	✓
d. Design the data quality check by providing validation rules for acceptable variable values.	✓	✓	✓
e. Design an on-screen data entry form which is identical to the paper form questionnaire so that data entry error is minimized.	✓	✓	✓
f. Identify the important steps involved in entering data into storage on a computer using an interactive data-entry software.	✓	✓	✓
g. Check that each identification number on the key variable is unique.	✓	✓	✓
h. Check that no "column shift" has occurred during the data entry stage.			✓
i. Identify and correct "wild", or unrealistic extremes for variable values in a given educational context.	✓	✓	✓
j. Cross-check values between variables in order to avoid contradictory responses.		✓	✓
Module 6. Database Management			
a. Manipulate files by sorting information on pupils, schools, or teachers in order to facilitate retrieval.	✓	✓	✓
b. Manipulate files by selecting a subset of cases on a data file.	✓	✓	✓
c. Manipulate files by selecting only a part of all the available information in a data file.	✓	✓	✓
d. Aggregate information and create a new aggregated data file containing means, totals, and standard deviations.		✓	✓
e. Work with multiple files by adding cases.		✓	✓
f. Work with multiple files by adding variables to link information about different variables.		✓	✓
g. Work with a relational database that permits data from different sources and levels of aggregation to be used in the same analysis.		✓	✓
h. Manipulate data by re-coding for the management of missing data. (Including re-coding to means, modes, "hot-decking, and regression methods).			✓
i. Re-code the values of variables in order to create categories from a continuous variable or to estimate the value of a continuous variable by using the mid points of categories.			✓
j. Construct new composite variables using existing variables.	✓	✓	✓

Table 1. (continued from previous page)

Objectives	1	2	3
Module 7. Data Processing			
a. Conduct a descriptive analysis based on a set of education data regarding inputs to school, pupils achievement, etc. in order to examine the level, observe changes, compare against criteria, or analyze the disparity and equity.	✓	✓	✓
b. Improve the technical quality of examinations by analyzing test items, reviewing and rewriting test items, and analyzing curriculum.			✓
c. Conduct a correlational analysis between two variablesbased on a set of educational data.			✓
d. Conduct a regression analysis to identify the impact of a set of selected independent variables on the dependent variable based on a set of educational data.			✓
e. Conduct a path analysis in order to study the relationship among a number of factors and their individual and overall impact on the dependent variable based on a set of educational data.			✓
f. Estimate school age population by single year by using the Sprague multipliers method.			✓
g. Calculate indicators of access and participation, internal efficiency, resource utilization, and measures of disparities, based on given data, in order to diagnose the educational situation.	✓	✓	✓
h. Project population based on simple mathematical formulae or complex demographic theories.			✓
i. Project enrolment by calculating the trend of enrolment on a few years in the past and to estimate it for the next year enrolment in order to identify the resource needs.		✓	✓
j. Use a simulation model to test several hypotheses or scenarios to project school enrolment, financial aspect, and manpower requirement.		✓	✓
k. Prepare a prospective map which proposes new schools and/or classrooms based on the analysis of zonal disparities combining several indicators.			✓
Module 8. Reporting			
a. Produce a document of moderate length that is in a style appropriate for policy or research reports.			✓
b. Produce a document or computerized visual presentation that include graphs that summarize data in a manner that ensures better communication of the meaning of the data.	✓	✓	✓
c. Produce a document with policy interpretation in order to formulate policy suggestions.		✓	✓
Module 9. Policy Input			
a. Make data accessible in the electronic format.			✓
b. Share reports with the decision makers through Policy forum.		✓	✓

Note: 1 = A five-day module 2 = A two-week workshop 3 = A semester-long course

Stage 6: Database Management

Using the database created or retrieved electronically, planners will manipulate files (sort, filter, aggregate, merge, etc.), and manipulate data (re-coding, creating variables, etc.). This is also the moment to "archive" the data for the future use.

Stage 7: Data Processing

Several process can take place at this stage. One example is the use of data (mostly aggregated data) for projection and simulation. Another example is to conduct statistical analysis using dis-aggregated data to examine the level, compare the mean, analyze the relationship between two variables, identifying the cause/effect, etc.

Stage 8: Reporting

Based on the data processing, educational planners will summarize the results by using tabulation or graphs/charts in order to prepare a report which better communicates the results. The report could be prepared as a research report, an indicators report, or a policy document.

Stage 9: Policy Input

As a feedback loop, educational planners will share reports with the decision makers through policy forum. The report should provide some policy options that can be chosen for better informed decision-making.

Scenarios for Potential Curriculum

This suggested framework provides a skeleton for a modularized curriculum for Educational Management of Information Systems. That is, the system as a whole can constitute a comprehensive curriculum for EMIS, and at the same time, each stage of a system is a building block and can form a "module". These various modules can then be identified and assembled to make a course. Within the suggested framework of EMIS, generally three different scenarios can be considered depending on the context: 1) a five-day module 2) a two-week workshop; or 3) a semester-long course (see Table 1).

Curriculum for a Five-Day Module

A five-day module could be a part of a continuous annual training course designed for practicing educational planners. Different "modules" are presented at different times of the year; this module can be offered within the first quarter. The trainees must have used computers to perform basic operations. They must have basic understanding of educational planning terms/jargon, and concept of "first-level" indicators on access, efficiency, and resource management. The suggested contact time for this module is 20 hours. A special emphasis is placed on the important role that educational planners can play at the front end in the identification of policy concerns and transformation of the policy into specific indicators. Regarding the technical aspect, more stress is placed on building and manipulating the database system rather than complex statistical analysis.

Curriculum for a Two-Week Workshop

This workshop can be presented as a stand-alone intensive course independent from a regular training programme. The contact time would be approximately 30 hours. Greater heterogeneity can be expected in terms of the participants' computer competencies. Therefore, more time should be allocated to the introductory part than the five-day course as part of the annual training programme. In the two-week intensive workshop, while the identification of information needs and the policy input are portrayed as one of the most important planner's role, increased stress is placed on the important distinction between aggregated data and dis-aggregated data and their consequence in the type of data processing possibilities.

Curriculum for a Semester-Long Course

This type of course is normally seen at any tertiary institutions. Contact time increases to 40 to 50 hours spread throughout the semester. This type of course is ideal when presented as a streamed "information literacy" course which is parallel with other courses. That is, the course on Educational Management of Information Systems can be considered as extra insertion points with appropriate timing to enhance various types of educational planning tasks presented in other courses.

Conclusion

The convergence of technology has influenced not only the media and communication, but also the world of education, more specifically educational planning. This development has an implication on how and what educational planning institutions can teach in terms of both the content and the method for training programmes in the area of educational planning.

The curriculum should address the important aspect of "information literacy", that is, information literacy required for policy dialogue. All training in this area must focus on the knowledge and skills that educational planners require in order to adopt the role of a "link agent" — operating between educational policy makers and educational researchers. Trainers and curriculum designers at educational planning institutions should be able to choose the knowledge and skills to be included in the curriculum according to the budget/time to be spent on the course and the complexity that need to be covered in the course.

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Researching IT's Assistance to Teaching and Learning in Higher Education

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There is no question that Information Technology is affecting most sectors of our society, but what is its role in teaching and learning in higher education? Some suggest that IT could bridge the gap in helping countries such as the United Kingdom (UK) to afford the high participation rates that we need to turn our information society into a learning society. Others suggest that the costs outweigh the benefits. The Higher Education Funding Council for England commissioned a six month research study into IT assisted teaching and learning in HE (ITATL) in order to inform the Council. While the original specification was rather ambitious, timely results were essential. This is due to the current review of Higher Education in the UK led by Sir Ron Dearing, which is due to report in July 1997. Therefore, the research study's final consolidated report will be validated against an invited seminar of policy makers in January 1997 before its wider publication.

Background of the Study

The research study is directed by Professor Niki Davis in the University of Exeter School of Education Consortium for Educational Telematics (COTE). The Exeter consortium has a long history of research and development in this area. For example they were a key institution in the national project to` improve IT in UK initial teacher education (INTENT) and have undertaken projects within the UK Teaching and Learning with Technology Programme (TLTP), the Joint Information Systems Committee's New Technologies Initiative and for the Department For Education and Employment. They also work closely with several major companies including British Telecom PLC and ICL. The economics team have been involved the TLTP programme and commercial organisations.

The research team is multi-disciplinary, multi-site and multinational. The principal researchers roughly split into educational and economic researchers. Both have collaborated on all aspects of the project, which provides an almost three dimensional view for the study. Colleagues in the USA, the European continent and Australasia have helped set the study within an international context too. The principal researchers and their institutionsinclude: Niki Davis, Penni Tearle and team: Consortium of Telematics for Education (COTE) University of Exeter, UK; Patrick Dillon:University of Reading, UK; and Steve Ehrmann: Annenburg CPB Project, Washington, DC,USA.

Literature Review, Including International Comparison

The literature review has been led by Dr. Patrick Dillon. Many publications were used in detail, including Diana Laurillard's seminal book "Rethinking university teaching." and a book edited by the first author with Bridget Somekh on the effective use of IT in teacher education (Somekh & Davis, 1977). The team has also used the grey literature which is not freely accessible, even over the Internet. By grey literature we mean papers that have been written for local consumption within universities and other organisations. These have included course evaluations or reviews, where IT is discussed. Policy documents which underpin the delivery of IT or teaching and learning within a department or institution. We have also collected views on the most important parts of this field from other parts of the world. Analysis of the recent articles influencing practitioners' thinking showed no generalisable characteristics, but it was noteworthy for range and diversity.

The journal *Educational Technology Abstracts* was analyzed to determine the main themes reported in the literature over the last five years for a relative index of 'scholarly effort' (2143 abstracts). The major *primary focus* found was instructional media. There was significantly less effort on learning, assessment and relatively little effort on instructional resources. The *secondary* focus was more on tools, applications, and teaching. There were considerably more papers on research and development than on superficial examination. CD ROM and 'multimedia' together represented the largest grouping of instructional media covered, although there was a relatively large amount of research and development in audiovisual and broadcast. Internet and communications were still emergent. There was a dominance of computer-based over telecommunications-based and the items on instructional design were numerous.

There was a wide range of research and development in teaching and learning, especially evaluation. The relationship between instructional design and topic, such as teaching, was significant. Analysis of subject applications showed a predominance of subjects where: routine or mechanical skills play an important part; or the knowledge component can be precisely specified or there is a well defined professional base. There was poor representation of creative and performing arts and subjects where skills/knowledge is less easily defined and/ or specified.

Case Studies of IT Use Within Programmes of Study in HE

The literature review provides an overview of the field as reported by others. We have also captured and documented a small sample of case studies to provide a set of rich descriptions of the ways in which IT can be used in a range of disciplines and institutions. Given the time constraints it has not been possible to take strictly comparable cases, but the important theme is to bring alive the issues which arise when IT is used to assist teaching and/or learning, and the associated costs and benefits.

A range of themes from literature can be seen in our six case studies:

- Merging market sectors where higher education links to leisure, commerce or other phases of education.
- There is a trend towards increased networking between several organisations, not just universities.
- Educational contexts change when IT is employed.
- Higher order cognitive processes can be significantly enhanced.
- Authenticity and transferable skills can also be significantly enhanced.

Issues also arise:

- Management of innovation and information is required, but is often absent.
- ITATL is in response to pressure, but the cause of the pressure varies.
- Overarching models of teaching, learning and management are not tested.

This paper will only briefly describe two case studies where IT was used to assist teaching and learning in a course. Readers should refer to the final report which is available from COTE in the University of Exeter (Davis et al, in preparation).

A Course in Orthodontics in the University of Bristol Dental School

Multimedia CAL with high quality images (of people with open mouths showing their teeth), simulations of a variety of processes and dental procedures and self test assessment was created to replace seminars in an existing course in orthodontics. The quality is high and it is linked to the student's text book, which is the standard in the field, at least in Europe. The leader of this development and the person who specified the style and content is Professor Chris Stephens. Significantly, he is also one of the editors of the text book and he has over ten year's experience in developing IT in teaching and learning, having been involved with the development of an expert system earlier. The creation of the CAL materials have been funded by several sources, including funds from the publisher of the text book which have been used to pay the writer of the CAL software. Central assistance was available to digitize the medical images. Students use the material in an open access lab near the library and the software is on the LAN. The learning is structured on the cases that the students encounter in their laboratory work. Assistance to develop expert orthodontics knowledge and skills are provided during these practicals. The pressure driving this development, according to Professor Stephens, arose from the lack of expertise in the UK in this subject and the need to create a new masters course to address the shortfall. The loss of seminar courses, during which specialist staff demonstrated techniques, has permitted the delivery of an additional masters programme for about ten students who use the same CAL materials at their level. Professor Stephens feels that it may also be possible for practising dentists to use a version of materials in their dental surgeries to learn 'on the job' in the future.

The UK Open University Postgraduate Certificate of Education

This is a part time course over eighteen months which students study at home and in two local schools. IT assistance to teaching and learning is provided in several ways, including the loan of a personal computer with modem, printer and computer conferencing software and an integrated package including a word processor and database called ClarisWorks (Selinger, 1997). Our study reviewed the case for electronic communications (First

Class), which included personal e-mail. The 1,000 student teachers in 1995 were surveyed at the end of their course. They had found the computer conferencing valuable in helping them, as remote students, feel part of a university community. The computer conferencing had been perceived as most useful for information. Reflection on their practice as teachers was about half way down the list and valued by approximately 30% of the sample. It was not a compulsory element of the course because the Open University's policy is to provide information in a variety of forms and to permit the student to choose the one most suited to their needs.

It should be noted that this course was new and did not have to fit in with existing structures. In addition, it was given special dispensation by the government bodies, who valued it particularly for its ability to train teachers to work in more remote locations where there were shortages of teachers. Networking of organisations was evident in two ways: staff from other institutions and schools act as local tutors and collaborating school staff attend mentor training provided by other universities. It was notable that the course was created by a multi-disciplinary team which included an educational technologist

Economic Assessment

The review of the literature showed that costs were almost always unclear and that benefits were even less clear. Opportunity appeared to be important. Although many papers suggested that economies of scale would occur tomorrow, the IT rarely persisted for a long time. Either the IT platforms or the subject matter was subject to change in a few years, or even annually. Estimating value for costs and benefits is at an early stage. The multilayered approach required can be considered to be in concentric circles moving from the centre outwards in this order: learner, teacher, department, organisation, the social system (including regional and national government). Costs can be either private or public and be assigned to one or more of the many of the actors in these layers. This is explained in more detail in our final report. Early evidence from case studies suggests a three way model:

1. No economic benefits, or
2. Benefits less than costs, where there are no REAL economic benefits (often due to a measurement error) or
3. Real economic benefits because benefits are greater than costs.

The economics research can be summarized as follows:

- Evaluation of ITATL needs careful use of measurement to assess both costs and benefits. However, costs are almost always obscured and it is even harder to provide a measure of each benefit. Clarification is easier where objectives are identified at an early stage for the way in which IT is expected to assist teaching and learning.

Finally, time does not seem to be a critical factor, despite our early expectations, although it is a significant cost.

Policy and Implementation: Community Views

The research project also involved higher education community participation through seminars and forms on the World Wide Web. Participants included a high proportion of agents of change, including those who develop applications or are involved in institutional and staff development. They also included users (teachers), service providers of IT and library services, and those who manage them, including Vice Chancellors and principals of institutions. Some of these experts provided a section of the final report on a theme. In many cases the points raised echo those of findings in other phases of education. We now use these to provide an indication of issues relating to policy and implementation.

Steve Ehrmann, from the USA, noted that there was little choice for UK higher education: "Damned if you do: damned if you don't." IT will cost, often more than it can be shown to produce in identifiable benefits, but institutions that do not use IT will get left behind and their courses will not be perceived to be up to date. Participants from companies such as British Telecom noted that the same had applied to their business in the previous decade. Firms also noted the need to use IT to support social interaction, but that the interaction would be costly in terms of time, both that of teacher and student. Bridget Somekh, with her background in educational research, noted that higher education was applying what was known about innovation and change, so strategic support and awareness raising of this was necessary. Educational Technologists were clearly important to the quality of these innovations and Eileen Scanlon for UK Open University noted that their course teams always incorporated this as a service course creation and evaluation. This change in working styles for staff and students was drawn out further by Greville Rumble, who is predicting that, in future, teaching staff may work for many organisations at one time and students may follow the teacher, rather than have a course designed and delivered by one university. The flexibility that IT can provide was noted as of particular importance for access to the curriculum for those with special educational needs, and this attention to individual needs was also good for all learners.

Summary of Points from Our Research

ITATL was seen to succeed on occasions where: teaching was of skills and routine tasks or the topic amenable to specification and did not change too quickly. Often the link to a professional context or teaching based on relevant cases significantly enhanced the quality and student autonomy. As yet few examples of the way in which IT can be used to assist teaching and learning in higher education have been well documented when taking place in disciplines related to creative arts or in a commercial or industrial location (on the job). Where ITATL does occur, it appears to be in response to one or more of the following three pressures: to increase numbers taught, or to improve access for students or access to experts, or where staff personally want to improve teaching and learning.

At the time of writing the research study is incomplete. However, early evidence suggests one general finding in relation to this new field: the benefits of economics and education appear to go together. We also have some tentative suggestions towards national planning. Support should be provided to those planning for innovation using ITATL. Staff, including managers in HE and companies, need awareness about what can be done, especially good practice. At the same time they need information on the management of innovation and change. Those implementing ITATL should plan to implement formative evaluation and to disseminate their work within higher education and beyond it to others who might find the content valuable in other forms. Indeed new models are required for teaching and learning, which recognize that the educational system is complex with many layers and actors. Appropriate models for costing and change many be similar to those for a weather system with an element of chaos within the complexity. These models should be evaluated against the evidence. Although we have started to generate a model (using the Stella software), it is far to early to suggest that we have already captured all the factors or been able to set a reasonable range of values for each parameter we have identified. We may be at the start of a new field in educational research.

We know that IT can be seen as the answer to the problems of increasing numbers in higher education within a falling resource, but we think that IT is unlikely to prove to be such a global savior. However, ITATL is likely to be good for aspects of Higher Education. We have been attempting to evaluate what it is good for and how it can be delivered effectively for the teacher and for the learner, as well as for the UK. Our research will continue, so we will be pleased to receive further information. Send your items to: ITATL, COTE, School of Education, University of Exeter, Exeter EX1 2LU. Email: COTE@exeter.ac.uk

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In Search of a Department-Wide Teaching Philosophy that Incorporates Modern Technology

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Over the past three years, our department has produced an Information Systems course that takes full advantage of multimedia and hypermedia (MMHM). Based upon Bloom's Taxonomy, learning style theory and cooperative learning, the course material is available 24 hours a day via the World Wide Web (WWW) for students as they prepare for class. The course director also utilizes elements of the material during the scheduled lecture period. This course has been highly successful in terms of student achievement and source material for academic research. Students walk away from the course with a deep understanding of the stated course objectives (Biehler & Carver, 1996), (Carver & Biehler, 1994), (Carver & Howard, 1995), (Carver, Howard & Lane, 1996a), (Carver, Howard & Lane, 1996b). The chief developer, Carver, has published over 20 papers around the world documenting all aspects of the project. Regardless of the course success though, many faculty members question the overall effectiveness. Their attitude is best stated by "Prove It!"

The department leadership is struggling with the concept too. How much technology do we make mandatory? How much is optional? The corporate world is moving towards MMHM in a big way (Adams, Carswell, Ellis, Hall, Kumar, & Motil, 1996). Shouldn't we be going there too?

In short, we are looking for a department wide philosophy in regard to teaching and technology. This paper will discuss these issues in detail. We will start with the practical benefits of using the World Wide Web. We will then examine the proven affects on learning through MMHM courseware. In contrast, we will then discuss what we do not know about the effectiveness of MMHM courseware. We will look at why we believe the WWW should be considered an effective teaching tool by looking at the underlying learning theory. Finally, we will complete the discussion with several recommendations and conclusions.

Practical Benefits of The WWW

Before we adopt a new technology, it is important to validate how the technology will benefit us. In some cases, the benefit is obvious. We can accomplish some tasks more quickly or with less resources then we were able to without the technology. In other cases, it is not so obvious. Some aspects of using MMHM courseware via the WWW are practical, some have already proven to be effective and some have not been proven at all. The following is a list describing some of the practical benefits to using the World Wide Web for instruction:

Students can view media elements many times. In the traditional classroom setting, a student may only see the information presented by the instructor once or twice. The student is expected to take good notes during the lecture period and study from those when appropriate. With the WWW, a student may "replay" some media element prepared by the instructor over and over again. The student can study what the instructor thinks is important on many occasions. Taken to the extreme, the student can almost replay the key points of an instructor's lecture whenever he or she decides to study.

The same material can be presented in many different forms: movies, sound, text, and/or pictures. In the traditional classroom, the teacher is limited to some form of lecture. In the interest of time, an instructor can present one or two viewpoints at the most. If a student is not clear on a concept, the teacher usually handles that on a one-to-one basis by presenting the material a little differently. On the WWW, a teacher can present the material in many different ways and make all presentations available to the entire class.

Likewise, the teacher may utilize other educators' work on the web. If a student is having trouble with a particular concept, the teacher can point that student to other web pages that deal with that subject. The student can see how other educators discuss the same material.

Electronic search engines incorporated into the MMHM courseware allow both the student and teacher instantaneous access to related information. In a traditional classroom, a key course concept may be distributed across a course lecture, a reading assignment, a laboratory exercise and a research project. It is generally up to the student to connect the dots so to speak with some gentle urging from the instructor. If a course incorporates a search engine, it becomes very easy to find all the references to a course concept throughout the course material.

Handouts are always available. Large printing requirements become a thing of the past. Many items that educators handout are looked at once by the students and then thrown away: course administration, syllabus, and other documents. With the WWW, students can access the pertinent documents, glean the required information and pursue their course of study. No paper is produced or wasted. On occasion, the educator may still wish to produce a hard copy document. That is OK. Putting a backup copy on the WWW will ensure that everyone will always have access to it. Some students may want to print the document as well.

Course changes are instantly available to all students. If the syllabus changes, all students have access to the change as soon as the instructor makes it. There is no longer any need to publish addendum or additional pages.

Some of the same practical benefits associated with the WWW are also available if the course utilizes a file server. The same movies, sound files and text files are as easily stored and made available on a file server as they are on WWW server. The advantage of the WWW over the standard file server is that with the WWW, the author of the home page can easily explain what each file is and what the student should use it for. With a file server, those accessing the file have only the file name to guide them.

What Do We Know about Multimedia and Hypermedia Courseware

Empirical evidence suggests that some students learn the course material faster in a MMHM environment rather then a traditional classroom/textbook environment (Najjar, 1996) (Tjaden, 1996). The implication of this observation is not clear. Perhaps a teacher could schedule more time for a practical application of the course material: a course project if you will. Perhaps a teacher could include more material in a course. More study is required in this area; but, presumably, a teacher could take advantage of this situation.

Preliminary evidence suggests that some students retain course information longer if they participate in a cooperative learning environment that takes advantage of a student's individual learning style (Howard & Carver, 1997). As discussed below, the WWW makes it easy to address a student's individual learning style. Again, more work is required in this area; but, if the preliminary evidence holds, students could end up with a deeper understanding of course material.

Developing full blown MMHM courseware is work intensive. It took Carver two years of development before his course was fully functional (Carver & Biehler, 1994) (Carver et al, 1996b). He did not do it all at once. Instead, he started small and built upon it. Still, moving a course from the traditional lecture style / textbook class to a WWW courseware class requires a substantial commitment from the teacher.

MMHM development tools are generally not designed for the average teacher. Many are very complicated. The tools of the trade include high-end workstations and a collection of expensive software that will handle the video, graphics and sound manipulation. Start up costs are high and there is a large learning curve attached to all of the software. Developing rich MMHM documents on the web is difficult at best.

Adding MMHM documents to course web pages is relatively simple. Once the media has been developed, placing the items on a web page takes little or no effort. Basic Hyper Text Markup Language (HTML) is not very difficult to learn. Placing documents, like word processing and slide show files, on a web page is no more difficult then using old word processors like Wordstar or using Latex to publish documents. The idea of embedding commands at each end of a body of text is the same. For example, if a teacher would like to bold face the following text "Four score and seven years ago" the teacher would simply place the bold tag at each end: <B> Four score and seven years ago </B>. When viewed in a web browser, the text would appear in bold face.

What We Do Not Know about Multimedia and Hypermedia Courseware

Empirical evidence does not suggest that students using a MMHM course are better prepared then students participating in a traditional course. In many experiments, the student grades from both groups (traditional VS MMHM) were not significantly different (Rice, 1996) (Shih, 1996). One interesting note is that Carver determined that his best students, his A and B students coming into the class, performed better than expected at the end of the course. His average and poor students, his C and D students coming into the class, still did average and poor work at the end of the course. Carver's conclusion suggests that even if a teacher develops the best courseware in the world, it will not help the student who does not study (Carver et al, SIGCSE 1996) (Tjaden, 1996).

Practical benefits not withstanding, is the effort worth the time investment? This is not clear. More study and experimentation is required in this area to make a definitive decision. Using Carver's work as a benchmark, two years is a lot of time for any teacher to invest especially if the average course grades do not improve. Still, if the preliminary experiments hold true, having students retain the course information longer and learn it faster may be worth the time investment.

Underlying Learning Theory

If so many issues regarding MMHM are unresolved, then why have so many people and organizations embraced the technology? One thought is that this is just the latest fad. The WWW is new and exciting and people are just now attempting to justifying it.

Another, more scientific approach, is that the WWW makes it so easy to subscribe to and teach with a particular learning theory. Many learning theories have been proposed over the years (Adams et al, 1996). Although they differ in the details, they have a common feature. From Gagne's Conditions of Learning to Gardener's Multiple Intelligence's to Felder's Scale, students have a particular way in which they like to receive information. If a teacher focuses the lecture toward each student's learning style, then more students receive the information in a manner in which they are comfortable. Presumably, this will enhance their learning and performance in the class.

To use the Felder model as an example, one student may be a visual learner. This student may have trouble learning anything unless the teacher uses some sort of picture or diagram to describe a concept. In contrast, another student might be a verbal learner. This student can completely assimilate a topic simply by reading about it or listening to a straight lecture from the teacher. This visual/verbal dimension is one aspect to how students may prefer to receive information. The average student will fall somewhere on the line between these two extremes. In the Felder Learning Style Theory, five different learning dimensions exist (Howard, Carver, & Lane, 1996b).

Organizations may be adopting the MMHM paradigm because it feels like it should work. Using learning theory to explain this feeling, the WWW makes it very easy to incorporate all the different learning styles into the presentation. Movies, sound, pictures and text can easily be organized to support every existing learning style on each topic in a course regardless of the learning model to which you subscribe. Intellectually, this approach should be hugely successful. The fact that grades have not improved in the preliminary studies is perplexing.

Some scholars have suggested that using grades to evaluate a teaching methodology is too blunt. (Howard et al, SIGCSE 1996) (Najjar, 1996). Other measures are required. This is why proponents of MMHM courseware are encouraged by the preliminary studies on student learning time and knowledge retention.

Recommendations

Adopting a department wide teaching methodology is a difficult task. At the United States Military Academy, it may be easier then at other institutions because of the military organization, but the task is still daunting. It seems logical that a department would subscribe to one teaching methodology; but, in truth, the way a teacher teaches is a highly personal thing. To suggest to a group of teachers that they change their method is tantamount to telling them that they were teaching incorrectly in the past. This, coupled with the failure of researchers over the years to substantiate any major benefits to learning theory, makes it difficult to convince faculty members to apply the theory to their courses. Thus, one cannot decree that the faculty will change their style. Instead, the faculty must be convinced and encouraged.

After looking over what we know and what we do not know about using the WWW to teach, the practical benefits mentioned above at least merit further experimentation. The long term benefits to teaching and learning may or may not materialize. At the very least, then, using the WWW to teach is simply another tool in the teacher's utility belt. The problem then is motivating faculty to at least give it a try.

The first thing that is required is a department wide seminar that teaches the basics of HTML. Hopefully this will be a hands on seminar that will last no more then an hour. In this hour, each faculty member will gain an understanding of how easy it is to create Web pages and will introduce a basic structure to a course home page. The department can schedule advanced sections at a later date; but, the main goal of the initial training is to demonstrate ease of use. The tools of the trade at this point are a web browser and a text editor.

Although the department should not mandate a teaching philosophy, it should impose some minimum web structure. For example, we suggest the following structure:

- Course Title
- Course Syllabus
- Course Description
- Picture of the various instructors associated with the course.
- E-mail address of the various instructors associated with the course.

At this point, some faculty will see for themselves the practical benefits and begin to incorporate some WWW elements into their course. Others will not. This is to be expected. We are not looking for the entire faculty to convert their courses to the Web overnight. We are attempting to introduce a new teaching tool and to encourage its use.

Finally, department leadership must encourage an open dialogue regarding issues that the faculty discover as they experiment with this new tool. The only way to do this effectively is to have the leadership embrace the technology too. The leadership should encourage informal discussions regarding the advantages and disadvantages of the web and should provide some sort of feedback on a recurring basis to the entire department. Perhaps after a year, the leadership may decide that using the WWW and MMHM courseware is a waste of time or that it is the only way to go. The only way to decide this is for everyone to get their hands a little dirty.

Conclusions

As stated in the introduction, we are looking for a department wide philosophy in regards to teaching and technology. The question concerning how much technology we make mandatory is a crucial one and a delicate one. Mandating a change in teaching style without articulating the benefits to learning or to practicality seems to be a waste of effort. Change for its own sake is not a good idea.

In this paper we have listed the many practical benefits of using the World Wide Web. We described how researchers think that using MMHM and learning style theory together enables students to learn the subject matter faster and to retain it longer; however, using MMHM and learning style theory together does not seem to improve the overall grades of any particular section of students.

We learned why MMHM and learning style theory are a natural match with the World Wide Web. We showed how the very essence of the WWW makes it easy to subscribe to and utilize any of the many popular learning style theories. Still, without a proved improvement in grades, mandating a change to this style of teaching is probably not wise.

We are then reduced to recommending the WWW as just another tool in the teacher's utility belt. Future research may or may not prove that using the WWW in conjunction with some learning style theory is beneficial to the average student. Until that time, the WWW is one more technique at the teacher's disposal to enhance the student's learning experience. What is left then, is to show the faculty how to incorporate the Web into their classes.

Finally, we must keep an open dialogue. Encourage the faculty to try the web in their courses. Discuss the good things and the bad. Some will find it extremely useful. Others will not. But we must encourage them to try. To quote Howard D. Mehlinger, "Today there are no learned people, only the learning and the slipping-out-of-date." (Kirkley, 1996).

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Development of CTU Information System

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We are agreed that a modern university will be more and more unthinkable without computers and networks. Everybody seems to be talking about the future Information Society, about e-mail, the Internet and the World Wide Web. Some universities already have excellent campus networks, others are only now beginning to establish an appropriate infrastructure.

However, all universities are faced with these or similar questions:

1. How to find funding for Information and Communication Technologies (ICT)?
2. How to obtain adequate software and courseware appropriate to the university curriculum?
3. How to give teachers new tutorial skills for such ICT, software and courseware?
4. How to make the best use of ICT in teaching, learning, research and administration?
5. How to deal with mediocre teachers and university managers, who will lose power, status and money in future competition with outstanding teachers and university managers?

It is generally known that the information society is a global society, so ICT will influence the whole society, not on a national but on an international level. It is therefore necessary within CTU to pursue all the trends that the information society as a whole follows, and to join in international cooperation. Because the Czech Republic is one of the candidates for European Union (EU) membership, CTU mainly follows the trends arising in EU countries and universities. Before describing the CTU projects in education, research and management, we will first mention some important EU documents. We believe that these documents will be of interest to any university.

Next we will describe ICT implementation at CTU. Brief information will be provided about the CTU Manager System and Campus Wide Information System. The projects aim to formulate CTU policy for introducing ICT into the educational processes, research activities and university administration. Our activities are planned to fit in our broad cooperation with international organisations and universities in the Czech Republic and abroad. The RUFIS'97 international conference is one such important means of cooperation. The conference is prepared for September 24-26, 1997, in Prague. More detailed information about the conference is given at http://www.cvut.cz/cp1250/cc/icsc/NII/index.html.

Education in the Information Society: Visions, Projects, Tasks and Perspectives

Bangemann's Report and other EU Documents

An important report has been Bangemann's Report "Recommendations to the European Council: Europe and the global information society" which is available at *http://www.ispo.cec.be/infosoc/backg/bangeman.html*, 1994. Generally speaking, this report outlines the EU vision of the information society and the benefits it will deliver to our citizens and to economic operators.

Comprehensive resources dealing with the Information Society (IS), including EU Projects in the area of Higher Education, can be found at the well-known *EU Information Society Project Office Webserver*, available at *http://www.ispo.cec.be/*. On the URL *http://www.ispo.cec.be/infosoc/educ.html* interested readers can find the EU's basic plans in the area of Education in the Information Society.

Similar projects have been proposed for cooperation between EU and Central and Eastern Europe Countries (CEEC). For information about this, see Second Forum of the EU and CEEC in Prague, *http://www.ispo.cec.be/peco/forum.html* and also 30 themes for European initiatives and actions, *http://www.ispo.cec.be/peco/peco002.html*.

Perspectives of ICT at the CTU Prague

Managerial Information System (MIS)

One of the most obvious domains in which ICT may impact the University's daily life is in management. The existence of CTU INTRANET (mostly fibre glass lines) and a relatively good awareness of modern management methods provide a good environment for the introduction of a sophisticated software system which will serve as a tool on all levels of University management. It is impossible to present the structure of MIS in full detail here. Let us just outline its main features.

MIS will consist of the following main components:

1. Study
2. Research
3. Public relations and marketing
4. Financial management
5. Personnel and wages
6. Library
7. Information center.

These components will share information contained in communal databases so that all new information and every change will need to be entered only once. Some components are at the pilot project stage, while others are under development. One of the most important features of MIS is limited authorization of access for individual users. This is a very sensitive topic, given that some extremely smart and enterprising students have access to the University LAN.

Campus Wide Information System (CWIS)

The basic principles of organization, management and control of the CTU Campus Wide Information System were agreed by the CTU rector's advising council on 10.6.1996 - see *http://www.cvut.cz/cp1250/INFO/vis.html.*

In contrast to MIS, the CWIS should be accessible to as many users as possible. It is therefore based on the WWW and Gopher platforms, see *http://www.cvut.cz*. The usual problem of keeping the displayed data up-to-date and avoiding unnecessary entry of new items is solved by direct interconnection between MIS and CWIS via SQL. This means that a subset of MIS information will be permanently selected for display and automatically transferred into CWIS whenever a change occurs, performing all the necessary format and type conversions.

CWIS, of course, presents much more information, for example, important CTU publications (CTU Bulletin, Acta Polytechnica scientific journal), personal pages of CTU faculty members, and pages of projects and institutions closely cooperating with CTU.

Wherever possible, the information will be transferred into CWIS automatically, without manual interference. This concept is backed by a hierarchy of information managers (department, faculty and University level), who coordinate all important changes and improvements in the system. However, it must be admitted that changes in ICT tools are easier to make than changes in human minds.

Project: "Policy for implementation of ICT into education, research and management at CTU"

Although there are many local and international initiatives in the area of "Implementation of ICT in higher education and research", most are directed towards creating an infrastructure. The information society is not only an infrastructure, such as the Internet, but also a society of people who are able to cope with fast changing ICT and are skilled at using it effectively to achieve their goals. See *http://www.csc.fi/forum/JH/iteurope.html*, Implementation of new information technologies in European higher education and research, Confederation of European Union Rectors' Conferences Recommendation. Following this recommendation, the CTU management should discuss the following items:

1. To create principles of policy for implementation of ICT into education, research and management, including a definition of objectives, strategies, budgeting and timing;
2. To establish a training and integration plan for staff, aiming at achieving efficiency in the implementation of new learning models based on ICT;
3. To implement resource centres in support of production, diffusion and research on new methodologies and new technology-based learning material;
4. To stimulate the participation of non-technological departments in new ICT-based learning processes;
5. To provide incentives for the implementation of Internet based courses, either autonomously or as a part of degree courses;
6. To provide incentives for electronic publication via the Internet of lecture notes, problems, laboratory manuals and other documents related to each subject;
7. To provide all students full individual access to e-mail;
8. To stimulate the electronic publication of student papers and projects via the Internet.

Project: "Integration of ICT into the CTU Educational Process"

ICT must be put into the classrooms of a wide variety of subjects. Information technology is an essential prerequisite, but infrastructure alone does not constitute an information society.

The project aims:

To Support the Creation of a Common Information Space and Supporting Services

Once teachers have acquired basic skills for using the WWW, this skill must be put into practice. The project will moderate special interest groups and provide a structure for a common information space and services.

To Transfer Skills to Teachers and Students

Teachers and students must learn to go beyond the simple use of e-mail and browsers and actually contribute materials to the Web, e.g. by designing their schools' home pages, designing educational materials and learning to work in groups to exploit the WWW for these purposes.

To Make Results Widely Available

The above activities will result in material, such as a school starters kit, training and educational material, which will be made available through publishers and the WWW.

An example of teaching material being prepared for publication on WWW is computer-aided learning materials for Physics. There is long experience of creating and using computer-aided learning materials at the Department of Physics, Faculty of Mechanical Engineering, CTU. Computer Aided Seminars accompany lectures in Physics I and Physics II (a two semester course). We have prepared about 30 computer models for each semester, including aspects of modem physics.

Our main goal was to approach physics through some real-world examples, where it is not necessary to eliminate certain influences because the problem does not have an analytical solution. This is followed by a different formulation of the task and different approaches in applications. With this approach, we can define problems which extend beyond the scope of present-day studies and teaching at technical universities.

While preparing CA Seminars in the Physics course, we had to cope with the following tasks:

choice of appropriate software - a user-friendly environment enabling easy display of graphs, tables, animation., etc.

choice of appropriate problems - which formed the main part of our work. Not only was it necessary to coordinate seminars with the lectures, but we also needed to find some problems that are interesting for students and which cannot easily be solved without computers.

intrinsic structure of problems- problems which cannot be solved using analytical mathematical methods; problems which can demonstrate some important physical law where the numerical values of the variables are extremely important, interesting, worthwhile and applicable to further technical courses and in working life; computer-assisted instruction in classical problems (similar to textbook examples).

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FACULTY DEVELOPMENT

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Technology continues to develop at an accelerated rate, bringing new opportunities for teacher educators to share with students what could hardly be imagined even a few years ago. As an example, the ability to tap into the tremendous research resources of the World Wide Web is evolving into an essential skill for students and faculty alike. Nonetheless, technology is still not central to the teacher preparation experience in most colleges of education today. Watkins (1993) suggests that the application and use of educational technology is at best a piecemeal and uncoordinated effort. However, like other educational reforms, practicing teachers and university faculty are expected to function within an environment generated by this Information Age with little or no assistance or training. In order to deal with these issues, teacher education programs are attempting to both model and infuse technology use into their teacher education curriculum and to assist faculty in this endeavor. This section documents a wide variety of issues and initiatives involving the integration of technology in teacher education programs.

To document an individual faculty member's approach, Wilkinson describes his personal journey in conquering his fear of technology. His desire to conduct research and communicate through e-mail inspired him to continue reading and learning until he mastered the technology maze. This article is complimented by O'Bannon's general discussion of integrating technology into a comprehensive faculty development program. She suggests that change in this area is a pyramidal structure leading to new ways of thinking and acceptance, but such change is not without a myriad of barriers placed by the fears of the very people change was meant to assist. She further suggests that professional development on the part of teacher education faculty must be continual with one-on-one training and mentoring as the best foundation for basic preparation.

The next three articles discuss methods of faculty mentoring using technology. In the first two cases, students are assigned to a faculty member to work one-on-one to help the faculty member integrate technology into his/her teaching. Beisser, Kurth, and Reinhart discuss an effective mentoring program with an undergraduate student and a college instructor that provided a successful partnership. This collaboration resulted in increased technological competencies and application for both the mentor and mentee, and suggests potential for future implications at the college level. At New Mexico State, Gonzales, Hill, Leon, Orrantia, Saxton, and Sujo de Montes have found a similar mentoring program, using doctoral students, to be effective. Their pilot program presents a viable solution to increase the faculty member's knowledge of technology in concert with their needs and/or interests while the doctoral student, gains from the close interaction with various faculty members.

Finally, Hubschman discusses an exploratory study of what might happen with a mentoring program and e-mail. Her findings imply that e-mail may be a more positive methods for faculty to communicate with graduate students, in that the mentored group communicated more often than the neutral group on matters of class activities and personal situations.

As seen in recent years, the faculty in higher education faces imminent challenges through declining budgets and expanding enrollment. Therefore, faculty and administration alike must demonstrate methods of adding value to information in ways that are appropriate to meet the need of the student population. The next group of papers focus on assisting faculty in expanding technology skill in many such areas. Madden and Madden propose methods of using the computer that faculty find on their desk to create "professional calling cards" through the use of desktop publishing templates. Truman and Sorg suggest instructional design courses using the World Wide Web to allow faculty to deliver online, interactive courses employing distance learning strategies. Designing online, Web-based courses can become too involved in the technology and loose site of the important instructional content. To this end, a Web-page generator was developed to provide templates to prevent faculty from being required to learn HTML. The high adoption rate of this user-friendly tool and the collaborative nature of developing the instructional project was the key to this successful project. Using collaborative models to diffuse technology into their faculty development efforts, Hoadley and Pike review provides educational opportunities to investigate technologies in innovative ways in traditional classroom settings, distributed learning environments, and distance education delivery systems through the Center for Instructional Design and Delivery at the University of North Dakota. The centralized approach discussed in this article supplies methods for providing assistance to faculty, students, and administrators to meet the technological needs that can be duplicated on any college campus. A similar initiative is discussed by Ritchie and Hoffman where tools, techniques, and training are being developed to initiate leadership for online course publication throughout the California State University system.

In this collection of articles, the locus of faculty and administration collaboration is the key to the models that have been initiated. Abbey focuses on inclusion of appropriate technologies using a diffusion model to reflect the best practices in education to incorporate technology for both integration and personal productivity. Formal and informal assessment is an on-going component of this model. Skeele and Daly discuss the Curriculum Development Initiative grant program at Seton Hall University that encourages faculty to redesign programs incorporating technology into teacher education. This program assists and financially supports faculty in developing expertise in the use of newly acquired technological resources and in modeling the creation of lessons by infusing technology into their university classes. Falk, Lochhead, Jacobs and Mooney investigate a technology-based faculty development community funded by the National Science Foundation for increased collaboration among leaders in teacher development. Their analysis of this community concentrating on teacher development has proven to date that this field is still emerging, but this research is developing a core of expertise beneficial to all.

The remaining papers focus on the critical components of the faculty development process in K-12 environment by improving teaching and learning in the uses of technology. Hampton and Allen explore how West Virginia teachers learn about the Internet and its educational potential using the RuralNet project run cooperatively through the state's two universities. Training in this project consisted of a five day workshop and an online course developing teacher awareness of integrating technology into their everyday teaching by using the Internet to create a water quality unit. Norton and Wagner discuss a university/school district collaborative that facilitates intranet and internet connectivity in each classroom including digital, audio, and video connections. The infrastructure developed supports and enhances existing learning opportunities and pushes learning vistas in new and creative directions. At Laval University, Quebec City, Canada, teacher educators are developing a tele-learning research network to enable future teachers. Laferriere relates how the Professional Development School model has inspired this network of associated schools to create a community of tele-linked project-based learners. A collaborative training effort at Washburn University and a local elementary school trains the K-6 faculty and preservice educators using a facilitator model. In this article, the educational technology faculty from Washburn teach lessons in the elementary classroom with the teachers acting as another participant in the learning experience. Preservice educators assist in the lab to observe the lesson and the methods used in technology integration. This project exhibits the many benefits of site-based collaboration.

This section proposes many ideas as to how university faculty and teachers, with a understanding of technology, can redefine teaching by providing hands-on access and training on new technologies, bring faculty together across disciplines, provide mentoring, include team approaches to teaching and research, change the focus from content to the learner, examine learners in terms of their styles and strategies, and generally improve faculty involvement in the use of technology.

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An Educator's Journey to Technical Competency

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Lamar Wilkinson was fifty before he learned how to open an electronic window. This simple task to my children was a mystery to me, even through they kept telling me there was nothing to the computer; stop being afraid. Enter the twenty-first century. They laughed with loving kindness and a lack of understanding towards my fears. These fears, as I reflect upon them, reminded me of the year I gave my mother a Jacuzzi foot massager for a Christmas gift. Later that year, I found the massager hidden and asked her about the gift. She said, "Oh, well, yes. I meant to use the foot massager, but you know how tired I get after working hard all day. I guess I forgot, but don't worry; I'll use your gift." A year later, the massager was still hidden. I laughed at my mother's fears and antiquated ways of thinking. Now I was experiencing some similar concerns and fears because I didn't understand computers. Computers were like monsters or aliens, something that was beyond my understanding. In reality, the only monster or alien was my own deep fear of learning something unfamiliar.

Many years ago I purchased a Tandy 2000 computer system that sat on my computer table. My children used this monster with elegance. I was afraid to touch it, even though I knew that I needed to master this machine. Then, I purchased a an Intel 386 personal computer with four megabytes of random access memory (RAM). A friend gave me a copy of Gookin's (1991) book entitled, *DOS For Dummies,* to help me understand my computer. I used this particular equipment a little more frequently, but not beyond typing and printing some correspondence. I purchased Thomas's (1993) book, *DOS 6: Instant References,* to increase my limited knowledge of MS-DOS. The book was an excellent resource, but my fears seemed to increase.

This fear of computers, coupled with my own personal fear of writing, prevented me from publishing articles about my counseling and psychology work. I kept stating that I did not like to complete paperwork. If I needed to revise my resume, I would type the entire document. Any revisions or new addition involved retyping everything again. Doing any paperwork was a tedious, laborious, and boring process. This aversive and negative process reinforced my limited interest in writing and publishing.

The psychology department where I work recently employed a new psychology department head. This individual is very fluent, well qualified, and knowledgeable in the use of computers and well published in the field of psychology. His expectations of the faculty to publish, which requires computer literacy, increased my personal resolve to learn about computers.

The event that exemplifies my accepting this computer challenge occurred one day while driving from Ruston to Shreveport, Louisiana. Because of my personal desire to send e-mail to my daughter Andrea, in Washington, D. C. I made a commitment that I would learn about computers. From that moment, my computer journey into the twenty-first century began.

Even with this firm commitment to learn about computers, the project was not a simple process. I had a great deal of trouble operating any computer either at the university or at home. Each day I realized more and more the need to learn about computers, personally and professionally, but when I would ask for assistance or discuss my computer problems with others. I found it was difficult following their explanations and directions. Later several colleagues shared, laughingly and kindly, that when discussing computers with me they observed that my face would go blank as I became overwhelmed during the discussion. The fact was that I felt inadequate, intellectually inferior, and confused even trying to understand the simplest information about technology.

Still, as much as I wanted to learn, I realized I simply could not understand what computer literate colleagues were saying. I imagined that everyone in the world was computer literate, and I alone lacked knowledge in this area. When I needed help editing material, they would say "just center the paragraph," or "use justification to put the material into proper form." They spoke in a computer language I didn't understand; until I mastered this, I was not going to be able to learn about computers. I began reading many different computer books: Rathbone's

(1994), *Windows 3.1 for Dummies*, McFedries' (1993), *The Complete Idiot's Guide to Windows;* Miller's (1993) *Oops! Windows What to do When Things Go Wrong*; and Owens' (1991), *Personal Computers for the Illiterate*. Once I started learning the language, I found myself becoming more comfortable and perhaps a little brave when operating my computer.

I learned some very hard lessons about using computers. At times, I felt very proud of my newly acquired computer knowledge, only to become humble because of a simple mistake. For example, not periodically saving my work caused the loss of this paper. Other learning experiences involved misnaming or misplacing files, thinking I knew how function keys did particular task when I really didn't, saving material to the wrong drive, and finally crashing my computer. Many times I felt discouraged and wanted to terminate this computer journey.

With the help of a colleague, Dr. Matthew, and others who humorously and endearingly offered tremendous support in my adventure with computers, I continued on my journey. They would patiently and painstakingly answer any questions, as well as, share knowledge that I needed to operate my computer on a daily basis. I was especially excited when they taught me the steps and procedures for e-mail. It was a very special moment when I sent and received e-mail from my daughter's Washington, D. C. address. I had kept my promise to correspond with her electronically. This experience created a newfound desire to learn, as I realized the power this technology gave me at my finger tips.

As I moved into my second developmental phase, I realized my lack of understanding about computer hardware, software, and operating systems. I began purchasing computer books to give me this technical knowledge, such as Maran's (1995) *Computers Simplified: The 3-D Approach to Learning about Computers*. This book helped me learn more about hardware, software, the basic computer, input and output devices (keyboard, mouse, monitor printer, modem scanner), processing (memory, central processing unit, memory cache), storage (hard drive, disk cache, floppy drive, CD-ROM drive, tape drive), multimedia, portable computers, operating systems, application software, and networks. Another useful and detailed book was White's (1995) *How Computers Work* which explained the inner workings of a computer. It discusses the boot-up process, microchips, data storage, input/output devices, networks, and printers.

James Redfield (1993) suggests that my receiving a brochure about a Louisiana Tech University class on the Internet would be considered a very powerful coincidence. The course objectives involved sending and receiving e-mail, subscribing to listserves, Telneting to CARL and other terminal resources, navigating the World Wide Web, using URLs and indices, downloading files from FTP sites, navigating the resources of the Internet, using gopher, and creating a personal World Wide Web home page. The Internet class used Gralla's (1996) *How The Internet Works*. This book is a visual journey through the inner workings of the Internet. A simultaneous coincidence occurred when a general psychology book representative visited the university to illustrate the advantages of using computers for teaching psychology classes. As part of the psychology text book, they gave us a manual by Stull (1997), *Psychology on the Internet: A Students' Guide*. This guide was helpful in understanding the origin and innovation behind the Internet, as well as the tools for surfing the Internet.

A third coincidence reminded me how technology also touches our lives personally. An old high school friend, whom I had not seen in twenty-five years, called to tell me he wanted to reestablish our friendship. He planned to visit me in Shreveport. As I started giving him directions, he said, "Don't worry. I already have a map illustrating the exact address and location of your home." He had simply surfed the Internet to obtain the information needed to reach my home. These incidences seem to be telling me that my pursuit was heading in the right direction.

In my third phase, I felt the need to purchase a new computer because my Intel 386 personal computer with 4 megabytes of RAM was limited and becoming obsolete. White's (1995) book, *How To Buy A Computer or Upgrade What you Have* was extremely beneficial. This literature helped me understand computer advertisements and learn how to choose a CPU, a printer, a monitor, a scanner, and multimedia add-ons. I began to learn about software, such as Windows 95, Microsoft Word 4.0, and the other various application programs.

I continued reading and studying, looking for sales on computers in the paper, and studying advertisements which were helpful for this next stage. This phase in my development involved going to computer stores asking questions like: "How many megahertz?"; "What's the RAM?; and "What's the print speed per page?" In addition, it was also helpful to collect the detailed descriptions on different computers, printers, scanners, and monitors. I found that studying these leaflets at home at my leisure was more beneficial because I became overwhelmed with the sales pitches about computers. Finally, I very carefully drafted my ideal computer from all my research and investigation. The configuration consisted of a 200 MHz Intel Pentium microprocessor, 32 megabytes of EDO RAM, a 3.1 gigabyte hard drive, an 8x CD-ROM drive, 28,800 baud fax/modem, a 17" non-interlaced color monitor (with 0.28 mm dot pitch), Hewlett-Packard Deskjet color printer (600x 600 dpi), and a flat bed scanner (with OCR capabilities). Maran's (1995) *Windows 95: Visual Pocket Guide*, Harvey's (1992) *WordPerfect for Windows Quickstart*, and Kelly's (1988) *Mastering WordPerfect 5* were extremely helpful in giving me additional knowledge about my software requirements.

With my new hardware and software, the mechanics of developing an article for publication became much easier than the old fashioned way of typing and editing. This new ability to cut, paste, and copy saved time. Being able to block and delete any sentence or paragraph, move the material to any other part of my paper, underline or italicize words or phrases was invaluable. The ability to use spell check, thesaurus, paragraph indentation, alignment, and justification reduced my fear of writing. Learning about and using technology has simplified writing and made it a wonderful experience.

Since I started my journey to learn to use technology, I have found many other colleagues in other disciplines as well as my own, who also have a limited understanding of computers. I felt by writing this paper and presenting it at a technology and education conference that I could share with other professionals my experiences and struggles and that through these encounters others would benefit.

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Faculty Staff Development: What is Being Done and What Works

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Preparing pre-service teachers to meet the needs of students in the Information Age requires adequate training in the use of technology and its integration into the curriculum. Colleges of education have been and are still being blamed for being negligent in adequate technology training for preservice teachers. A survey of graduates in teacher education conducted nationally indicated that only 29% felt competent to use computers in teaching and learning (US Congress, 1988). Even more dramatic are the findings of a later national survey by conducted Fratianni, Decker, and Korver-Baum (1990) which revealed that a mere 19% of student teachers ranked technology training in teacher preparation as adequate. More recently, the Office of Technology Assessment reports, in *Teachers and Technology: Making the Connection*, that technology is not a primary emphasis to the teacher preparation experience in most colleges of education in the U.S. and most new teachers graduate with limited knowledge of the ways technology can be used in their professional practice. (US Congress, 1995).

Many universities have relied on a single technology class to carry the burden of informing perservice teachers on not only how to use the equipment and software but also how to integrate the technology into curriculum. Such is an impossible feat. It is mandatory that preservice teachers have educational experiences, throughout their preparation programs, that show how computers and related technologies can be used for instruction and as learning tools if they are to be competent using technology in the classroom (Byrum & Cashman, 1993). The need for training in teacher preparation has existed since computers initially appeared in K-12 schools. Shao (1989) reports, "Only a third of all public school teachers have even ten hours of computer training—and the time is mostly spent learning to use the machine, rather than how to teach with...But in general, little is being done to remedy the training gap—by the education colleges, school systems, or the companies that sell into this market" (p.110).

Guidelines

Assisting the infusion of technology in college of education training programs are two national organizations, NCATE and ISTE. The National Council for Accreditation of Teacher Education (NCATE) is the official council for accrediting teacher preparation programs and the International Society for Technology in Education (ISTE) is the professional education organization that is responsible for recommending accreditation guidelines to NCATE. Current guidelines were adopted by NCATE in May 1994 and presently govern the accreditation of colleges of education. Included in these guidelines are standards for teacher educators which state, "higher education faculty are knowledgeable about current practice related to the use of computers and technology and integrate them in their teaching and scholarship" (ISTE, National Standards for Technology in Teaching and Learning, p.2). In lieu of research findings and in order to meet NCATE standards, it is apparent that colleges of education must make faculty development a priority.

Technology Integration Requires Change

Change is not an event, it is a process. And as with all processes, it does not happen with a single event or even a series of isolated events. It is a gradual building of activities in a pyramidal structure leading to integration of the change as a new way of thinking and acceptance as the norm. There is resistance with any change. However, Roberts and Ferris (1994) suggest that reasons for resistance to technology integration in colleges of education are complex. There is no single culprit, but rather a myriad of barriers. Three of the most serious barriers are lack of adequate hardware and software, lack of active support from administration, and faculty who are unwilling to take the risk and make the commitment.

Initially, considerations must address the hardware/software holdings in the college. Equipment has a very short "shelf life"; state of the art equipment today becomes obsolete tomorrow. Funding must be available to provide the support for adequate hardware/software. In addition, funds must be allocated for the upkeep and upgrade of equipment and software to keep up with the rapidly changing advancement of technology.

The active support of the administration is key to meeting the resistance. If top leadership do not place technology integration as a priority issue for change, the struggle with resistance will defeat the effort. Drazdowski, Holodick and Scappaticci (1996) suggest that making meaningful, significant changes takes considerable time and hard work by all involved shareholders. Further, based on findings in their quest for change, they explain that "desired change occurred more effectively when department members did not feel neglected and believed that they were an important part of the decision making process, and department chairpersons were not threatened, but inspired by the special talents of their faculty" (p. 492).

Often resistance of faculty lies in their comfort with existing methods. In order for change to occur, faculties must be willing and ready to accept the importance of this change and see the personal benefit. Becoming competent and at ease, when using or modeling the use of computers, requires more than a casual brush with this technology. Roberts and Ferris (1994) report that it takes approximately 1000 hours of training for a faculty member to feel comfortable enough with technology to think about integration issues. And even after this amount of training, it is essential for faculty to commit to keeping up with the ever changing market. This commitment of time and effort may be frustrating for faculty at any level, especially those higher ranking members that are trying to slow down during the waning years of long careers.

Rutherford and Grana (1995), suggest that the resistance to change is caused by an array of faculty fears. Included in these are "fear of change, fear of time commitment, fear of appearing incompetent, fear of techno lingo, fear of techno failure, fear of not knowing where to start, fear of being married to bad choices, fear of having to move backward to go forward, fear of rejection or reprisals" (p. 512). Roberts and Ferris (1994), after interviews with faculty members, reveal that barriers for lack of integration include: technology is not seen as important to their specialization, lack of knowledge of available hardware and software, time commitment, lack of support personnel, rapid technology changes create inability to stay current, using technology is risky and faculty find it hard to take risks, and using technology is frustrating. Other research, (Hirumi & Harmon, 1994, Galliher, 1995) support these findings.

What's Being Done and What Works?

Teacher education faculty must not only develop expertise in using the array of technology that exists but also feel competent to model its use and integrate the tools into the curriculum. Providing faculty the opportunities to learn these skills has been problematic in many teacher education institutions. (Thompson, Hansen, and Reinhart, 1996).

Research (Berliner, 1988) maintains that professional development must be continual in order for any degree of proficiency to be attained. There are various models being developed and/or practiced in colleges of education for the infusion of technology. The models that report the most success with Berliner. These models have other similarities. The similarities that report the most success include needs assessments, workshops, one-on-one training/mentoring and follow-up. Workshops and seminars provide opportunities for faculty to be introduced to various aspects of technology however the integration of these technologies into the curriculum requires more intensive training. "One shot" training sessions do not significantly effect behavior however, continued training with follow up can be effective. (Strudler, 1991; Kortecamp & Croninger, 1994; Thompson, et al, 1996). Strudler (1991) suggests that working with faculty one-on-one is the most effective method to facilitate the integration of technology into teaching and learning. Success has been reported when using this method of training for faculty using graduate technology students or faculty members as faculty mentors. Using state-of- the art technology classrooms in professional development schools to serve the multipurpose of training preservice teachers, university faculty, and teachers and students at the Professional Development Site is also being practiced with much success.

Summary

Most teacher preparation programs are not preparing preservice teachers for instruction in the 21st century. In an information-rich society, some faculty continue to use traditional methods of instruction. In order for new teachers to be comfortable with technology, university faculty must model technology in the classroom and integrate these tools through out the preservice preparation period. In order for this to happen, many faculty members must change. This change will be long and slow; however, with adequate equipment and software, a supportive administration, a willing faculty and a plan, the challenge of meeting the needs of students in the 21st century can be met.

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The Teacher as Learner: An Undergraduate Student and Faculty Mentorship Success

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We are at a point in the history of education when radical change is possible, and the possibility of that change is directly tied to the impact of the computer (Papert, 1980). Nearly two decades ago, Papert prepared us for the Information Age at the time when excitement for the potential of technology to enhance learning abounded. What he did not state is that "radical changes" are slow to occur in teacher education programs at the university level. Use of computers is pervasive in the personal lives of most college students, yet their professional preparation implementing technology in education reflects only rudimentary levels of sophistication in most teacher training institutions.

While many colleges of education require an initial technology course on basic computer literacy, too few teacher education programs have faculty who are modeling instructional methods that integrate computer technology (Handler & Marshall, 1992; Office of Technology Assessment, 1995). Teacher training programs must recognize the need for training in technology, taught either in a specific class or across the curriculum. While scholars have advocated integrating technology in both methods and foundation courses (Berger & Carlson, 1988; Billings & Moursund, 1988; Bitter & Yohe, 1989), coursework needs to be redesigned to integrate technology in courses so that computers are used in relevant contexts. Computer technology should facilitate content learning from carefully designed course goals and objectives which, then, can be developed using appropriate technology-based activities and practices (Todd, 1993).

Preservice teachers learn to teach the curriculum using the technology they have learned or seen being modeled in their college classrooms. Without role models to observe in methods courses, preservice teachers are deprived of opportunities to witness models for teaching with computers (Bruder, 1989; Fulton, 1989). According to Wetzel (1993), most college professors simply do not use it, in spite of adopted competencies that education majors should learn how to use computer productivity tools for effective instruction, and how to demonstrate that ability.

The International Society for Technology in Education (ISTE) and the National Council for Accreditation for Teachers (NCATE) have established Foundation Standards that suggest such competencies as the use and evaluation of computers and related technologies; to operate software, multimedia and hypermedia, and telecommunications to support instruction; to demonstrate skills in productivity tools for personal and professional use, to understand equity, ethical, legal, and human issues related to technology; and to stay current in educational applications of computers and related technologies. In spite of the National Standards first initiated in 1991, many universities have not adhered to these guidelines nor have they taken leadership role in this movement (Wilson, 1995).

However, this poor response to technology may be due to the fact that many college of education faculty lack the requisite skills to model teaching techniques using computers much less to infuse ISTE Foundation Standards. Therefore, it is necessary for them to receive assistance in learning how to use computers, as well as implementation of computer technology in their respective courses. Using graduate students to mentor college of education faculty has shown to be an effective technique for integrating technology into the coursework of preservice teachers (Brewer, 1995; DeWert & Cory, 1996; Thompson, Hanson, & Reinhart, 1996; Thompson & Schmidt, 1994; Zachariades, Jensen, & Thompson, 1995; Zachariades & Roberts, 1995). However, not all colleges and universities have graduate programs in technology and, therefore, do not have available graduate students to serve faculty needs.

Consequently, the use of undergraduate students as technology mentors is a viable option for addressing technological needs of college faculty members. Such a mentoring program could facilitate the development of basic technological competencies, implementation of technology in college course goals and objectives, and reflection of the mentoring process. However, the success of any mentoring relationship is dependent upon several key factors:

1. Developmental, multidimensional relationship (Clemson, 1987)
2. "Spontaneity and personal fit" of the mentoring relationship (Clemson, 1987, p. 86). So that participants in a mentoring program have the freedom to choose one another.
3. Both the mentor and protégé should benefit from the relationship (Clemson, 1985).
4. Mutual respect and trust (MacArthur, et. al, 1995; Clemson, 1987)
5. Mutual participation (Kay, 1990).
6. Open dialogue between mentor and protégé allowing each participant to express their feelings, talents, knowledge and expectations (Gehrke, 1988)

The more success factors present in a mentoring relationship, the more beneficial the relationship will be to the participants.

The Study

The purpose of this study was to investigate the approach of mentoring a college of education faculty member by an undergraduate education student. Sally, a social studies methods instructor, and Jason, an elementary education major and vice president of The Educational Computing Club, were brought together because of their desire for more technology experience. Their mentoring experience took place during the Spring 1996 semester at Iowa State University. The participants were asked to try to meet at least once a week for an hour throughout the semester. Participants were interviewed, observed, and asked to keep a journal of their mentoring experiences, as well as, provide a copy of any e-mail correspondence between each other during the mentoring process. Sally was able to establish her own goals for the mentoring experience thus, providing her with an individualized learning plan. The following perspectives from the participants reveal many of the keys to successful mentoring relationships as previously mentioned.

College Instructor Mentee's Perspective

Given that one of my philosophical tenets as an educator is that the "teacher is a learner," I was eager to interact with one of my social studies methods students who had demonstrated tremendous technological sophistication during the previous semester methods course. In fact, his class project, an interactive internet e-pal program using HyperStudio resulted in an additional two-credit independent study. I felt increasingly challenged by the need to develop my social studies methods course using technological competencies which I, admittedly, lacked.

Having had absolutely no formal coursework, in the use of technology, I was initially satisfied to use my university office computer for word-processing, e-mail messaging, and intra-university communication. My limited infusion of technology was not related to "technophobia," but rather, to lack of understanding of what the computer can do and how technology could transform my college-level course.

Aware that I am a role model for my elementary education students and realizing preservice teachers benefit from integrated technology in their teacher training courses, I was anxious to begin to learn from my student, Jason. We established weekly meeting times and shared goals and objectives for our collaborative sessions held in my office. My introductory objectives included learning how to prepare mailing labels, access the internet, and use Word 6.0 while my end-of-the semester competencies included use of PowerPoint, HyperStudio, how to prepare a data base using FileMaker Pro, and assemble an address book in my e-mail. Notably, there were functions of the computer I did not know that I should know!

Admittedly, I had information "gaps" in my acquisition of technological knowledge. Importantly, our one-to-one mentorship provided a risk-free atmosphere to ask rudimentary questions about files, folders, menu bars, tools bars, and how an application works. Guided by my initial objectives to learn basic word processing and communication skills, Jason Kurth first provided assistance in response to my inquiries. Eventually, he introduced more complex productivity tools to present and organize information, in particular, those which would relate to my social studies methods course he'd taken the previous semester.

Once I realized that fundamental comprehension of one computer program helped me understand another and knowing that I could use an application without knowing every single feature of that program, I felt free to investigate various software applications and to progress to networked services!

Weekly journaling kept me aware of my three goals established prior to the mentorship:

1. To increase my own technological proficiencies personally and professionally,
2. To impact student learning by modeling technology integration in my class, and
3. To expect students to incorporate technology in their lessons and activities.

Throughout the semester, as I learned new skills, I was courageous enough to implement them in my social studies methods course or at professional meetings and conferences through:

- Organizing e-mail address books and groups,
- Using electronic communication with my students as well as university colleagues,
- Preparing databases of names and addresses for professional and personal use,

- Holding class in university computer labs with time for independent exploration,
- Creating HyperStudio program for introduction and explanation of my course,
- Indexing WWW sites to explore social studies resources for lesson planning,
- Preparing PowerPoint presentations for coursework and professional conferences,
- Hooking up the LCD panel and PC at conferences and for in-class presentations,
- Inviting technological use and display of student work in my course,
- Providing independent options for students (like Jason Kurth) who wanted to do more,
- Investigation of exciting new software for course use and development,
- Upgrading my word processing version (Word 6.0) and using more features, and
- Asking questions and expecting the best of myself in searching for answers.

In summary, I realized the power of new technologies to impact teaching and learning. Technology wasn't primarily used to automate what I already did, in ways I had always done it. Rather, technology was infused to enhance academic content and skills areas involving thinking, decision-making, and problem-solving experiences. I now have increased proficiencies to explore technological advancements in order to improve instruction for my students, to integrate computer-related technologies in my professional activities, to increase the use of technology among preservice teachers in my courses, and to uphold expected ISTE competency levels.

At the time of this writing, I have students creating theme unit constructs using Inspiration® webs, communicating with elementary "key-pals" using e mail, searching the internet for professional teaching strategy resources, creating newsletters using The Writing Center®, building electronic portfolios, evaluating state-of-the-art geography software, and connecting to my homepage (which is not too exciting yet). But, I've certainly progressed from mailing labels! I confess that I still use a little red grade book for compiling student grades—maybe in order to sit in front of the fireplace to compute end-of-the-semester marks and to contemplate how much I've learned. However, my portable laptop computer is on order!

Undergraduate Student Mentor's Perspective

When I was presented with the opportunity to participate in this mentoring project, I was excited and accepted immediately. Opportunities such as this are rare for undergraduate students. Having taken a number of educational technology classes in my coursework and having worked in our Technology Support Office, I was ready to apply all that I had learned. At this point in my academic career, I felt challenged to "produce" or "provide" something above and beyond the usual undergraduate curriculum. Needless to say, I was eager to work with Sally, my Social Studies Methods instructor the previous semester, to help her learn to integrate technology into her personal and professional life.

During our initial meeting, Sally Beisser and I set up weekly meeting times and shared our goals and objectives for the mentorship. Sally had brought a printed list of fourteen goals she wanted to accomplish throughout the semester. I had also printed a list of my goals for the semester which were actually quite different from hers. I was participating in this mentorship with the expectations of playing a role in helping Sally become the leading example of a computer using educator for other faculty to follow. The specific goals that I printed out for our first meeting were lofty, specific, and teacher oriented. My goals addressed what I wanted out of the mentorship and not what Sally wanted. After the meeting, I realized that Sally had taken ownership of her goals, and I felt it was important to work towards meeting those specific goals rather than my own. However, I realized that my goals would still play a role in the progression of the mentorship and that they could not be totally ignored.

Initially, Sally Beisser focused her attention to learning several applications and learning a lot of the functions and features of the programs. I tried to emphasize the relationship between the applications — how various programs have similar features and functions. Towards the end of the semester, Sally began to transfer that knowledge and began to recognize the relationships between applications, and as a result, began to focus less attention on the details, thus, shifted more focus to the big picture.

A number of factors played an important role in the success of this mentorship: positive reinforcement, attention to individual goals, one-on-one working relationship, and communication. The relationship between Sally and myself was extremely positive. I would give her positive reinforcement, not only during our sessions, but also in my e-mail correspondence with Sally between sessions. And Sally was such a great role model by the way that she was always giving me, the teacher, positive reinforcement.

Sally came into this mentoring relationship motivated by the desire to attain technology goals relevant to her personal and professional lives. Thus, my decision to focus our attention on Sally's goals and objectives made each session personal and relevant to her. If I had only focused on my own specific goals, the entire mentorship would have lacked relevance, and Sally's interest would have diminished quickly.

There is little doubt that our one-on-one working relationship was a key factor in our success. Working in this situation, we were able to form a positive relationship, not only a professional but a personal friendship, too. Developing such a positive relationship helped make this a truly enjoyable experience for the both of us. Because we worked one-on-one, both of our needs and concerns were addressed immediately, as opposed to a workshop setting, where it is typical of participants to become frustrated when help is not immediately available. Another benefit to working one-on-one is that our total attention was on the task at hand, thus allowing us to make significant progress in a short amount of time.

Communication was also a major factor in the success of our mentoring relationship. We were in constant communication with each other, either by seeing each other in the halls or via e-mail. Oftentimes, I would send Sally a brief synopsis of what we had done and what we/she accomplished during a session. I would occasionally provide a quick review, sometimes outlining the basic steps involved in completing a particular task, and at other times even send her homework! Though not very many undergraduates have the opportunity to send their professors homework, I felt it was important Sally spend time working with technology during times other than our sessions. While one factor may have weighed more heavily in our success, it was the combination of factors that accounted for our overall success.

Future Implications

The reality is that many teacher preparation programs do not have graduate students to mentor faculty on the use of technology as seen in a number of studies mentioned above. Encouraging teacher education faculty and new teachers to use technology in teaching and learning is possible using effective mentoring with undergraduate students to increase technological competencies and applications in teacher preparation courses. One-to one mentorships can provide cost-effective, personally-rewarding experiences for both students and faculty with motivation and freedom for faculty to learn at their own pace. The mentorship team can explore and investigate responses to individual technological needs, address challenges of complex and open-ended problems, rely on inquiry and invention rather memorization of procedures in instruction manuals. As Harrington (1991) suggests, there is a difference between preparing teachers to use technology and using technology to prepare teachers. If we only prepare teachers to use technology we limit the conception of the role of technology in education. Empowering undergraduate students as facilitators of technological learning experiences for university faculty enables both to take more responsibility for acquiring technological competencies. It's a win-win solution. Papert would be proud.

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Faculty From Mars, Technology From Venus: Mentoring is the Link

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As we get closer to the 21st century we see an emphasis placed on technology in education. Recent trends show "a new insistence that teachers must become technologically literate" (Ely, Blair, Lichvar, Tyksinski, & Martinez, 1996, p. 33). Unfortunately, colleges of education are not adequately preparing teachers to use technology in the classroom. This situation is due, in part, to the fact that faculty are often not able to model its use (Wetzel, 1993; Staman, 1990). New Mexico State University has implemented a pilot program using masters and doctoral students in the "Learning Technologies Program" to mentor faculty one-on-one to integrate technology into their courses.

Preparing preservice and inservice teachers for an Information Society where technology plays a prominent role requires that education faculty be knowledgeable about technology resources and model their uses. Yet, research indicates (Colon, Willis, Willis, & Austin, 1995; Office of Technology Assessment [OTA], 1995) that teachers do not feel adequately prepared to integrate technology into their teaching. According to the OTA study, technology is not a central part of the teacher preparation experience in most colleges of education, despite its importance to teacher education. Most new teachers graduate with limited knowledge of how to integrate technology into their teaching.

In recent studies, faculty identified lack of knowledge about software, time constraints, and limited recognition of technology's potential as obstacles to effectively integrating it into their curricula (Wetzel, 1993; Staman, 1990). For many college of education faculty, technology experiences have been bad at best. These faculty often receive outdated hardware and non-supported software. In other words, castoffs from other departments where technology use among faculty is considered mandatory. To further complicate matters, on some campuses computer science departments supply the only training available. Unfortunately, these trainers may carry preconceived ideas about college of education faculty and their ability to acquire the necessary skills to integrate technology.

Willis (1993) argued that questions about hardware, software, and teacher training are no longer the most important topics in educational technology. Today the major issues are related to instructional strategies, instructionally appropriate software, training and support as a process, and facilitating organizations. A study by Oke (1992) found that teacher training in the application of technology in education, not familiarity with technology, must be emphasized in preservice teacher education.

The literature on the use of technology by college of education faculty comes to the same conclusions as the literature regarding technology and the K-12 faculty. If technology is to become the tool of choice for learning and information sourcing its use must be modeled by faculty and administration members alike. In order for this to occur, an environment of support and commitment needs to exist at the university and within the department for faculty to be exposed to, acquire and implement technology into their course work. Other institutions have found mentoring to be an effective way to encourage their faculty to begin integrating technology into their courses (Thompson, Schmidt, & Hadjiyianni, 1995). At New Mexico State University (NMSU), we have implemented a pilot program using masters and doctoral students (who are experienced teachers and users of technology) in the "Learning Technologies Program" to mentor faculty one-on-one.

Pilot Faculty Mentoring Program

We began our pilot program in the fall of 1996 with five faculty members and five graduate students matched up by area of interest and expertise. The participating faculty, all volunteers from Curriculum and Instruction Department, include a literacy educator, a bilingual educator, a multicultural educator, an ESL educator and the department chair. Each faculty member and each graduate student has written up a set of goals to be accomplished during the semester. They meet each week face-to-face for approximately two hours to work towards these goals. The goal of the program is that when the semester is complete, the faculty members will feel comfortable integrating technology effectively into their courses. In the spring of 1997, we will interview the faculty members and visit their classes to see how they are progressing with their technology use. Below we will review tendencies in technology use in multicultural and literacy instruction and relate them to the mentoring relationships.

Multicultural Education

Multicultural Education and Technology. The curriculum of the twenty-first century will be driven by: (a) the shift from an industrialized, print-driven age to an information, computer-based age, and (b) the increasing diversification of the United States (D'Andrea, 1995). The need for a new technology oriented multicultural curriculum calls for preservice teachers to both master technology skills and understand the concepts of culture and cultural diversity.

The central role of schools of fostering academic success for all students and multicultural education represents a promising means to achieve this goal. Being multiculturally literate requires being respectful of the history, traditions, and values of people of diverse backgrounds. Teachers and teacher educators in today's schools, with their diverse cultural and linguistic populations, have the challenge of developing curricula for their students that is meaningful, interesting, and engaging. Technology offers opportunities for success in this endeavor for students and teachers alike (Gonzales, 1992).

Garcia (1993) argues that the use of technology in multicultural education is the return to the earliest form of information delivery: one-on-one communication. When interactive systems (interactive video, hypermedia, and hypertext) are used in the classroom, both teacher and students are continually adapting the learning process to reflect individual needs, interests, and past experiences. Technology also allows educators to alter content for level of difficulty, or mode and speed of presentation. No two students need be treated alike, and individualization can become the norm.

The Multicultural Graduate Mentor's Experience. One of the major goals of the mentoring experience with the multicultural educator was to learn some management techniques to aid in becoming more comfortable with technology. At the beginning of the semester, the biggest problem reported by this faculty member was her student's resistance to using technology. She also felt somewhat uncomfortable using the computer in a professional or classroom setting.

After the initial meeting, it was found that the professor used the computer to explore the Internet and to use her email account. Students in her classes were required to keep electronic journals. As a multicultural educator, she is concerned with the depersonalization of education, and one of her fears was that the technology of electronic journals may feel more impersonal. Her fears were allayed by the recognition that the journals were more contemporary, more current and alive.

During the semester, the faculty member and the doctoral student explored various pieces of software and found HyperStudio to be the most advantageous for her work. Prior to this mentoring experience the professor was using the lecture method as a means of instruction. Although she did not feel comfortable just lecturing, she did not know another effective way to introduce the course material. With the use of technology, she now has a more interactive method of instruction available to her and her students.

Another important aspect of the relationship between this faculty member and the doctoral student was the open dialog characteristic of every meeting. Dialog centered not only around technology, but around multicultural education and how it affects every aspect of life in society. The doctoral student gained multicultural insights from this mutually beneficial experience.

Near the end of the semester, the professor was asked what she planned to do with technology in the future. Her plans included finishing her HyperStudio project, asking students to evaluate software using multicultural standards, and keeping the electronic journals. Above all, she realized that professors are the students' role models when integrating technology into the curriculum. Now that she has had this mentoring experience she feels more comfortable modeling its use.

Literacy Education

Literacy and Computer Technology. To understand the relationship of computer technology in reading and language arts today, there needs to be a review of some of the problems of the past and a preview of future potential alliances. In the late 1960s, the 1970s, and the early 1980s, educators frequently viewed reading and reading comprehension as a set of discrete skills. Reading instruction often focused on the teaching and practicing of individual skills (Cooper, 1997). The efficacy of this kind of approach to reading instruction was seriously questioned (Goodman, 1965; Rosenshine, 1980; Smith, 1971), which led to a strong movement during the late 1980s and the early 1990s to view reading and writing from a more holistic perspective. From this vantage point, authentic experiences, referring to reading with real texts with real, student-centered purposes, was of paramount importance.

Reading and computer technology trends were not moving in synchrony. When many reading and writing programs had been skills oriented, there was little or no computer access in classrooms. When hardware and software access became more commonplace, the computer programs supported more traditional teaching and skill development (Neill & Neill, 1990) which was not adopted in the classrooms by holistic, literature-based trends in reading. Maddux (1993) stated clearly that the field of educational computing had been plagued by an abundance of poor quality software.

New software trends and hardware capacity of the 1990s often: (a) provide for student-centered, open-ended features, (b) encourage interactive responses and active intellectual involvement, (c) incorporate full length reading text, (d) support the writing process, (e) require problem solving, and (d) include interactive multimedia (Thompson & Montgomery, 1994).

Reading and language arts educators are currently more likely to embrace what technology has to offer. Galloway (1994) determined that students were motivated and interested by the inclusion of multimedia video prompts in the writing process. Others (Boone & Higgins, 1992; Davis & Shade, 1994) suggest applications for integrating hypermedia with content area reading and writing; and Reilly (1994) confirms positive effects of students composing and producing their own multimedia video images. Electronic books also may provide distinct advantages to readers by extending opportunities for interaction between the students and the story (Sharp, 1996; Harrington-Lueker, 1996). Sharp reports that electronic versions of well-authored text can expand and support print by both capturing the children's interest as well as fostering skills.

The Internet increases ways teachers can transform classroom projects, such as with research support services like ERIC and WWW search tools (Black, Klingenstein, & Songer, 1995). Another form of Internet use is expanded through electronic journaling. For example, a study of a reading education class reports positive uses of electronic mail which increased reflection and visions of email as a pedagogical tool (Anderson & Lee, 1995).

The most recent trend in reading education appears to be towards a balance of the skills tradition and holistic methodology, and an expanding concept of literacy that includes technology in preparing students for the "real world" (Cooper, 1997). Technology is now more in synchrony with the search for authenticity in the reading and language arts arena, and there are multiple ways in which reading and technology can interface (Willis, Stephens, & Matthew, 1996).

The Literacy Graduate Mentor's Experience. The literacy professor and her mentor have established a working relationship integrating technology into the reading courses. Initially using the mentor to model the integration of technology into language arts classes as a "guest speaker," the professor has progressed to using the mentor as a consultant. Multiple uses of technology have been presented and utilized by preservice teachers in many ways such as newsletters (*Bilingual Writing Center,* 1992), multiple charts and posters *Print Shop Delux* (1992), laserdisc technology in combination with *Hyperstudio* (1995) and *Desert Classroom* (1994) programs, story writing with *My Own Stories* (1993) and *Storybook Weaver* (1993), email journaling, and Internet searches.

The mentor facilitated this kind of integration by previewing materials, modeling, and problem-solving in private two hour sessions each week. The department of Curriculum and Instruction was supportive by providing a multimedia teaching classroom and near-by labs with both Macintosh and IBM formats. The mentor supplied the technical basics for using this classroom. With this kind of support, the professor was able to redesign teacher preparation curriculum in reading and writing instruction to incorporate computer technology. Having success with the preservice teachers, the professor has achieved a confidence level to continue this kind of integration in future classes. Specifically, she desires increasing the use of the Internet and multimedia possibilities.

Conclusion

If faculty members are comfortable with technology, they are more likely to integrate technology into their curriculum. The one-on-one interaction between doctoral students and faculty members may present a viable solution to increase faculty technology knowledge concordant with their needs and/or interests. From this relationship, doctoral students also gain from the close interaction with different faculty members who share their expertise and model behaviors for the future professors.

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Can Faculty Effectively Mentor Students Through E-mail?

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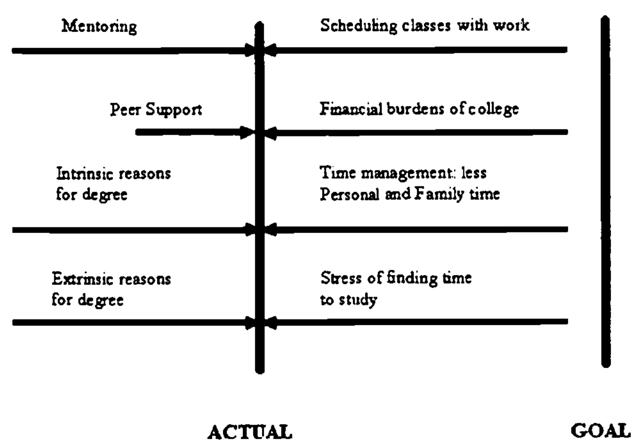
The purpose of this study was to see if using electronic mail (e-mail) would open another channel of communication to graduate students. Interrelationships between faculty and students contribute to the success of the graduate student (Galbraith & Zelenak, 1989). Mentoring is a one-to-one relationship between mentor and mentee which can help mentees develop their personal, educational, or career potentials. Since electronic mail is one way people can relate on a one-to-one basis, it was hypothesized that a mentoring relationship through electronic mail could lower the alienation felt by many graduate students in a commuter university, and lead to higher achievement and attitudes toward academic classes.

Model: Force Field Analysis of Mentoring

Lewin's theory of force field analysis was applied to the concept of mentoring graduate students. Lewin (1935, 1948) developed the model of various forces (negative and positive) acting upon an individual. The same forces may vary in direction (whether negatively or positively affecting the individual's attainment of the goal) and in intensity (strength of force or drive in steering individual toward the goal). Figure 1 shows a typical graduate student with some negative force fields such as finding time to schedule class time along with work time, the stress of finding time to study, the financial costs of college, and the loss of family and personal time. Positive forces would be external motivations (such as better jobs, increases in salary, and increased opportunities for job promotions) and internal motivations (such as self-esteem, confidence, career satisfaction, and the overall quality of life). This example shows forces of differing lengths. By increasing the strength of positive forces, and/or reducing the strength of negative forces, the student can attain the goal of graduation.

Statement of The Hypothesis

This study emphasized the positive forces of a good mentoring relationship as contributing toward a student reaching the immediate goal of completing the class successfully. This study proposed to see if this mentoring can be accomplished through e-mail, and if mentoring by e-mail can be an effective way of increasing student achievement and student attitude toward the course and educational research in general. Therefore, it was hypothesized that (1) students receiving mentoring e-mail messages would score significantly higher on an instrument measuring attitudes toward educational research than those not receiving mentoring e-mail messages, and (2) students receiving mentoring e-mail messages would score significantly higher on objective exams covering the research material than students not receiving mentoring e-mail messages.



Method

Subjects

Sixteen males and 83 females from four graduate level educational research classes at a state university were randomly assigned to one of two e-mail treatment groups (Hubschman, 1996). One group received mentoring messages through e-mail, and one group received neutral messages through e-mail. Mentoring e-mail, which was defined as e-mail that includes one or more of the qualities of establishing trust, offering individualized advice, introducing alternatives, challenging the mentee, motivating the mentee, or encouraging initiative (Cohen, 1995) was individually sent to each member in the randomly assigned mentoring group. Neutral e-mail, which was defined as messages that relay general information in an impersonal, generalized way, was individually sent to each member in the randomly assigned control group.

Data Collection Instruments

Attitudes Toward Educational Research Scale. The Attitudes Toward Educational Research Scale (ATERS) was developed by Isakson and Ellsworth (1979) in order to develop a measurement instrument that would assess the attitudes toward educational research of teachers who are enrolled in an educational research class. Fifty questions were arranged in a Likert-type scale (5 points, from strongly agree to strongly disagree) to measure teachers' attitudes toward educational research.

Hardy Educational Learning Profile. The Hardy Educational Learning Profile (HELP) was a self-administered and self-scored cognitive learning style instrument designed especially for adult populations. The purpose of the profile was to determine one's preferred style of learning (Hardy, 1995). The first page consisted of instructions and demographic information. The second page was a worksheet displaying word pairs according to the three cognitive dimensions of interaction, gathering information, and processing information. The third page was the self-scoring design. The last page was a summary of cognitive learning styles according to one's self-scoring. The scale for introversion/extroversion was scored on a range of 10-60 with scores toward the higher end indicating someone who was outgoing and verbal, eager to discuss and debate, and learning through action and doing. Scores toward the lower end would indicate a reserved and nonverbal person, and one who likes to reflect and listen.

E-mail and Course Evaluation Survey. An e-mail and Course Evaluation Survey (Hubschman, 1996) was administered at the end of the treatment. This qualitative dimension asked for students' attitude toward e-mail, attitude toward the course, and any general comments they had about the course or treatment groups. Student anonymity was protected.

Procedure

Two sections of the introductory graduate research class were taught by the researcher, and the other two sections were taught by different colleagues. The same textbooks were used, and the same objective midterm and final were given to all four evening classes. The researcher obtained mainframe computer VAX accounts (VAX) so that the students in all four classes were able to send and receive e-mail the first night they went to the computer lab. A Congratulatory Letter from the researcher was waiting when they first accessed their VAX account. The researcher spent the first night demonstrating the fundamentals of logging onto the VAX, receiving e-mail messages, replying to existing e-mail messages, and composing new e-mail messages by showing transparencies of actual screens they would encounter, and by distributing a handout which included copies of screens shown on the transparencies. That same night the students were given their VAX account names and passwords (the VAX accounts had been setup in advance), and taken to the computer lab where they had the opportunity to log onto the VAX and read, reply, and compose messages to the researcher.

The researcher started the mentoring relationship by taking the initiative in establishing a relationship that is conducive to open communication. Questions were asked about the advisee's interests, goals, and reasons for pursuing graduate study, and when the student preferred to be contacted. It was expected that those in the mentoring e-mail groups would reply to, and compose, more e-mail than those in the neutral e-mail groups. It was also expected that introverts would reply to, and compose, more e-mail than extroverts.

Results and Conclusions

Hypothesis One. Hypothesis One stated that there would be a significant main effect of method of e-mail communications treatment on the students' attitude, as measured by the ATERS. Table 1 shows the factorial analysis of method of treatment and level of introversion/extroversion as independent variables, and score on the ATERS posttest as the dependent variable. Neither main effect (group or level of introversion/extroversion) nor interaction of group and level of introversion/extroversion was significant at the .05 level of significance.

Table 2 shows the means on the ATERS posttest of the introverts in the mentoring group, introverts in the neutral group, extroverts in the mentoring group, and extroverts in the neutral group. Extroverts in both treatment groups scored higher on the attitudes posttest than introverts in both groups. Extroverts in the mentored group scored approximately 1 point higher on the ATERS posttest than extroverts in the neutral group. Introverts in the mentored group scored almost 9 points higher on the posttest than those introverts in the neutral group.

Table 1.
Factorial ANOVA of ATERS Posttest (Method by Introversion/Extroversion)

Source of Variation	*SS*	*df*	*MS*	*F*
Method (M)	89.60	1	89.60	.37
Introversion/Extroversion (I/E)	198.78	1	198.78	.83
(M) x (I/E)	34.48	1	34.48	.14

Table 2.
Means of Two Factor Treatment Groups on ATERS Posttest

	Treatment Groups	
	Mentored	Neutral
Introverts	184.19	175.29
Extroverts	193.27	192.07
TOTAL	187.89	186.48

Our conclusions relative to Hypothesis One are as follows: Although there was not a significant difference in the main or interaction groups of method of e-mail communication on attitude toward educational research, introverts in the mentored group had higher attitudes toward research (by almost 9 points) than introverts in the neutral group. Extroverts scored higher than introverts in both groups.

Hypothesis Two. Hypothesis Two stated that there would be a significant main effect of method of e-mail communications treatment on the students' achievement, as measured by multiple choice final exam grades.

Table 3 shows the means for final exam scores, broken down into treatment groups and interaction between treatment and level of introversion/extroversion. Extroverts achieved higher final exam scores than introverts in both treatment groups (51.57 for mentored, 52.02 for neutral). Introverts scored almost two points lower in both treatment groups (49.01 for mentored, 47.75 for neutral). Introverts in the mentored group had higher scores than those in the neutral group, though not to a significant degree.

Table 3.
Means of Two Factor Treatment Groups on Final Exam Scores

	Treatment Groups	
	Mentored	Neutral
Introverts	49.01	47.75
Extroverts	51.57	52.02
TOTAL	50.11	50.66

Our conclusions regarding Hypothesis Two are as follows: Although no significant difference was found in main or interaction groups of method of e-mail communication on achievement as measured by the objective final exam (by using a factorial analysis), extroverts in both groups scored higher than introverts. Mentored introverts had higher scores on the final exam than introverts in the neutral group.

Responses to E-mail by Treatment Group. The factorial analysis of variance (ANOVA) shown in Table 4 shows significant main effect ($p < .05$) of treatment method on number of responses to researcher. Table 5 shows that the mean responses of the mentored group was 6.89, while the mean responses of the neutral group was 3.09. Introverts responded more often to e-mail messages, whether they were in the mentoring or neutral treatment group.

Table 4.
Factorial Anova of Responses (Method by Introversion/Extroversion)

Source of Variation	*SS*	*df*	*MS*	*F*
Method (M)	141.45	1	141.45	7.20*
Introversion/Extroversion (I/E)	13.44	1	13.44	.68
(M) x (I/E)	.36	1	.36	.02

* p < *.05*

Table 5.
Means of Two Factor Interaction on Total Responses to E-mail

	Treatment Groups	
	Mentored	Neutral
Introverts	7.44	3.71
Extroverts	6.17	2.80
TOTAL	6.89	3.09

Discussion of the E-mail and Course Evaluation Survey

The five-question e-mail and course evaluation survey was administered to all four classes at the end of the term. Since the surveys were completed anonymously, breakdown of replies by treatment groups was not possible.

Positive and Negative Aspects of E-mail. Replies to the positive and negative aspects of e-mail were combined in the first two questions. Responses varied from lack of time to lack of interest. Students mentioning lack of time referred to the fact that no extra credit was given for using e-mail, and that not enough time was given in teaching the fundamentals of e-mail. Some students felt that more of the course should have been interrelated to e-mail by posting assignments and articles on e-mail. Other students mentioned that they didn't have computers or couldn't find computers in the lab, or that their computers at home or work didn't have modems. Other students mentioned they were computer-phobic, and couldn't relate to the new technology.

These negative impressions of e-mail correspond to the research which mentions problems of integrating e-mail into the curriculum (Meacham, 1994; Yao, 1993). It is anticipated that as more computers are sold with modems to connect to the Internet, and that as more students are required in classes and the workplace to use e-mail, that this problem will be resolved.

Positive responses to the use of e-mail included the opportunities to get quick responses to drafts of papers and questions, the convenience of communicating without having to meet in a certain place at a certain time, the uniqueness of learning something technology-related, and the rapport developed between teacher and student. This corresponds to literature on e-mail (Berge & Collins, 1995; Velayo, 1994) which mentions that some students might find e-mail a more comfortable outlet for expressing their feelings.

E-mail's Effect on Attitudes Toward the Class. The third question asked if the e-mail affected attitudes toward the educational research class. A relationship between e-mail usage and educational research was mentioned by 29 students; no relationship was said to exist by 35 other students. Students expressing a positive relationship mentioned the connectedness to the course, the teacher, and the college. Being able to get research information to and from other students, and finding it easier to ask questions and get advice through e-mail rather than in class were also mentioned. The majority of the responses mentioned no relationship between e-mail correspondence and attitude toward educational research. They ranged from "No, e-mail is fun, while educational research isn't," to "No, I enjoy educational research with or without e-mail."

Since the answers to this question were not grouped by treatment group, it is hard to say if the mentoring e-mail group would have answered in a more positive way than the neutral e-mail group. The premise of this study was that mentoring through e-mail would also develop this positive attitude. It appears that at this time teachers who wish to incorporate e-mail in their course should add it to their syllabus. Self-directed students will seize the opportunity to learn; those who do not feel that it applies to the particular class will avoid the situation. By planning time for computer instruction and finding a location where computers are available, teachers can insure that all students are comfortable with e-mail communication. Articles and general information can be sent to the class. Questions can be sent to students, and they can send the answers back by e-mail.

Discussion of the Qualitative Analysis of Mentoring and Neutral E-mail Responses

Students in both the mentored and neutral groups used e-mail to ask questions related to e-mail, exams, to get feedback on research paper tasks, and to thank me for sending them information. Both groups used the one-to-one correspondence to confide personal information, and both groups sent me information they thought would be useful to me. Research supports the use of e-mail as another outlet for communication (Berge & Collins, 1995), and the positive effect of mentoring for both the mentor and the mentee (Confessore & Confessore, 1992; Daloz, 1986). The teacher had more individualized time with students, and could provide more advice and alternatives tailored to the individual student, and, in some cases, challenge and motivate individuals to grow mentally and/or professionally (Cohen, 1995).

For the duration of this study, this researcher logged onto the mainframe computer and read and responded to e-mail messages three times a day on weekdays, and at least once daily on Saturdays and Sundays. It was hoped that prompt responses to e-mail would be positive reinforcements to continued e-mail. More messages from the mentoring e-mail group dealt with personal feelings and comments, while more responses from the neutral group wanted specific information on using the computer or my feedback on their research paper.

Summary

Even though this study dealt with the effect of mentoring e-mail on students, it can be seen that those in the neutral e-mail group also benefitted from the one-to-one correspondence. The opportunity to communicate at a time and place convenient to the student, and the knowledge that affirmation of that message would be sent within 24 hours was used by students, whether they were in the mentored or neutral groups, and whether they had been classified as introverts or extroverts. It is suggested that e-mail communication be considered in other situations. E-mail can be of benefit to the student at various levels. The lower levels of relaying general information about the class and the university can be used. Higher levels of communication would include one-to-one communication and discussions among research groups. At the highest level of communication would be the mentoring opportunities, and the chance to guide and challenge the student to envision and achieve higher goals.

Implications

The implications of these findings are that mentoring might be a positive way for teachers to communicate with graduate students, for it was found that those in the mentored group communicated more often than those in the neutral group on matters concerning class activities and personal situations. In addition, introverts in both the mentored and neutral groups responded more often than extraverts to e-mail messages from the researcher. Qualitative analyses of anonymous comments by students and e-mail messages from both the mentored and neutral groups revealed the benefits of e-mail to those who used it. Finally, it was noted that more than 50% of the students in the study did not respond to any e-mail messages from the researcher.

Recommendations

The conclusions and implications drawn from this study serve as a basis for several recommendations. These fall into two categories: recommendations for educational practice and recommendations for future research.

Recommendations for Educational Practice

1. Students should be given adequate hands-on time during class to learn the basics of e-mail before being asked to use e-mail for communicating.
2. Students should have more access to computers. Over time it is expected that more students will own computers capable of connecting by modem to the university mainframe. Until that time, more computer labs should be available to students.
3. Teachers should require e-mail usage in their classes, to insure greater participation. General information can be distributed to a class via e-mail.
4. Teachers should send mentoring e-mail messages to their students in order to increase the positive one-to-one relationships needed by adult learners.

Recommendations for Future Research and Theory

1. Research should be conducted in a classroom situation where e-mail is an integral part of the course, so that student access to computers is not an intervening variable.
2. Research should be conducted with a greater sample size, so that gender can be included as an independent variable.
3. Future research should explore the lower scores in achievement and attitudes toward educational research of introverts, as compared to extraverts.
4. Future research should explore the variables responsible for student nonresponse to e-mail, such as computer anxiety and learning styles, so that educators can find ways to reach these students.
5. Follow-up studies should be done to see if the mentoring relationship established for this research through e-mail continues.

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Slick Tech Tips: How to Polish that Professional Image

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Declining budgets in post-secondary settings have led to a corresponding reduction in secretarial assistance to instructional staff. Faculty members are suddenly finding themselves with a computer and are expected to produce documents that have a professional appearance. In response, they are throwing their hands up in frustration, as their lack of knowledge and experience in page layout places them at a significant disadvantage. For individuals accustomed to being in control, this situation may also contribute to the reluctance of many to utilize the available technology. Some faculty have openly stated that if they simply refuse to do it, the university will have no option but to return secretarial support to the levels to which they had come to expect.

Too often, professionals have taken for granted the skill that has resided in their secretarial pool when it comes to producing a polished looking document, even something as simple as a letter. Now, suddenly placed in the role of having to duplicate these same results through their own efforts, it has become obvious that office professionals were doing more than "just typing." An attractively designed letter, syllabus, or paper is a professional's calling card, their representative to another individual when personal contact is not always possible. A good impression is important.

The Challenge

Within every institution or setting, there tends to be a spectrum of personal skill when it comes to technology. When focusing on those who display reluctance to involve themselves with computer technology, one of the most frequent comments is that it wouldn't make sense for them to spend time using the computer because they are unable to type. Naturally, the urge is to suggest a popular, computer-based typing program which would assist them in acquiring the skills. There is no doubt that the individual who can touch type has an advantage when it comes to producing a document. Exploring further, though, is important. Given that they would have low to moderate keyboarding skills, the next question arises, what are they going to do with them?

Knowing how to operate a kitchen machine doesn't make one a chef. In the same vein, knowing how to type doesn't necessarily guarantee an attractive final product. Yet, it is often presumed that before someone can produce a piece of which they will be proud, they are first going to have to master keyboarding. Perhaps the reverse is really the way around this. Show a professional how to produce an attractive document their first time out, and just maybe that will serve as the incentive to become more skilled at both keyboarding and computer technology.

Let the final product be the incentive rather than the diligence to master keyboarding eventually leading to a reward. Your aim is to motivate and as Boylan (1996) states, motivation creates momentum. Motivating someone creates "an energized attitude" which in turn leads to motivation. "What's motivation? Getting people excited so that they act in a focused direction" (Boylan, 1996, p. 157). Institutions need to find an array of possibilities that might serve to motivate and engage the individual at the person level. Change may be mandated from top-down but lasting change only occurs from the inside-out. The individual is the lowest common denominator in the change process, and the most powerful.

Implications

A private conversation with a dean at a large university recently revealed that this issue is having larger ramifications for post-secondary institutions. His own college had faced secretarial cut-backs a couple of years before, and faculty were now producing their own documents without guidance. It wasn't until he encountered samples of these documents out in the community, that he realized that faculty knowledge of page layout was impacting on the impressions people were forming of the university. He saw this as a more serious issue when it came to competing with surrounding institutions for students, especially when it came to contract classes, which are situations where businesses or school districts have a population of students drawn from their work place settings and universities are contracted to provide the instruction for those individuals. His concern was that outside agencies would interpret a poorly designed document as reflecting the skill level of the faculty at the institution.

Williams (1994) produced an excellent resource that addresses the needs of novices, *The Non- Designer's Design Book: Design and Typographic Principles for the Visual Novice*. In the opening statement the author, speaking from the perspective of a professional designer, says the book was produced for students who understand that a better-looking paper often means a better grade, the professionals who realize that an attractive presentation garners greater respect, the teachers who have learned that students respond more positively to information that is well laid out, the statisticians who are seeing that numbers and statistics can be arranged in a way that invites reading rather than sleeping, and on and on (Williams, 1994)

The point is that the design of a document is an important issue, that it does have an effect on the way information is received, and, at the heart of that, it may combine with personal reluctance to form another barrier to impede effective utilization of technology among post-secondary instructors with limited skills.

Is There Another Way Of Looking At This?

Rather than view this refusal to adopt technology as a sign of lack of cooperation, it is more important to see it as an ego-protection device. Highly educated individuals, unaccustomed to feeling inept, are suddenly placed in situations where they have limited, if any, support and little experience. Culbert (1996) argues that the key to motivating individuals to change is understanding the psychological perspective of that person. How do they see what's happening? "Self-interests and personal, work-related effectiveness agendas significantly impact - even wholly determine - how people see events at work, and ultimately how they think to operate given those perceptions" (Culbert, 1996, p. 30). He points out that all people wish to be seen as competent and effective in both their work place and personal settings.

While every institution needs to communicate a vision of where they want their people to be, and the goal they are striving to fulfill, Culbert (1996) reinforces the importance of the individual in this process. Instead of pointing to a mark on the wall and telling someone that's what they're going to have to aim for, he suggests administrators need to look at where the person really is. His advice is to "engage them where they actually are" (Culbert, 1996, p. 33) and facilitate ways of having them incorporate the larger vision into their personal agenda. So, when it comes to getting faculty to use computer technology for everyday tasks, what is the pay-off for them?

The budget cuts that have reduced secretarial support are not likely to be reversed any time soon, so that faculty have no choice but to take personal ownership for much of their work. At the same time, these individuals also want their work to be seen in a positive light, an important aspect of which is a professional look. Practicality suggests that running all faculty through a design course is not feasible. Apart from heavy workloads limiting available time to fit in another workshop or meeting, design is not only a skill, it is a talent. Recognizing that mastery of page layout will be uneven among faculty, how then can institutions facilitate people producing documents that reflect well on the individual and the institution? How can administrators give faculty, especially the reluctant user, the confidence and ability to produce an attractive, credible document their first time?

The answer to the question is far simpler than it appears. Surprisingly, a tremendous number of people using common word processors are not aware of the page layout features built into the software. Even reluctant beginners can produce a newsletter or brochure that compliments their professional selves. People have tended to use the word processor as a typewriter without a carriage return resulting in underutilization of the many features that can make the job easier and the results quite professional-looking.

Recently, a faculty person with very limited computer skills, saw a newsletter this author had produced. Complimenting the final product, the faculty person commented that they would never be able to produce anything like that. Knowing the computer system that had recently come to reside on the individual's desk, the author pointed out that if the faculty person wanted, she, too, could produce a document that was a mirror image of the one she was presently admiring without having to know much more than how to type in the content. The secret is templates.

A Look At The Possibilities Of Templates

All of the major word processing packages residing on faculty desks including Microsoft Word, Corel WordPerfect and Lotus Ami Pro, have built-in templates. These templates are professionally designed documents covering a variety of tasks, including business letters, brochures, newsletters, signs, and a number of other categories. Most of the latest versions also include the ability to convert certain features to HTML. In addition to those already in the software packages resident in the building, commercial design packages are also available for purchase, and many cover a vast array of possible projects.

The only effort required on the part of the end-user is the content. A faculty person can call up the newsletter template (usually there are three or four designs to choose from), follow the on-screen instructions, enter their information, and a while later, they have a beautifully designed document. A complete novice to word processing will need some assistance to get up and going to use templates, just as they would regular word processing facing a blank screen but the end result is what is different in the two scenarios.

The valuable feature about templates is that they can also be generated locally. Faculty are required to fill-in countless forms every year. Electronic templates of these forms can be easily produced and distributed to faculty, decreasing effort. Another point to consider is that faculty supervising students have a variety of communication tasks, many of which are common to all colleges. Producing a document template for each situation assures administrators that students are all receiving the same core information, while at the same time, allowing faculty opportunities to personalize the letters, yet cutting down the time required to produce them. At the most rudimentary level, templates incorporating the institution's letterhead can be stored in electronic format so there's never the need to hunt for the right stationery again.

Most high-end word processing packages also allow for the incorporation of "macros" into documents. This would allow templates to be produced which would prompt the user for information. Think of it as word-processing with a guide.

Finally, use of templates also serves as a teaching function. Using professionally designed templates exposes faculty to models of how documents should look. They learn that a Times Roman font is more appealing than a Courier font. They see how professionals would design a page. Inevitably, they will begin to utilize some of those same features when they produce their own original work.

Templates are nothing amazing. In fact, they're very ordinary. But most faculty are unaware that they have such powerful and flexible assistance only a couple of mouse clicks away. As technology, regardless of its sophistication or complexity, is fundamentally a tool, the critical question for most in higher education is whether a given tool can improve the caliber of their work. As templates address issues of format and layout, instructors can be freed to focus on the clarity of a document's content. If an attractive product that clearly communicates has been produced by leveraging their existing skills rather than demanding that they acquire new ones, faculty may regard the technology as a empowering tool rather than an impending threat. Thus, readily available temples can be valuable tools in reaching faculty who need to master technology skills and don't know where to begin.

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INSTITUTIONALIZING SYSTEMATIC FACULTY DEVELOPMENT FOR INTERACTIVE DISTANCE LEARNING

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Established in 1963, the University of Central Florida (then called Florida Technological University) began classes in October 1968 with an enrollment of less than 2,000 students. Today UCF is a metropolitan university that has five colleges, two branch campuses and a downtown center that serves over 28,000 students. The institution has had a history of ad hoc distance learning activity to serve specific populations over the years. In the summer of 1996, an initiative was made by Academic Affairs in the Provost's office to begin a systematic process of faculty development for the creation of on-line courses within certain academic programs. The success of this faculty training has lead to rapid institutionalization of distance learning with an emphasis on faculty development.

Demographics in Florida

Enrollment projections in the State of Florida indicate that an increase of 35% is anticipated between the years 1990-2001 for graduating high school seniors (State University System Addendum to the Master Plan 1993-94 to 1997-98). These figures do not take into consideration the numbers of adult students returning to school. The need for alternative delivery systems is evident. The state task force on distance learning defines distance learning as:

> Planned learning that normally occurs in a different place from teaching; as a result of the separation of learning and teaching, special techniques of course design are required, as well as special instructional techniques and special methods of communication by electronic and other media (State University System Addendum to the Master Plan 1993-94 to 1997-98, p. 2).

Factors Leading to Delivering On-line, Interactive Courses

The University of Central Florida has six feeder community colleges in its service area. These schools and UCF serve 11 counties within the Central Florida region. A consortium among UCF and these six community colleges was established in the late 1980s, called the Central Florida Consortium of Higher Education (CFCHE). The Consortium applied for and received one of five distance learning demonstration projects awarded by the State University System in 1995.

The Consortium's Distance Learning Demonstration Project had three areas of interest: faculty development, learner support and a survey course. Advisory committees were created with participants from every member school. The authors were also involved with the Distance Learning Demonstration Project. Steve Sorg was the executive director of the Consortium and Barbara Truman was the Consortium's communications specialist and webmaster. The Demonstration Project brought together faculty and staff from the seven institutions on a regular basis to collaborate on identifying common needs and goals for distance learning.

During the year-long project each advisory committee researched and participated in forming and fulfilling distance learning objectives. The Faculty Development Advisory Committee created a survey instrument for assessing the knowledge of, use of, and attitudes toward technology and distance learning. Next, introductory, intermediate and advanced workshops on distance learning were conducted at various institutions within the Consortium. The Learner Support Advisory Committee conducted a survey of student services offered at member institutions and an all-day learner support workshop was held by Sprint. The Survey Course Advisory Committee planned and created a series of video tapes based on the use of technology within Consortium schools.

UCF's First World Wide Web Course

The World Wide Web and Internet provide hypermedia (point and click) access to instruction which is linked with hypertext. The Web combines photos, graphics, test, audio and video (where available) in an interactive environment. The Internet and the Web have two advantages over other media according to Thomas McManus. The Internet combines media advantages of other media so that the Internet conveys sounds and video better than books and is more interactive than videotapes and unlike CD-ROM delivery people can be connected cheaply from all over the world. The Web is also a content provider.

The first UCF Web-based distance course was an experiment based on necessity. Steve Sorg was a professor in Vocational Education slated to teach three methods courses in the summer 1996 session. One of the courses was only offered at UCF within the state. Barbara Truman was also finishing up her masters degree in Instructional Technology. Her internship requirements necessitated finding a suitable project to stay on at UCF. Steve Sorg proposed collaborating to put his Vocational Courses on-line. The paperwork was filed and research began with a review of literature. Apart from the knowledge of the department chair, the college and institution was unaware of the project. Sorg and Truman prepared themselves for designing a Web-based course by attending the distance learning workshops conducted by the Consortium's Distance Learning Demonstration Project. The pair also attended video and teleconferences on distance learning whenever available. A conference was attended to meet actual faculty involved in distance learning. The authors learned that courses inviting debate, discussion, and knowledge-based opinion sharing were best suited for Computer Mediated Communications such as the Web (Ursery, 1995). Sorg's courses for teacher certification met these criteria.

Findings from the Literature Review

Reviewing the literature involved searching the World Wide Web for actual course examples. The World Lecture Hall is a rich source of course Web pages. Most pages located there appeared to be for Web-enhanced classes rather than pure distance classes. In a face to face, Web-enhanced class, existing course materials are put on the Web for students to refer asynchronously. Often, these materials do not appear to be modified in content from their original states. In on-line distance learning this is the worst possible mistake: same materials only in a different format. Web-enhanced classes that have meetings afford opportunities for the faculty member to elaborate on the meaning and purpose of these materials. In an on-line distance course, the students do not have these frequent opportunities for clarification.

Other course Web pages reviewed in the literature had inconsistencies in design conventions. Few pages had recurring elements such as the faculty's name, university affiliation or course name. Even fewer had *mailto* links to contact the faculty member. Some pages were not printable and others were easy to read until the textured background popped in.

Designing on-line courses requires thorough research because some critics believe that successful distance education must replicate face-to-face classroom interaction. To attain the highest quality teaching and learning at a distance, consideration must be equally made in the theoretical perspectives of learning, subject content, and learning context such as delivery mode and learner characteristics (Naidu, 1994). On-line instruction affords the opportunities to create learning environments as well as communities of scholars.

First Course Design, Development and Lessons Learned

Unlike the traditional classroom, in an on-line class students are expected to construct their own knowledge and see many perspectives. Students must be more autonomous, self-motivated and independent, although they also must work collaboratively in groups. Students must also learn about how they learn to better manage their study time. Students' access to study resources is greatly enhanced with links to computer resources and other experts (Collins & Berge, 1996; Zack, 1995).

The first course design included deliberate elements that were specifically found or not found in the literature review and Web search. The first element was a student information form. Besides helping us know our learners, anticipate problems and intervene quickly by telephone, these forms were collected and used to create and publish a student directory list on the Web site. This directory helped facilitate the student-to-student interaction. In distance courses it is absolutely critical that this is initiated by the faculty member (Barker & Baker, 1995). It is not enough to interact with the faculty member and the content; students must interact with each other in order to build learning communities. With e-mail, senders do have the opportunity to see what you think before someone else sees what you said (Maddox, 1995). Without the use of frequent, meaningful e-mail, the course would wind up being little better than a correspondence course.

Advanced organizers were another design feature incorporated into the Web-based first course. Advanced organizers are tools that help stimulate thinking and activate prior knowledge and recall. They help the learner hang new information on their existing schema. One drawback of the Web as a media is the abundant distractions that are available a mouse click away. The ability to discriminate between valuable and junk information is a critical attribute for on-line distance learning students. Judging sensationalism, distortions, persuasion and understand how the technology itself shapes the information it carries (White, 1987). Another deliberate design feature was centralized content links on certain home pages for the subject matter, study helps, general education links and metacognitive links. Embedded links to content were also used in specific page locations as parts of activities and potential resources, but centralized links were used because of the learner characteristics (adult learners) and the lack of prerequisite search skills.

Our on-line resources included study helps and distance learning critical competencies as a teaching strategy. The other courses reviewed in the literature review made very little to no effort to support students with general education references, nor were they frank about letting students know about necessary skills to succeed as distance students. These skills include responsibility for one's own learning, self-discipline, time management and knowing one's own learning/personality styles (Sherry, 1996).

Evaluation was another design element built into the first course's Web site. Feedback along the way during course implementation was important for formative evaluation so that adjustments could be made to activities. One of the greatest dangers in on-line distance courses is that instructors cannot read from students whether the work they are assigning is attainable or that the students are grasping the instruction. In a face-to-face class, students can whisper to one another, react with dismay and check with other students for the reality checks of assignment load. Not so in an on-line distance setting. Students in the first course were able to click on a Web form and fill out the questionnaire regarding the usefulness and difficulty of each activity. The CGI-scripted form sent back an easy to read e-mail message to the instructor when filled out and submitted by the student.

Summative evaluation was also a very important design feature for improving future courses. The university's traditional instructor course evaluation was used, but it clearly did not apply to this new learning environment so another instrument was created. Students in the first course were required to drive in for the final exam. At that time, students sat down and filled out a pencil and paper evaluation. Sixty-one of the seventy-two students filled out the final evaluations. The data collected was helpful later in designing faculty workshops.

Humanizing Web pages was another design strategy incorporated into the first course pages. On-line course materials reviewed showed a great deal of "professorese" in the style of writing. Our first course reflected instructions re-written to reflect the first person voice. Students were spoken directly to from their professor. Personal photographs were also added to the pages to show the professor working on the computer and talking to the students on the phone. Use of a personal homepage for the professor was also considered very important to give students an identity to connect with so that e-mail messages were more personal. The professor's photo, hobbies, research interests and work affiliations were all known to the students.

A technology not overlooked in the design of the first on-line course was the facsimile (fax) machine. Students recommended improving distance learning courses by using a fax machine as an additional resource.

Lessons Learned from the First Course

The first course did not employ sophisticated media or software tools. Rather, the course used only the World Wide Web and e-mail. The professor requested that students copy him on course-related e-mail interactions and as a result was inundated with e-mail traffic. The interaction soon broke down and students were asked to be patient. The decision to allow 72 students soon revealed the burden of responding to messages and grading work.

Specific lessons learned were:

1. Make equipment and prerequisite skills clear well in advance.
2. Market the class appropriately to get the right students in the class.
3. Establish protocols and Netiquette for the composition of e-mail messages.
4. Establish expectations for reasonable interaction and response time for grading.
5. Create an e-mail account for the class so that e-mail does not all go to the faculty member's personal inbox that also has adequate memory for course materials.
6. Use asynchronous computer conferencing to balance the push and pull of interactions.
7. Obtain an e-mail software system that has filtering for sending received mail into specific folders, and that has custom autoresponse for replying to students sending in work.
8. Install virus protection software and scan everything all the time.

The Institution's Systematic Process for Faculty Development

The first Web-based course was being designed and implemented as the UCF central administration was investigating a systems perspective of thinking for designing new distance learning strategies (Thach & Murphy, 1994). Distance learning needs for students were assessed with data collected from Brevard Community College, one of the Consortium's member schools. Based on the number of community college students taking telecourses, the direction was taken to develop an on-line Liberal Studies bachelors degree. Another program developed was actually a doctoral track within the Curriculum and Instruction doctoral program for community college faculty. To meet these goals, a budget was set aside to create the Course Development Project. Office space was assigned and a faculty position was created within Academic Affairs for an instructional designer/course developer (Truman) with support from a graduate assistant and student assistant. A faculty coordinator was also assigned (Sorg) to assist in planning, researching and delivering the faculty development workshops.

Lorraine Sherry (1996) states, "The most important factor for successful distance learning is a caring, concerning teacher who is confident, experienced, at ease with the equipment, uses the media creatively, and maintains a high level of interactivity with the students" (p. 5). The faculty selected for UCF's interactive course development were first nominated by their deans for inclusion in the Course Development Project and later chosen by Academic Affairs. An assessment was then conducted to determine skill levels and the state of equipment being used. Compensation was given to faculty for a course release to attend training and develop an on-line course. New multimedia computers were purchased in the cases where antiquated computers were in use.

Interactive Course Development workshops were held in July 1996 and in September-October 1996. During the summer, faculty were expected to attend five, three-hour workshops. Critical technical skills were handled on an individual basis based on need. Distance learning technologies were used and modeled. Eastmond and Ziegahn (1995) describe a good teaching experience as one where students can master new knowledge and skills while examining assumptions and beliefs, where students can engage in invigorating, collaborative research for holistic development. This holistic development also applies to faculty members. Course Development Web pages were created with photographs, both posed and candid shots, of participating faculty. Links were made to all the Web content handouts, computer conferencing forum, Web page generator and forms for supplying feedback (See http://www.oir.ucf.edu/tpt).

One of the greatest needs for systematic faculty development in developing Web-based courses is the need for faculty to prepare themselves for their change in role from lecturer to facilitator. Another consideration in the quality of designing a distance course is the faculty member's ability to relate to students. Ross Paul (1995) states:

> Faculty members who tend to be the most powerful political group within an institution... may be less sensitive to the personal and skill development needs of part-time, adult students, given that the great majority of them completed their degrees on traditional university campuses on a full-time basis and were successful students who faced far fewer academic problems (p. 54).

Teaching skills for distance learning include: understanding the philosophy of distance learning, dealing with copyright, adapting teaching strategies, designing interactive courseware, identifying learner characteristics, organizing instructional resources for independent study, using telecommunications systems, collaborative planning and decision making, and evaluating student achievement and perceptions (Schlosser & Anderson, 1994).

A formative evaluation was held after a month of running the first eight courses. The evaluation revealed a need for more hands-on activities. The September workshops were expanded and redesigned with an extra one and one-half hours of hands on, computer activities. The subjects of the three-hour workshops were:

1. Orientation to distance education
2. Orientation to distance learning practices and technologies
3. Systematic design process
4. Quality, interaction and assessment and
5. Distance learning course administration.

Creating Web pages was not considered to be critical for creating on-line classes. Rather the focus of the faculty training was on instructional design for creating Web-based, learning environments. The course development process is a team effort consisting of subject matter experts (faculty members), instructional designers, programmers and graphic artists. In addition to the support provided by this course development team, an automatic Web-page generator tool was developed to prevent the faculty from having to learn HTML. The page generator tool uses CGI-scripted forms and Java scripting for interactivity. Faculty involved in the course development project assisted with the course instructional design components incorporated into the Web page templates used with the page generator. A template for each college was designed with all of the course conventions and instructional design components. The Web page generator tool was not expected to be widely adopted by those faculty that preferred to do their own HTML, but the adoption rate was high because of the tool's user-friendliness and time saving feature.

Nearly thirty faculty members participated in the summer and fall Course Development Project. Eight courses were produced in the Fall 1996 term and ten more are being developed for Spring 1997. The College of Arts and Sciences allowed faculty to work in teams for development and conducting the class. One team chose to design their own pages with Pagemill (Macintosh) software. The temptation to get something up on the Web caused these pages to be redone and the course to be simplified. Some faculty chose to take up the design team's offer of assistance such as creating forms for quizzes while others did not. The greatest challenge to the course development process was the existing campus technology infrastructure. The campus computer support was inadequate and the new pressures to support distance learning faculty, much less students, was a tall order. Designing on-line, Web-based courses is a change process that takes time. The success of the Course Development project, despite the obstacles, is leading the campus towards greater networked learning.

Networked-focused learning is resulting from the exponential growth of the Internet where student-initiated data gathering and interactive communications make learning potential incomprehensible (Barker & Baker, 1995). They add that network-focused distance learning will one day ellipse the practice of classroom-focused distance learning.

The key to success in distance education is the teacher. Faculty must be master teachers (Barker & Baker, 1995). Instructors must challenge the student to use their higher thinking to research, problem solve and inquire about their own answers (Mizell, 1994). UCF's Course Development Project has lead to rapid interest in distance learning across disciplines and colleges. Systematic faculty development is the key.

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A University Model for Promoting Technology Innovations Across Disciplines

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As a result of its reinvestment strategies for the campus, the Center for Instructional Design and Delivery (CIDD) was established at the University of South Dakota in July of 1996. The CIDD is a centralized collaborative model promoting quality instruction and learning, as well as providing educational opportunities for development of innovative instructional methodologies. The primary focus of CIDD is to provide opportunities for faculty to investigate and utilize technologies in innovative ways in traditional classroom settings, distributed learning environments, and distance educational delivery systems. The purpose of CIDD is to help faculty incorporate technology into training/teaching, course/curriculum design, evaluation/research, delivery adaptations and expansion, and faculty development.

CIDD Facility

Currently CIDD is borrowing other facilities around the campus for its training workshops, but that inconvenience has resulted in the development of a plan for a centralized center. The renovation of this facility will provide a location for training and teaching activities, as well as equipment for use and skill development by individual faculty members. Office space and meeting rooms for staff and faculty will be available on the second floor, as well as space for hosting corporate training seminars. Once renovation is completed in July of 1997, the CIDD will also serve as a showcase for the USD campus as part of its recruitment and admission activities.

CIDD Staff

Co-directors of the CIDD represent collaboration between academia and support services on the USD campus. Other currently funded CIDD staff positions include the following:

- Graphics Designer/Multimedia Design and Production Specialist
- Photographer
- Videographer/Digital Video/Audio Production Specialist
- Administrative Assistant/Smart Classrooms Technician
- Electronics Technician
- Senior Secretary
- Four Graduate Assistants

Two positions yet to be hired are the Instructional Coordinator and the Instructional Technologist. The Instructional Coordinator is a staff position and he/she will be responsible for scheduling and conducting training sessions for USD faculty, staff, and students. The Instructional Technologist is a tenure-track faculty position with half-time appointment to CIDD and half-time appointment to the School of Education. Typical faculty duties of instruction, research, and service will be part of his/her responsibilities in the area of instructional design. That person will also be instrumental in the establishment of curricula for the new graduate degree programs in the Division of Technology for Training and Development in the School of Education.

CIDD Faculty

The CIDD model reinforces the idea that faculty members need release time to develop their skills in the rapidly changing field of technology. The CIDD faculty consist of two representatives from each of the academic units on campus (the College of Arts & Sciences, the School of Business, the School of Education, the College of Fine Arts, the School of Law, and the School of Medicine). Currently 12 faculty members have 50% release time (25% funded by CIDD and 25% funded by the individual College or School) to devote their energies and talents to the CIDD activities and the campus initiatives in technology. This sharing of costs for release time is considered an integral part of the CIDD model since it requires a commitment and shared responsibility by both the academic unit and the University.

Expectations

As a result of their assignment to the CIDD, the following expectations (as a minimum) have been placed upon those faculty relative to their duties during the academic year:

Design or redesign at least two courses during the year. It is the intent of this project that CIDD faculty keep in mind the need to integrate new and emerging technologies into courses when appropriate. This is extremely important as curricular needs change and new programs are being developed. This specific task provides some focus for the faculty members and provides a direct product for their academic unit.

Serve as a liaison between the CIDD and their academic unit. CIDD faculty are expected to share the information they receive from training workshops and informational meetings with their colleagues. Hopefully this approach helps address some of the public relations needs for a project of this magnitude. Efforts are also being made to promote the idea of CIDD faculty working with their colleagues at other institutions of higher education and the profession.

Assist in the development of basic technology courses appropriate for their academic unit at both the graduate and undergraduate levels. This task is extremely important because of the change in skill levels of incoming freshmen and returning graduate students. Each academic unit is represented in this discussion, with the hope of developing core competencies in technology. CIDD faculty have surveyed the faculty and are currently in the process of making recommendations to the academic units relative to competencies in the areas of word processing, use of presentation software and equipment, and use of the Internet and World Wide Web. Recommendations are also being made to address competencies specific to certain disciplines, such as spreadsheet software for the School of Business or imaging software for the College of Fine Arts. Eventually CIDD faculty will have the responsibility for offering some of the training seminars (credit and non-credit) in technology for students.

Work as a mentor to help three other faculty members redesign his/her courses. As part of the return to their college or school, CIDD faculty are expected to share their newly developed skills and/or facilitate discussions with their colleagues concerning appropriate resources on campus. Each CIDD faculty member has identified colleagues from their academic units responsible for redesign of their curricular offerings, with whom they plan to collaborate during the academic year.

Attend all training sessions offered by the CIDD. Three to four training sessions are offered weekly to CIDD faculty to assist them in their skill development. Sessions are informational and hands-on in their approach to learning. Topics for this year include Multimedia Overview, Networking Overview, Instructional Design Issues, Basics of Photography, Basics of Videography, Web Page Development, Videoconferencing, Web Page Design Principles, Multimedia Overview, Use of SMART Classrooms, Creating Forms for the Web, Digital Photography, Digital Imaging, Digitizing Audio, Audio Editing, Overview of Using CD-ROMs, Pressing CD-ROMs, Video Editing, Digitizing Video, and Video in Multimedia. Plans are being made to provide additional topics as appropriate. All sessions are repeated at least once each semester and are made available to all faculty on the USD campus.

Assist the CIDD in offering workshops to others around campus. Faculty who have been identified to serve as campus resources are paired with CIDD faculty to provide training to others. Currently twelve training sessions are offered to the campus each semester, with more being planned as the need arises. CIDD faculty will be responsible for coordinating and marketing those sessions. Some of the sessions will also be offered to faculty at other state institutions via videoconferencing.

Make a presentation at a CIDD-sponsored conference. An annual campus-wide conference in April known as IdeaFest will serve as one avenue this academic year for the dissemination of information to the campus faculty, staff, and students relative to research in the field of technology. The presentations will address the conference themes of Undergraduate Research and Diversity. In addition, weekly presentations are made by CIDD faculty during noon forums to highlight new innovations in technology and the direct application of technology to their courses and curricula. Many CIDD faculty have also had presentations accepted at the state, regional, national, and international levels for conferences in their content-specific disciplines. In the future, the plan is for CIDD and the University to sponsor a technology conference for the region.

Provide advice and/or assistance in the design, development, and maintenance of the CIDD home page. A web page has been designed by the CIDD faculty (http://www.usd.edu/cidd/) in order to keep the campus informed of CIDD activities. This activity is a direct result of training provided to CIDD faculty in the area of web page development. CIDD faculty will also be responsible for reviewing and evaluating the effectiveness of that medium for distribution of information.

Assist the CIDD in the pursuit of grant funding. As with any group or organization, receipt of external funding is encouraged. Although the University of South Dakota has decided that this initiative deserves annual funding, not all needs can be met as technology and personnel change. It is also hoped that this type of activity will encourage faculty from different disciplines to work together in the development of proposals in new areas of research and instruction. Currently, several individual CIDD faculty proposals which incorporate the use of technology into their design have been funded by internal and external agencies.

Attend one professional meeting related to the use of technology. Faculty development can not be limited to local expertise. The CIDD philosophy encourages faculty members to attend technology conferences (not just ones related to their content areas of expertise) and then return to campus to share that knowledge with others through seminars, colloquiums, and general presentations. That information will also be shared through the CIDD home page and other resources available on campus.

CIDD Advisory Board

The CIDD Advisory Board has also been created to represent the interests of faculty, staff, students, and administrators at USD relative to technology-related issues. In particular, this Advisory Board will assist the CIDD in addressing academic and support services for the campus by its monthly review and advisement relative to CIDD-sponsored activities. Advisory Board members have also been asked to serve on numerous committees to deal with policy issues, recommendations for equipment purchases, and renovation of the CIDD facility.

Summary

The University of South Dakota has made a commitment to the use of technology by its faculty, staff, students, and administrators. The Center for Instructional Design and Delivery (CIDD) provides a model for other colleges and universities wishing to meet the technological needs of their campus. By investing in training and development for the users of technology and by promoting the integration of support services, this cooperative approach should reap benefits this year and in the future.

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Tools, Techniques, and Training: Helping University Faculty Put Courses On-line

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In 1996, the authors of this report were funded by the California State University's (CSU) Chancellor's Office to train faculty from each of the 22 CSU campuses in a workshop designed to wed innovative pedagogical techniques with new models of distance education. An outcome of that grant was a program entitled Distributed Course Delivery for Problem Based Learning (Hoffman & Ritchie, 1996). This program included video teleconferencing sessions with each of the collaborating universities, a series of newsletters showcasing innovative educational ideas, a series of on-line Internet chats with experts from around the country, and a culminating two-day workshop. Although participant evaluations indicated high praise for both the knowledge and skills gained, we felt there was still something missing—that there was more we could do to help CSU faculty adopt emerging technologies in their teaching and scholarly activities.

In the fall of 1997, the CSU Chancellor's office published a second round of requests for proposals, again looking for faculty development with an emphasis on pedagogy and distance education. This year we submitted what we believe is an evolutionary step towards a faculty development model that is particularly relevant to technology integration in the CSU system. Rather than bringing faculty from around the state to our campus for training, we proposed conducting an entire institute through a variety of distance delivery methodologies; in essence creating a virtual institute that would assist faculty from around the state in creating on-line materials for their courses. We believe that this proposal synthesizes the best features of training, peer coaching, and modeling, with the power of Internet communications and automated tools and templates to support faculty on-line publishing efforts.

One of the strengths of the proposal is the use of a variety of communications technologies to supplant the time and cost involved in travel, physical accommodations, and instructional facilities of a central site. These technologies not only allow for more effective use of faculty time, but also model the essence of the proposal's intent which is to implement distance learning technologies capable of making lasting changes in the educational system. We also requested that funds earmarked for Institute participants' travel expenses be re-allocated to support the connectivity needs of participating faculty, including underwriting the cost of desktop video conferencing and screen sharing capability at each campus, as well as reimbursing faculty to serve as coaches/mentors at each of the 22 campuses. The total cost of these capacity-building expenditures is a fraction of the expenditure required for physical travel.

We also proposed an innovative method of distributing institute materials. Rather than merely maintain the tools, templates, and training materials on a web server at the host university, we proposed to upload and maintain these components on servers at each of the 22 CSU campuses, thereby providing a local course development resource that can be customized and expanded to meet the needs of each campus community.

Taken together, we believe this model is not only a step forward in the creation of programs for California, but is relevant and applicable to other universities or state agencies as they move towards expanding their use of the Internet for course delivery.

Strategies

Few faculty use the Internet for course delivery. Bemoaning this state of affairs ignores the fact that universities hire faculty primarily for their content expertise, not their Internet programming skills. The time and effort required to surmount technical hurdles, such as mastering hypertext markup language (HTML), prevent many faculty from attempting to publish course materials on-line. In the recent past we have not expected faculty to master all the crafts, such as typography, page layout, and offset printing, needed to deliver their print-based course materials; universities and publishers provided these services.

The World Wide Web presents a different situation. For the moment, at least, the Web has removed intermediaries between faculty authors and student readers. Web publication appears, on the surface, to be merely an extension of word processing (a technical skill itself, which, we should remember, we have come to regard as a "baseline" skill for faculty only in the past decade, if at all). Web publication, however, is in a difficult stage of development. At its best, it is not merely an extension of word processing, but a new, interactive medium of instruction. Taking full advantage of the Web's interactive capabilities requires much more than word processing skills. Yet we often assume that faculty who want to "stay current" can and should become competent Web authors.

Even when faculty are agreeable to and capable of Web publishing, the availability of on-line services to students, availability of existing content in electronic form, and appropriateness of course material and instructional interactions for on-line delivery may prevent a given course from being successful.

Our goal in creating the Institute is to provide faculty with easy-to-implement methods whereby they can rapidly and easily create and manage web-based course materials. The strategies we use center around three components: tools to facilitate rapid creation, development, and management of web-based course materials; techniques to enhance on-line teaching ability and conceptualization of the Internet as an instructional medium by the faculty; and training via the Internet, including a pyramid-type dissemination system, to help distribute the ideas of the Institute throughout the CSU system. We will also purposefully model ways in which faculty can exploit intermediary campus resources, such as faculty development offices, publishers, and campus bookstores, to aid with Web site development and maintenance.

Tools

We realized early in our research that although many faculty believe the Internet is becoming an important means of communicating and delivering information to students, many feel overwhelmed by the rapid evolution of the medium, and fail to envision how they can use it to their advantage. Much of this apprehension is due to the newness of the medium, the skill required to master the programming techniques, the time required to create course materials, and the lack of valid peer examples to set a standard for development.

To help faculty overcome some of these obstacles, we decided to create a series of Web-based and stand-alone tools and templates that, when completed, will provide many of the necessary components of an on-line course. To determine what type of templates would be most needed and feasible to incorporate, we examined professors' current practices for both on-line and traditional course delivery. Results of this analysis led us to include templates for creating the following components:

- a personal home page,
- a course home page,
- a course syllabus,
- a course schedule,
- course notes,
- WebQuests (Web-based student inquiry activities),
- forms for reflective questioning, and
- on-line testing.

The templates will be available in two formats. First, they will be available on line as forms which prompt users through a series of questions, then automatically create relevant Web pages based upon the submitted information. Faculty can then view and save the document source to obtain the HTML code. For faculty creating their pages on machines not connected to the Internet, the templates will also be available in standalone multimedia programs which also create HTML documents. In either case, as faculty complete the templates, they will have a basic, but fully developed, ready-to-run custom Web site for their course.

Techniques

After developing and implementing the templates described above, the Institute will engage faculty in further explanation and customization of their site as they explore possibilities for both innovative and traditional learning activities. To this end, we are creating a five-module on-line course, consisting of approximately 10 hours of instruction. The course will provide the techniques and strategies to help faculty develop and manage their own on-line course modules as well as model technologies such as videocassettes, print material, and World Wide Web delivery. On-line resources and instruction for the Institute will include publication of course documents, research, asynchronous forums, synchronous chats, instructional multimedia, e-mail, collaborative design, exchange and critique of electronic documents, and on-line assessment. These will be supplemented with instructional videocassette and print materials. The course will also model on-line course management incorporating both innovative and traditional instructional strategies.

Course content will center around five major topics:

Strategies and tactics for on-line teaching and learning. This module will include the following topics: benefits and limitations of on-line learning, identifying course content appropriate for on-line delivery, implementing traditional pedagogies on-line; new possibilities and opportunities for teaching and learning on-line, best practices in on-line instruction and education, and pedagogy for distributed multimedia and distributed learning communities.

Document preparation for on-line courses. Topics in this module will include: using templates specially designed by the Institute for helping professors quickly and easily mount course-related Web sites, using HTML editors; preparing graphics and media files, and converting existing text (word processing) files for delivery via the World Wide Web.

On-line student learning activities. This module will focus on: organizing selected course content around on-line learning activities, best practices in on-line learning, creating activities that are easy to implement and maintain, searching the web for content, activities and other resources, and assessing on-line learning.

Nourishing an on-line learning community. Topics in this module will include: facilitating on-line student communication by designing and managing on-line forums and chats, and creating and maintaining student document exchanges.

Management of on-line course resources. This final module will include: developing and maintaining course-related on-line publications and activities, especially a course Web site, strategies for increasing personal productivity as an author and manager of on-line course resources, developing a plan for gradual improvement of on-line course-related content and activities, and identifying CSU and local campus support for web-based publishing.

The course content is designed to provide faculty with the conceptual understanding and techniques to create, develop, and manage an on-line course. The tools are designed to provide faculty with easy-to-use templates to create many of the required components of an on-line course. The third component of the Institute—training—provides a method for effectively disseminating these tools and techniques throughout the CSU system.

Training

The Institute combines the dissemination power of a "train-the-trainers" approach with the instructional effectiveness of coaching and mentoring in a "peer coaching" strategy. Our plan is scheduled to operate in four tiers.

First, we will recruit one participant with at least a base level of experience with on-line course development from each of the 22 campuses to serve as an on-campus mentor or coach. This individual will participate in training through a combination of on-line instruction and coaching via video conferencing and screen-sharing. Each campus coach will in turn spend a total of 15 hours supporting three other faculty on their own campus, one-on-one or in small groups, as they participate in the on-line course. As an incentive, our grant proposal requested a stipend of $1,000, two Internet software packages for screen sharing and web page development, and a desktop video conferencing unit for each of these 22 campus mentors.

The second tier training will begin when the three secondary participants at each campus begin the five on-line modules. The previously-trained campus mentors will provide coaching for these participants: The Institute will provide back-up support for both coaches and participants. Each of these second tier faculty will be responsible for recruiting, training, and a total of 15 hours of coaching for three additional faculty members through the on-line course. We requested a stipend of $500 and an Internet software package for web page development for each of these 66 faculty (three members at each of the 22 campuses).

In the third tier training, the 66 second-tier faculty members will each assist three additional faculty members as they complete the five on-line modules and develop on-line course publications and activities. These nine additional faculty members at each campus (three second-tier faculty each coaching three additional faculty members) will work individually or as a team, as they prefer.

This model optimizes the potential to reach faculty in a significant way throughout the CSU system. The initial mentor, three participants, and nine additional faculty participating at each campus totals 286 faculty who will create on-line materials for students in one or more of their courses by the end of the Institute.

In addition to the 286 faculty directly reached through this initiative, the potential to reach even higher numbers exists. The course material will be uploaded to and maintained on servers at each of the 22 CSU campuses to provide a local course development resource that can be customized and expanded to meet the needs of each campus community. This distribution of the material will allow a fourth tier—an unlimited number of faculty at each campus—to complete the training and use the tools and templates to add value to their courses.

To qualify for their stipends, each coach and original faculty participant team members are responsible for publishing on-line course documents, including a home page for the course, a syllabus, a course schedule, an instructor home page, and on-line learning activities equivalent to one class session. In addition, each faculty must perform their respective coaching activities.

Assessment

To evaluate the effectiveness of the proposed approach, we plan to enlist the help of graduate students in our Department of Educational Technology to assess the breadth and depth of impact on course related use of the Internet and World Wide Web. The Institute will develop and maintain a directory of all web sites developed by participants and use this to monitor faculty contributions. Institute staff will monitor each course web site and determine the percentage of participating faculty who actually meet the criteria for successful completion of a course related Web site.

For purposes of this goal, minimum standards for a successful Web site will be:

- course home page,

- instructor home page,
- syllabus,
- schedule,
- student activities (group or individual) for one class session, and
- student interaction site or activity (forum, chat line, or document exchange).

The Institute goal is to ensure that no less than 88 course Web sites (four per campus) are fully established by October, 1997. We expect to see many more sites than this established in some form.

From sites completed by October, 1997, the San Diego State University Center for Learning, Instruction, and Performance Technologies will randomly select 40 for further study to include a qualitative analysis of the content and the degree to which faculty have gone beyond the minimum standards. Going beyond the minimum standards is an important indicator of impact because it serves as a measure of enthusiasm and interest as well as the degree to which faculty are able to adapt the technology to discipline specific content and campus idiosyncrasies.

Benefits

Individual faculty and the CSU system as a whole will receive four major benefits from this Institute.

- Empowerment to publish course materials. The modules and templates will allow professors to quickly develop and post course materials on the World Wide Web for use by CSU students and as examples for other faculty.
- Increased degrees of freedom. Fast updates, changes in course sequences, enhanced collaborations, distance delivery, and enhanced administrative protocols will allow professors to reduce some of the barriers to providing students with the information and support they need to be successful.
- Exploration of new strategies for teaching and learning. Sharing student files for peer assessment and feedback, teaching at a distance, and inquiry activities will enhance the variety of learning strategies implemented in faculty participants' classrooms.
- Modeling new technologies. The instructional modules will model the use of a variety of technologies including; videotape, Web-based instruction, Internet chats, and video conferencing, thereby providing professors with direct examples of the structure and system of implementing new learning modalities.

Summary

In many locales, private enterprise and distant universities are beginning to make inroads into the delivery of instruction through electronic delivery formats. Local institutions that are slow to respond may find that their traditional clientele are no longer required to settle for the nearest facility, and may instead turn to those institutions that provide the most expedient material.

Our purpose in designing, developing, and delivering the Institute proposed in this article is to provide a catalyst for the development of on-line courses for the CSU system. Whether creating teacher training courses or delivering content in other areas, we believe there is a need to adapt to changing modes of delivery to stay competitive in an expanding market place created through electronic media.

The tools, techniques, and training described in this article will augment CSU capacity building through the proliferation of new modalities of instructional delivery, faculty experimentation with on-line delivery methods, and a demonstration of methods for system-wide support of on-line publishing. These methodologies should help the CSU universities, as well as other interested educational institutions, maintain their competitive edge even in a time of reduced budgets. The Web location for the Institute will be available to participants at the SITE97 conference.

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Developing a Technology-Friendly Faculty in Higher Education

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In response to recommendations from a state external review team and the National Council for Accreditation of Teacher Education (NCATE), a small southwestern university made a decision to bring the Teacher Education faculty and students into the 21st century as rapidly and efficiently as possible. This involved acquiring computers and other technologies, providing professional training for the faculty, and revising courses.

At the beginning of the 1995 Fall semester, the School of Education and Behavioral Sciences was allocated two computer labs: an existing lab with 20 IBM 486's and a new Education Multimedia Lab of 20 Power Mac 7100's to be funded in two stages. Although the labs would have open access hours for all members of the university community, priority would given to teacher education classes and faculty use.

An existing tenure-track faculty position was redefined as a Technology Coordinator. Release time would be provided in order to incorporate faculty training and support and lab management responsibilities. Additionally, this faculty member would work with current faculty to revise and update both instructional technology courses and other education and methods courses.

The three major goals established were to develop a technology literate faculty with training in and access to education-related technologies, to support and promote faculty to integrate technology to enhance instruction and professional productivity, and to prepare pre-service teachers to use educational technology.

The project would affect faculty and staff of the School of Education and Behavioral Sciences and Teacher Education faculty (n = 93) and approximately 1200 students per year.

Model

The project model addressed and was based on three components: use of a systems approach, the theory of diffusion of innovation, and a cyclical orientation.

Systems thinking is a technology of the 1980's and is a way of looking at the whole system in order to recognize the interrelatedness and interdependence of it parts. Tinkering with one system element affects other elements. The use of this approach provided a means of identifying and addressing impacts of faculty training on other faculty, students, administrators, courses and other schools' faculty and students. A system analysis and design process was used to provide a procedural structure for the plan.

Anticipated responses to the plan were based on the Rogers' (1995) theory of diffusion of innovation. An innovation may be a process or a product and resultant changes because of the process or product. Diffusion is the way in which an innovation spreads. Technology diffusion reflects a complex system of interaction and interdependence that depends on the interplay of adopters' capabilities, opportunities and strategies (Shodjai, 1996). The implementation of the plan would attract the early adopters who would use and incorporate information technology for instructional and professional activities; mid- and late adopters would be addressed in subsequent stages.

The emergence of information technology as a curriculum component (or experience) is a significant innovation in higher education. The events of the past 15 years suggest a steady migration of information technology into instruction and other aspects of the learning experience (Green, 1996).

The model also reflected a cyclical orientation. In order to effectively address technology - use, training or acquisition - it is important, not only to understand but to proceduralize a non-linear format. Information technologies are not static; change has become a permanent aspect of hardware, software, training, and support. The model presents an affirmation of the recurring nature of technology in higher education.

Initial Stages

There were four stages in the first year: computer labs set up and operations, preliminary training needs assessment, beginning training sessions, and pilot collaborative plans to integrate technology into existing courses.

The initial stage required that the labs now available to the School be organized for faculty and student use.

A lab policy and procedures manual was created that specified access and operational procedures, and acceptable ethical practices and policy.

Software was purchased to meet faculty and student needs in five areas:

- To provide student productivity tools,
- To provide faculty productivity tools,
- To provide access to educational software for use by students in curriculum areas,
- To augment existing course content, and
- To create multimedia programs for use by faculty and students.

A newsletter was established to communicate training information, technology and lab updates, current technology news and as a vehicle to illustrate potential instructional tools and techniques.

Concurrently, the faculty was surveyed to identify the most pressing technology and training needs. It was critical to address existing needs of faculty currently committed to the use and integration of technology. Responses to this initial assessment indicated a significant need for training and support in operating systems, word processing and presentation software.

After the labs were effectively functioning and using results from the survey, faculty and staff training sessions were developed. Two basic training sessions were prerequisites for additional training: an overview of computer principles and the labs and introductory word processing. Subsequent to the required modules, training was also offered in other software programs. Sessions were offered at varying times in order to accommodate faculty class schedules.

Lab orientation sessions were also developed. The orientation consisted of an explanation of lab operating procedures, clarification of and signed agreement to abide by the Acceptable Use Policy (AUP), and introduction of lab hardware and software. These sessions were recommended for classes with assignments that required use of the labs. Faculty that did not attend any training sessions but wanted to use the labs for class instruction were also required to attend a lab orientation.

A beginning training manual was produced for each person that attended the training. The manual included reference and support materials for the basic training sessions. Additional material was made available for subsequent training sessions.

The fourth component, collaboration and integration, was piloted during the 1996 Summer semester. One faculty member who had received training worked with the Technology Coordinator to modify existing course content to integrate instructional technology tools. Within the context of an elementary education language arts methods course, a traditional instructional technology task (visuals preservation) and an information technology tool were incorporated. The class received task specific instruction in word processing in order to create a poetry book that included graphic elements.

Evaluation was an on-going component of the project. Informal formative feedback was used to adjust scheduling, session lengths, training class size, and frequency of sessions. A formal summative evaluation was conducted at the end of the spring semester.

First Cycle Summary

Results from the first year indicated a positive acceptance of the program and model. The twenty percent of the faculty that represent early adopters was larger than would be expected from a rural university. Faculty evaluations reflected unanimous support and provided constructive suggestions for modifications. These evaluations from the early adopters were viewed as a needs assessment for that group and suggestions were implemented for the second year.

Plans for the second cycle were based on the model of diffusion of innovation. Early adopters would receive maintenance support in the form of task specific practice sessions and individual review sessions, and identify additional opportunities to integrate technology in direct support of existing curriculum. Advanced training in specific applications would also be made available. Mid-adopters would begin to participate in the training, the application sessions and a new series of less lengthy "how to..." sessions, and identify approaches where technology could be integrated.

Problems

Of course! Problems arise in the best thought out plans. A major area of concern was time - the time for the Technology Coordinator to create appropriate training materials, the time invested by the faculty for the training sessions which affected prep and professional activities, and the time involved in reducing student lab access time for multiple sessions.

Another major problem was the shortage of up-to-date desktop computers for the faculty. Although the labs were equipped with current technology, it was not always convenient for the faculty to use the equipment for personal and professional daily tasks. Newly acquired skills need to be exercised regularly.

Quo Vadis?

What do we do about faculty who do not want to use technology? Is it important that all faculty integrate technology? Does the use or lack of use of technology fall under the aegis of academic freedom? What is the value of authoring specific applications for specific courses? How will integration efforts alter traditional higher education instructional patterns and tasks? Which roles will change and how? Training occurs in new situations, but distance learning and the Internet represent alternative forms of "old" situations (classrooms and research). Is re-training necessary for effective use of these alternative forms?

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TECHNOLOGY, PEDAGOGY, AND ACADEMIC FREEDOM: A DEMOCRATIC PARADIGM FOR THE 21ST CENTURY

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Pahl states, "We have met the [computer] revolution and the revolution is us" (Pahl, 1996, p. 342). Like Pahl and Pogo (Trager, 1994a) before him, most of us have finally come to the realization that we have created a monster, in this case technology, which must be tamed and exploited. Because of its great potential, we are allowing technology to change the way we live, communicate and learn. New technologies exist which can support and strengthen democratic ideals and actions throughout society. In preservice teacher education, areas affected by the revolution are: academic freedom, the "new" role of the teacher and the need to create technological equity among groups throughout society. As teacher educators, we have the opportunity to promote transformation and become members of a community of learners that encompasses both students and teachers. Where and how do we begin to retrofit for these changes?

Recently, Seton Hall University had developed the goal of becoming a leader in the use of technology. Faculty, staff, administrators, and students were to play a role in this mission. The University administration recognized that the use of technology for instruction must be accompanied by reform in pedagogy. One challenge that arose was how to initiate this goal without it's being perceived as a threat to academic freedom. As one initiative to encourage the integration of technology into curriculum, faculty were invited to apply for in-house grants that could assist them to accomplish this task. Curriculum Development Initiative (CDI) grants of up to $25,000 a year for three years were offered to teams of faculty for program redesign that included technology. Recognizing that faculty possessed a wide range of technology skills, the University wisely decided to fund all teams that submitted a grant, received a critique and resubmitted revised proposals. Funded projects included everything from using e-mail to development of sophisticated multimedia packages.

A funded team representing the undergraduate programs in the Educational Studies Department of the College of Education and Human Services (CEHS) is collaborating to effect a redesign effort that will incorporate technology into the teacher education curriculum over the next three years. We are redesigning three programs to meet the technology needs of undergraduate teacher education students and interested faculty, to meet National Council for Accreditation of Teacher Education (NCATE) standards for technology, and to integrate the technology with instruction and course content. During the first year, three required courses in the elementary, secondary, and special education programs have become laboratories for providing our faculty and teacher candidates with the philosophical basis, the pedagogical rationale, and the skills to meet their technology needs based on the recently expanded NCATE standards for knowledge and use of technology. Currently there are over 400 undergraduate students majoring in education. During the first year, 90 are being served by this project. Each remaining year of the project, the use of technology will be addressed in other areas of the curriculum until all of our technology objectives are met by every student in the college.

Educational Needs Addressed

The United States Department of Labor has released studies showing an increased need for teachers, technology specialists, and health care professionals in the near future. These positions are described as being in high demand and as the only middle management jobs with new openings for job seekers. During fall 1995, the College of Technology Advisory Committee conducted a study to determine the technology needs of students in the college. First, technology objectives were developed and approved by the CEHS faculty association. These objectives fulfill NCATE requirements for both faculty and pre-service teachers. Faculty then completed technology surveys for each course they teach and reported any technology objectives met in their classes as well as the kinds of technology they are currently using. The results were compiled and a curriculum map developed to determine specific needs. We discovered that our students were receiving their technology skills in bits and pieces, with no coordinated plan to assure that they acquired a solid foundation of technology competencies by the time they graduate from any of our programs. The survey also confirmed our suspicions that our faculty shared a problem common in higher education today. They are enthusiastic about using technology, knowledgeable about its importance in the curriculum, but lack knowledge in many aspects of computer-based learning. The survey and curriculum map graphically displayed our technology needs and alerted everyone in the college about the problem. The CDI grant proposal was our collective departmental response to meeting the training needs of our faculty and the educational needs of our students through curricular reform in the three programs areas of elementary, secondary, and special education.

Desired Student Outcomes

Our desired student outcomes are inextricably intertwined with our expected faculty outcomes. Faculty are active participants in the learning process; they guide learning and assess the effectiveness of a technology-based curriculum. The curriculum is designed to accommodate a variety of learning styles, be project oriented, and allow students to integrate various subject areas. Students encounter and investigate real educational problems, explore valid pedagogical approaches, and using a variety of computer-mediated solutions, present their findings with the knowledge that they can justify and explain their technological decisions. Professional presentations, projects, and portfolios are employed as alternatives to traditional forms of assessment. The research and projects produced by both faculty and students will become resources for other faculty and students.

We believe that our students will be better positioned in the job market after completing a technology integrated curriculum. School superintendents are resolute about hiring new teachers who possess technological skills and can integrate them in the curriculum. The proposed curricular changes require our students to produce a technological portfolio that will showcase their abilities. We are also preparing preservice educators who will be able to use technology reflectively, in ways most likely to support the democratic ideals and values upon which our society was founded. Skill in assessing, evaluating and delivering information and material is critical. Where teachers cannot do so, others will. Apple's (1982) concept of the de-skilled teacher seems potentially replaced by the superfluous teacher. Preservice candidates must recognize the potential for technology to allow them to use pedagogical practices more likely to engage the learner. In addition, they should be able to guide student analysis of new technology. Preservice students need to reflect on the biases and claims for truth that emerge from information and materials delivered electronically. Critical evaluation of the impact of technology on equity issues such as race, gender, and class is essential. The teacher and the school will have important roles to play in this process. Preservice teachers must be prepared to embrace that role. The desired outcome most important to our profession, however, is that we will instill in both our faculty and students a pedagogical paradigm for creating learning environments which is dynamic and long lasting. Also, one which our graduates will take with them to classrooms all over the United States and promulgate electronically throughout the world.

Project Activities

We are accomplishing our goals over a three year period by making profound changes in our curriculum, pedagogy, and modes of achieving learning. We are providing learners, both students and faculty, with experiences using technology as a tool for personal and professional productivity, direct delivery of instruction, and learning activities that can take place anytime, anywhere. As we progress through the three year period, new, more advanced technologies will be added to the programs, and faculty will bring their knowledge and skills to their other courses. Students are being exposed to a wide range of technologies and to their specific application to teaching.

Participating faculty: revise courses to integrate technology use by both faculty and students; produce multimedia presentations to change their modes of teaching; develop student projects that incorporate multimedia; initiate a variety of network-based links with schools all over the world; use a network-based student mentoring program with a public school; use various communication channels to disseminate creative student and faculty projects; and will eventually use distance education and Web-based courses to send enrichment programs and courses to elementary and secondary schools. For next year, we envision the creation of a CEHS Education Information Exchange that employs the College Wide Information System (CWIS), e-mail, the Internet, and distance learning as means to showcase student projects, communicate with students engaged in field experiences, exchange knowledge with teachers around the world, provide a database of curriculum information for students in the undergraduate programs in our college, and provide the activities and motivation for faculty and students to acquire knowledge and skills for integrating computer-based communication tools in the curriculum.

Four faculty from four different programs in the Educational Studies Department enthusiastically volunteered for this project. Participation from these four programs assures that all undergraduate education majors in CEHS will have their technology needs addressed by this project. All of these faculty have made a three-year commitment to devote one-quarter of their work/course preparation time during the school year and one summer session to this project. Each member of the team is skilled in a specific focal discipline, as well as in curriculum development; each has participated in some technology-related project either in courses they teach or in their research; and each team member has participated in technology workshops on campus. One team member is the project director, who is skilled in instructional design, technology, and curriculum construction.

Recommendations and Conclusions

Prior to the CDI grant, many obstacles impeded faculty from making any real progress in the use of technology. A few early adapters, with computing skills made some inroads, but interested faculty without technology skills often faced frustration. Lack of training for faculty, no rewards or recognition for using technology, no time for preparation of course materials, lack of funds to purchase software, and absence of hardware for production and presentation had been serious impediments to technology reform.

The CDI grants attempted to remedy some of these problems. They provided the following support and incentives: released time, specialized training, support personnel, student assistance, software, hardware, funds to attend conferences, interdisciplinary networking, peer support, team building with a project director, communication with technology support services, and administrative recognition. Each team was allowed to use the supporting funds to accomplish their goals. The CEHS team initiated the project last summer by attending workshops to learn about and explore various technologies currently available. Using this information, we began to implement the following schedule of project activities for this year:

Summer 1996
- Redesign of course outlines
- Selection and purchase of commercially produced software for courses
- Home page authoring and development training for faculty
- Multimedia integration and presentation training for faculty

Fall 1996
- Development of multimedia packages
- Attendance at technology conference/workshops by faculty
- Continued faculty training - Internet and use groups
- Attendance at technology conference/workshops by faculty
- Multimedia authoring and development training for faculty

Spring 1997
- Teach revised course one
- Develop initial Internet communication links with public schools
- Develop student mentoring program with off-site students
- Make changes to revised courses
- Year one project evaluation

Having completed two-thirds of our activities, we have many suggestions and recommendations for new technology users. Multiple levels of support are needed. Peer support, availability of an in-house project director to resolve immediate problems, professional computing staff assigned to projects, and a room and equipment coordinator sensitive to faculty and project needs greatly contributed to our successes. Meetings with peers to discuss projects, problems, and issues provided encouragement and resolutions for problems when things were not progressing as planned. Classrooms and labs easily accessible to both faculty and students with a nearby help desk are essential. The greatest problems arose from an institutional lack of preparedness to provide the needed resources. The University did not anticipate the increased demand for assistance, equipment, and rooms to accommodate increased faculty and student technology usage. The challenge of new technologies should be in mastering their use within your discipline. There needs to be a match between University goals and the funding and resources that it can provide to accomplish its mission. Failure to do so creates significant negative reactions toward both technology and the institution from faculty and students.

Despite many first semester problems, the CDI project has accomplished its basic goals in the College of Education. New faculty are using technology in their classes. Not only are they using the technology, they have consciously redesigned their program curriculum to include a variety of technologies essential for our students' future success. Our project is a model of current curricular and instructional developments in the preparation of pre-service teachers. We are using the recommended standards (NCATE) for faculty in colleges of education and standards for the training of teachers, and developing innovative curriculum and projects that weave the required technological skills into a remodeled undergraduate curriculum.

Project Significance

The College of Education and Human Services at Seton Hall University is attempting to develop teachers who are reflective practitioners with the depth and breadth of knowledge needed to make informed decisions about learning. Teachers have academic freedom and considerable autonomy about the teaching methods they employ. We want our faculty and students to have the knowledge they need to make curricular choices about technology. Learning is more than a process of transmission. We don't perceive our students as empty vessels passively waiting to be filled. We subscribe to the current educational view that learners are active beings who construct, interpret, and reconstruct rather than simply absorb knowledge (Apple, 1982; Freire, 1987; Giroux, 1988; Goodlad,1984; Kelly,1955; etc). As Kelly (1955) says, the learners are scientists who hypothesize about how the world works and use the new understandings they have gained to reshape the mental constructs they use to make further predictions. Here the learner has more control of the process of knowing, and the teacher, in the words of Giroux (1988), not only promotes academic achievement, but also endeavors to "empower students so they can read the world critically and change it when necessary" (p. xxxix). What better way to support and strengthen democratic ideals in our society? Apple and Beane (1995) cite conditions necessary for a democracy to exist. These include a recognition that democracy is a process requiring creative involvement in the lives of individuals and groups, and an organization of our social institutions to facilitate this process. We commenced our technology saga with Pahl and Pogo, but because of an institutional commitment to academic freedom, active, involved faculty, and a well-planned Curriculum Development Initiative we are ending this chapter on an optimistic note with Oliver Hazard Perry, "We have met the enemy and they are ours" (Trager, 1994b).

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TEECH Lessons Learned: Strategies for Facilitating Communication in Teacher Enhancement

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TEECH (Teacher Enhancement Electronic Communications Hall) is a three year project, funded by the National Science Foundation. It aims to advance the work of Teacher Enhancement projects by fostering increased collaboration among leaders in teacher development. TEECH endeavors to draw on the strengths of over one thousand principal investigators (PIs) and senior staff of teacher enhancement grants from the National Science Foundation, the U.S., State, and local Departments of Education. Its purpose is to encourage communication, collaboration, joint exploration, and pooling of this community's collective resources.

TEECH's first major task was to determine whether its constituents could in fact be considered a community. We needed to understand if they had common backgrounds, common interests, and an agreed upon need to communicate more with each other. We needed to ascertain what would tempt PIs to participate in an electronic community and what would deter them from doing so.

Initial Needs Survey

An initial needs survey (Falk, 1996) was sent out to 465 Principal Investigators (PI) and we received 255 responses, a 57% response rate . Their responses to our survey revealed that PIs of teacher enhancement grants could not be considered as one cohesive community. The only factor that all PIs had in common was that they had obtained funding in order to conduct a teacher enhancement grant. The backgrounds of these PIs spanned a broad spectrum of expertise that included fields as diverse as psychology, geology, discrete math, genetics, neurology, engineering, teachers, principals, administrators, physicists and chemists. What they shared was that in some capacity they were working with teachers in grades K-12 to improve math or science education.

While these Principal Investigators did not share a common background, a common professional vocabulary, or a common theory of teacher change, we hoped that they would use the diversity of their backgrounds to enrich each other. We were encouraged that they identified themselves as being most interested in discussing shared topics of concern such as Teacher Change, Professional Development, Assessment and Educational reform. In fact they rated these topics higher than their specific interest in either math or science or a specific grade level range to which their project was aimed.

In order to effectively begin to facilitate an electronic community it was important to understand how participants were using the Internet. We found that 91% of respondents had access to the Internet. 84% replied that they had used e-mail, 56% had used gopher, 46% had used mailing lists, and 41% had used the World Wide Web.

Respondents were asked to rank the purposes for which they use the Internet. Communication was the most frequently cited purpose (79%). This was followed by browsing and exploring (53%), retrieving information (53%) and posting or publishing was the least frequently cited among PIs at (35%). The results suggested that these PIs were more comfortable retrieving information than they were posting information.

PIs were asked what would tempt them to connect to an electronic community. Their responses revealed that they were interested in three main categories: connecting to other PIs, sharing between projects, and gaining access to information. Some of the reasons expressed for wanting to connect with other PIs included joint proposal writing, seeking individuals with expertise for collaboration, and gaining advice from others on running a project. PIs expressed that projects would benefit by sharing with each other solutions to common problems, tentative findings, and successes and failures. Information that PIs wanted access to included proposal information, material development, resources, and funding information.

PIs also described many factors that would dissuade them from connecting to an electronic community. These included (in order of frequency) time, quality, volume, access, cost, format, technical expertise, organization of the community, equipment, and abuse of communication. Time was stated as the most common stumbling block. Issues of quality that were expressed concerned fear of "long windy conversations" and "exchanges of jargon and phrases." Many were concerned about "receiving excessive e-mail" and "difficulty accessing a network."

Multiple Strategies to Facilitate Communication

During its first two years TEECH has developed multiple strategies to meet the needs of this heterogeneous community. These have included listservs moderated by leaders in the field, electronic seminars, on-line lectures given by leaders in the field made available on our Web site through RealAudio and text copies, and a database of PIs and their teacher enhancement projects. While listservs were intended to encourage active communication between PIs, the posting of lectures, in both text and audio formats, was intended to meet the needs of those PIs who wanted to use the site as a resource rather than as a vehicle for communication. We also have made attempts to combine these formats, having a RealAudio discussion with a listserv connected to it.

Evaluating Participation

Although our Web site is set up to collect Web site statistics these statistics are often difficult to interpret. While they tell how many "hits" a particular page receives it is not clear how many people this count reflects. What is clear is that more people tend to connect to the TEECH web site in order to hear or read lectures than they do to engage in a listserv conversation.

The listservs that TEECH has run have varied in their rates of participation. On average listservs tend to run 8 -12 weeks before participation begins to drop markedly. Our most successful listserv to date was a discussion entitled "After the Workshop Ends; Difficulties Reflections and Strategies." This listserv had 119 subscribers, and over 250 postings. Slightly more than half of the PIs (64) posted messages to the list while the rest received messages but did not post.

A follow-up survey was sent to the 119 participants of this list and 38 PIs responded. The results indicated that of the respondents 89% found the discussion to be useful, 68% shared parts of the conversation with other colleagues, 24% connected or corresponded with PIs who had posted to the list as a result of their participation, and 91% responded that the discussion was informative or relevant to their project's work. Fifty-five percent of the respondents reported that they had posted to the list; 45% reported not having done so. It is interesting to note that on most questions there was no significant difference between those who had posted to the list and those "silent participants" who had only read the messages. In particular both groups overwhelmingly thought that the discussion was useful (95% of contributors, 82% of non contributors) and relevant to their project's work (86% of contributors, 82% of non contributors). While 67% of those who had posted shared the conversation with their colleagues, a similar 65% of silent participants had done so as well. The only area in which we saw a significant difference between contributors and silent participants was whether they corresponded or collaborated with a PI who had posted to the list. On this question 43% of active participants reported having had such a follow-up communication where as none of the silent participants reported doing so. (p=.002 by Fisher's Exact Test)

Listserv Dialogue

Many respondents have written that it has been meaningful to them, both personally and professionally, to participate in a dialogue with other Principal Investigators. Two examples are:

> It is always good to hear that other people are struggling with the same problems. It was interesting to hear the range of solutions to the problems proposed.
>
> A chance to have informal discussions with peers around the nation in the comfort of my own office! Since having young children, the time I can spend traveling has been radically decreased. I have felt cut out of some of the discussion with national colleagues.

While the tenor of the listserv dialogues has generally been respectful and friendly there was often a competitive edge to the conversation. It sometimes appeared that there was a greater desire to express what a project had done than to learn from, or to collaborate with, others. While the majority of those who participated felt the tenor was positive some expressed a concern that this was not always the case. Two comments that express some reservations follow:

> Was not at first sure whether the tone was coming from the heavy academic orientation of some or whether the lack of sitting face-to-face in a room with other discussants caused some to feel they could be disrespectful of ideas—disembodied ideas.
>
> Often, PIs talked about their own project without talking about its particular strengths, challenges or weaknesses. There was also some "grandstanding" that wasn't particularly substantive or reflective.

The pace of the dialogue was often quick. Although e-mail dialogue is asynchronous, so that participants do not have to participate at the same time, the conversation is a moving target. It is often difficult to jump in the middle, especially when the conversation seems to shift its direction. Some of the difficulty in joining such a conversation is expressed particularly well by a subscriber to one of the TEECH lists who writes why she has not posted.

Why have I not actively participated thus far? I would say that lack of time has been the main reason. I have saved various messages, including your message of two weeks ago, with the intent to respond, but framing a brief thoughtful, response takes some time- and as time passes it seems that the heat of the opportunity has passed. Perhaps with time I will feel that I can just dash off a quick response or thought, but given the spunky nature of some of the discussion, I'd rather make sure that my words are appropriately chosen.

In this particular case the subscriber says the main reason that she has not participated is "time." It is not that she has not had the time to read, but that she would like to be careful in composing a response, and by the time she could do that, the conversation would have moved on.

Lessons Learned

In reflecting on the listserv dialogue we have decided to make several changes in the future format of TEECH listservs. In developing true communities of practice it is important to nurture a sense of trust, a sense of a common vocabulary, a common goal, and common interests (Gal, 1993). The audience of PIs is very diverse. This group changes each year, when new grants are awarded. The PIs have professional affiliations that are usually much stronger than their affiliation with other PIs of teacher enhancement. Our question at this stage in the project is no longer "are they a community?" but "how can we better facilitate a collaborative community of practice?"

In our last year of TEECH we are determined to focus on smaller sub-communities where there is a clearer sense of a shared background and perspective. The aim will be for people to build on these shared experiences and apply them together to the field of teacher enhancement.

In addition we hope to raise the level of trust of those within the listserv and decrease defensiveness and a desire to grandstand, by increasing familiarity of participants with the other participants on the list. We will do this by having listservs that follow face to face workshops. Photographs of participants, abstracts of their projects and biographical information will be shared to decrease the sense that one is speaking to a group of unknown people. Several listservs will be designed explicitly to sustain communication between people who have already begun working with each other, or have experienced a workshop together.

We have come to appreciate that silent participants in a listserv also gain a great deal from listening to the conversation. We will continue to not only appeal to those who like to post but to find forums for those who prefer to retrieve information and to listen to the dialogue of others.

Last, we have come to realize that "teacher development" is eclectic, ununified, and perhaps just emerging as a field. Professional conferences specifically targeted towards professional development have just begun to emerge within the past two years. While communication between PIs is important, it is equally important to build a core of expertise by gathering lectures and debates of leaders in the field and making them available to a wider audience of those in teacher enhancement. Hence, we will expand our efforts to make TEECH a vehicle for dissemination of key lectures and resources in the field while continuing to encourage communication and collaboration between Principal Investigators.

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INTEGRATING TECHNOLOGY INTO ELEMENTARY SCHOOL WATER QUALITY STUDIES

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As the Internet and its related computer technologies enter K-12 classrooms, teachers should be encouraged to use these tools to supplement and expand present curriculum. However, many teachers are not versed in computer technology and unsure how best to develop it. If teacher are given proper staff training and development, computers can be a wonderful addition to the educational environment, unlocking doors and exciting students' natural curiosity and desire to learn.

In West Virginia approximately 400 teachers are learning about the Internet and its educational potential through the West Virginia K-12 RuralNet Project. This is a National Science Foundation (NSF) funded, three and a half year program of faculty development and training run cooperatively through the state's two universities. Participants attend a five day workshop designed to teach computer/Internet skills. This is followed by two on-line courses developing teacher awareness and understanding of integrating computer technology into everyday teaching. With the help of this project, we have developed an elementary water quality unit.

Students participate in a project which combines technology, a study of current water conditions, and intergenerational experiences. Computer technology plays a vital role in the students' water quality unit. The children use HTML lesson plans to begin studying the Ohio River, learning about topics such as flooding and water pollution. They use the Internet as a research tool to learn even more about the River and to contact other RuralNet schools studying water quality. They take a field trip to a local stream, Four Pole Creek, which empties into the Ohio. They examine stream life and collect water samples for water quality experiments. Through one of RuralNet's partners, The Global Rivers Environmental Educational Network (Project GREEN), students enter their data directly into a water quality database and extract water quality information entered by other students from around the world.

The teachers use a whole language approach emphasizing curriculum in science, social studies, language arts, and writing. The multi-media components include: tape-recorders, a video, Internet access, graphics, text, WordPerfect, and Microsoft's PowerPoint. Students use technology to learn about the water cycle, water quality, the Ohio River, past flooding, current water problems, and river preservation coalitions. Students use Internet research, e-mail, and personal interviews to get information which they use to make written and oral presentations for parents, guests, and senior citizens. Students use computers to type reports, take notes, and write stories about their experiences. These activities are excellent examples of how computer, and specifically Internet, technology can be added to make learning more interesting and fun for students.

Project Description

In the course of water quality study, students will discuss the importance of water in our everyday life. Using software programs, they study the water cycle and ground water and develop the vocabulary of the hydrologic cycle. The software programs Hydrologic Cycle Version 1.01 by IBM (Haeberlin & Kulda, 1986a) and Ground Water Version 1.01 by IBM (Haeberlin & Kulda, 1986b) are part of IBM's Earth Science Series and provide lessons and quizzes for the topics.

Students study macro invertebrate animals using pictures and information in the Field Manual for Water-Quality Monitoring by Mark K. Mitchell and William B. Stapp (1995) that can be ordered from Project Green. A matching card game is played with cards made from photocopied pictures of the macro invertebrates. The rules are similar to the card game Rummy. Rules for playing can be found at the RuralNet pages, http://www.marshall.edu/coe/wvrk12/lp-safe_water.html. After familiarizing themselves with these macro invertebrates and their importance in determining water quality, students take a stream walk to the local creek. Using nets and seine screens, they collect macro invertebrates, identify them, and catalog them in their notebooks. Upon returning to the classroom, the students analyze the stream quality by rating the macro invertebrates using the Macro invertebrate Taxa Groups table found in the Field Manual for Water-Quality Monitoring. They then report their findings to

Project Green at the Internet site http://www.igc.org/green/ green.html.

Students use the lesson plan Microorganisms in our Water at http://www.marshall.edu/ coe/wvrk12/ehtml/ microorg.htm. This lesson directs students in discovering the variety of microorganisms and how microorganisms can effect water quality.

Further analysis of water quality is done by chemical testing of tap water, fountain water, and stream water. Using materials provided by Students Watching Over Our Planet Earth (SWOOPE) called The Tapwater Tour from LaMotte (Johnson, Anger, & Troxel, 1989), students test samples of the three water types for pH, chlorine, iron, copper, and hardness. They then do a water quality report and data comparison.

To increase the students' awareness of government involvement in water quality, the lesson Who Controls Our Water Quality at http://www.marshall.edu/coe/ wvrk12/ ehtml/who-cwq.html. is used. This lesson has students use the Internet to find out what government agency is responsible for water quality. The students make a class terrarium to demonstrate the water cycle. They review water sources, water vocabulary terms, and the recycling of the earth's water supply. They explore the meaning of a watershed and call the local water department to get information on sources of water for our community.

As they study the Ohio Valley watershed, students watch the video *"A River Called Ohio"* (Mitchell, 1995) This recent film gives a history of the Ohio River. Brainstorming activities, prior to the viewing, show their current knowledge of the River. The boys and girls work in teams at the computers and follow RuralNet student lesson plan to find river facts: (http://www.marshall.edu/coe/wvrk12/ ehtml/ohio-river.htm). Hyperlinks lead to the Ohio River Valley Water Sanitation Commission's home page (ORSANCO) and the EPA's Office of Wetlands, Oceans, and Watersheds. Students record information on a teacher made research worksheet giving the origin of the River, its length, the states it flows through, and its final destination. They also look for the number of people who use it as a source of drinking water and for its economic impact.

Students try to find a map of Ohio Valley Watershed which they can print. At this point the best available one is in not on the Internet, but in the U.S. Environmental Protection Agency's (1991) manual, Always a River: Supplemental Environmental ED Curriculum on the Ohio River & Water. On a Xerox copy, each student outlines the two rivers which unite to form the Ohio. Then they mark the 15 other rivers that empty into the Ohio. The group gains access to the KidScience Home Page on the Internet, types in their data, and sends it to the Water Sources West Virginia Date Input/Output DataBank. (http:// paa.mhpcc.edu/waterWatch/ waterSources/html/ home.shtml)

The class divides into groups and cooperatively creates a bulletin board which depicts the River. They split the River into sections, draw in its tributaries, and depict life along the banks. The emphasis is primarily on our immediate area. To continue their understanding of water quality in the Ohio River, students tour the West Virginia American Water Company Treatment Plant, and learn more about the purification process for drinking water. The drinking water in our area is drawn from the Ohio. Afterwards the class eats a picnic lunch at Harris Riverfront Park and gets a first hand, up-close view of the Ohio.

At another session, a representative from the US Army Corps of Engineers visits to discuss its role in watershed management, and to explain navigational and flood control dams. The representative explains how during the early expansion years of our country, the CORP gradually assumed water management responsibilities.

Using WordPerfect, students practice writing paragraphs and composing letters for e-mail correspondence with keypals who live in other River Cities. Before composing their letters they use Netscape Navigator to access the Miller School home page (http:// boe.cabe.k12.wv.us) and link to the Huntington home page to read about the town. They type several defined paragraphs, one describing themselves, another telling something about Huntington, and concluding with their favorite river activity. They also read and discuss excerpts from Wind In the Willows found in The Junior Great Books Program (Great Books Foundation, 1992). They read a play version of Huckleberry Finn. These selections help them as they discuss animal activities and human life along a river.

Students continue Internet research by using search engines to learn about flooding and water pollution. Using the RuralNet lesson plan The Ohio River at http:// www.marshall.edu/coe/wvrk12/ehtml/flood.htm, they learn more about flooding and river watchers. They access home pages of schools participating in water studies in other states and countries. They learn about The Ohio River Sweep and group efforts to keep the river clean. Using hyperlinks from the Miller home page, they begin preparation for an oral history project. The boys and girls read an account of a victim's experience in the Huntington's 1937 flood. They use additional printed materials and work in teams to complete a 1937 background work sheet. They practice interviewing, then make appointments, and arrange to tape a visit with a 1937 flood survivor. After completing the interviews, students return to class and share parts of their tapes and videos. They listen to them again and take extensive notes using Word Perfect. They begin the process of writing, editing, and revising. Using Alpha Smarts, students work on reports at home where parents can help. In the classroom, they transfer their work to a WordPerfect document. After they spell check and format their work, the teacher helps edit the story. Final drafts are compiled into a booklet.

Once the stories are written, students make Power Point slides to share excerpts from their reports. The scanner is used to add pictures they have found of the 1937 flood. The students invite parents, the person interviewed, and friends to the center. The reports are presented using the computer and a LCD panel. Students give the visitors copies of the finished booklets and show how they used technology in their learning process. In follow up sessions the group goes to the Woodlands Retirement Community for lunch. Using a lap top and the LCD panel the students gives their presentation to a group of the residents. A number of parents join students in a field trip to the Robert C. Byrd Locks and Dam. They tour the museum, eat a picnic lunch, and watch a boat as it enters and exits the locks.

Evaluation

The success of the project is measured by the interest, skills development, and participation of the students. It is gauged by their completed work. They have a portfolio which includes Internet research notes and printouts. The portfolio has a benthic invertebrate analysis, water quality report, and a map with the Ohio River and its tributaries. Their work shows copies of the e-mails they sent and received. The portfolio also has a completed 1937 flood background work sheet. There is a completed summary of their interview responses, a rough draft of their report, an edited manuscript, and a finished report. Students have a tape or a video of the actual essay and some have pictures of the person whom they interviewed. Each student has a booklet of collected oral history stories and completed slides from the PowerPoint presentation.

Success is also measured by the effectiveness of using Alpha Smarts as a writing tool to improve the quantity and quality of writing. When students write at home and transfer the file to the school PC for formatting and spell checking, this allows maximum use of class computer time. This gives students who have no "home computer" an equal opportunity on a writing assignment. It provides a less expensive way to get more "keyboard time." This is applicable to other learning experiences and beneficial to the entire learning community. Once our academic goals are met, additional successes are determined by the students new awareness of the community in which they live. Their field experiences provide interaction with Ohio River projects, community resources, and senior citizens.

The authors realize that there can be many complications with using the technology of computers and Internet access. Teachers need to be flexible and have alternate plans for times when there are technical failures. Technology can be so beneficial and time-saving on one hand and can be frustrating and time-consuming on the other. This is all part of the learning process for both teachers and students.

This is a class unit which can be duplicated in many places. It can be modified, enhanced, and adapted to fit almost any area of our state, the United States of America, or the world. Some of the ideas came from e-mail messages from peer teachers in the RuralNet program. Others came from Internet research. Since William Smith Miller Elementary is a West Virginia Education designated technology center, there are opportunities to share this project with others.

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The Double Eagle Experiment: A University/School District Technology Integration Collaborative

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In the Fall of 1996, the Double Eagle Elementary School opened its doors to approximately 630 Albuquerque Public Schools (APS) elementary students. Considerable time, energy, and resources had been spent to create a climate at the Double Eagle Elementary School conducive to the incorporation of technology to support learning for these students. Phase One was complete. This phase included the construction of a main building and auditorium. In the main building were three classrooms, a computer lab, and a library-media center. Portable classrooms were in place for the first instructional year. Two computers and a printer for each third, fourth, and fifth grade classroom and 12 computers and four printers for the computer lab had been ordered. Apple IIGS computers had been donated so that two computers and a printer could be placed in each first and second grade classroom.

Phase Two construction began with the opening of school and is scheduled to be complete for the opening of the school's second instructional year (1997-98). This phase includes permanent classrooms and a cafeteria. The DynaComm system will be completely installed, facilitating intranet and internet connectivity for each classroom. Upon completion of Phase Two, this system will provide each classroom with digital, audio, and video connections.

The infrastructure existed for school-wide implementation of an educational program that has the power to use technology to support and enhance existing learning opportunities and to push learning vistas in new and creative directions. That infrastructure will expand and be elaborated during the school's second year. The context for remarkable educational potentials and innovations has been established. What remains is to realize these potentials. Toward the goal of realizing these potentials, the Albuquerque Public Schools (APS) and University of New Mexico (UNM) Double Eagle Collaborative was created. This two year collaborative has as its central mandate the goal of promoting staff development and instructional support systems to facilitate the design and implementation of a school-wide, technology-using curriculum.

The APS/UNM Double Eagle Collaborative

The APS/UNM Double Eagle Collaborative established a two year partnership between the Double Eagle Elementary School and UNM's College of Education program in Mathematics, Science, Environmental, and Technology Education (MSET) with particular emphasis on professional development activities and the integration of technology. The gist of the collaboration focuses on multiple layers of staff development activities that include mutual feedback between scholarship, teaching, integration, and application especially as it pertains to: 1) student learning, 2) technology integration, 3) staff development, and 4) classroom management.

Forming the Collaborative

APS and UNM have a long history of successful collaboration. Building on this history, the authors met to discuss a site-specific collaborative during January of 1996. A final proposal resulted from those meetings in early March. Because of the unique nature of this collaborative, the proposal was shared with a wide range of individuals during March, April, and May. Supporting signatures were obtained from the APS Director of District Technology, the APS East Region Assistant Superintendent, the APS Assistant Superintendent of Curriculum and Instruction, the UNM-MSET Coordinator, and the UNM Associate Dean of Research and Graduate Studies. The endorsed proposal was submitted to the Dean of the UNM College of Education and the APS Superintendent. This six month process of conception, sharing, and nurturing culminated in the collaborative's inclusion in the 1996-97 collaborative contract between the two institutions finalized in July, 1996.

Funding the Collaborative

The collaborative is funded by an "exchange of services" agreement between the two institutions. Two classrooms, a second grade and a fourth grade, at the

Double Eagle Elementary School were reserved for the collaborative, and no teachers were hired for those classes. Instead, APS released the equivalent funds to UNM under the contractual agreement. UNM redistributes those funds to support three doctoral fellowships and tuition stipends for preservice and graduate students. UNM assumed responsibility for instruction in the two classrooms and support for school-wide inservice activities. This funding agreement resulted in no additional expenditures for either institution.

Creating a Learning Community

Mecklenburger (1994) sharply challenges traditional academic practices as too often removed from the needs of real communities. The Pew Charitable Trust "Roundtables" present an image of educational reform that is increasingly assailed by charges of irrelevance, technologically resistant, and excessively beholden to research agendas at the expense of teaching and public service (Baker, et al., 1994). In contrast to traditional academic practice, a subset of the growing interest in educational restructuring has shifted to a national conversation about "service learning." Lynton (1995) affirms the relevance of service learning at all levels of education. Throughout the literature runs the notion that institutions of public education need to forge formal and mutually beneficial relationships with their supporting communities, and that the tradition of academic study isolated from the needs of particular communities is an increasingly unaffordable luxury. Instead, Boyer (1990) offers an image of "complete scholarship" by advocating an institutional balance among four types of scholarship: teaching, discovery, integration and application.

Consistent with Schon's (1995) notion that practice generates knowledge no less than knowledge informing practice, the APS/UNM Double Eagle Collaborative is aimed at producing significant learning for professional educators from both institutions participating in this partnership, and as a consequence, significant learning for students at the Double Eagle Elementary School. Joint participation by UNM faculty, doctoral students, and preservice students and APS teachers and administrators facilitates the service learning model by bringing together a wide range of academic and professional credentials as well as significant life experiences while simultaneously setting the learning act squarely in the domain of informed practice.

The collaborative is designed to capitalize fully on the creative energy and focused power of two cooperating institutions jointly dedicated to the goal of improving education. By combining a pool of energy and talent, the collaborative seeks to create a learning community with participants assuming a variety of roles and responsibilities.

APS Principal/UNM Faculty. Primary leadership for the work of the collaborative is jointly supported by the school's Principal and a lead faculty member from UNM (the authors). Shared responsibilities include 1.) selecting, supervising, and evaluating participants based on guidelines established by their respective institution, 2.) jointly planning workshop, inservice, and staff development activities, and 3.) jointly assisting all participants with the planning, development, and implementation of curriculum development and technology integration.

Double Eagle Staff. All classroom staff were selected by the Principal and agreed, as a condition of employment, to participate in the study of technology, curriculum, and the teaching/learning process as framed by the collaborative. In addition to regularly required classroom responsibilities, the Double Eagle Staff assumed responsibility for 1.) working to further their competence in the use of technology as an instructional tool, and 2.) to participate in and continue a commitment to extensive staff development in the use of technology as an integrated instructional tool. Since APS elementary students are released early on Wednesday afternoons, all teachers agreed to participate in workshops for two hours the first and third Wednesdays of each month as well as to work with others within the learning community on a continuing basis.

Double Eagle Interns. Four UNM preservice teacher licensure candidates who had completed all prerequisite course work for the student teaching experience were selected based on a demonstrated interest and emerging expertise in the integration of technology into learning. These Interns' applications were reviewed by the authors, the candidates were interviewed by each of us individually, and the final four were selected. The four preservice Interns were teamed. One team was assigned to a second grade classroom, and the other team was assigned to a fourth grade classroom. These Interns assumed classroom responsibilities for the entire academic year commensurate with District criteria as well as participation in on-going staff development. Each team took responsibility for the conduct of classroom curriculum and instruction with rigorous and sustained supervision from expert teachers described below as Double Eagle Fellows. Four new Interns will be selected for the Collaborative's second year.

Double Eagle Fellows. Three doctoral fellows with expertise in elementary education and technology integration were selected and placed 2/3 time (approximately 20 instructional hours) at the Double Eagle. These Fellows were selected for their successful elementary classroom experience, their experience with in-school technology teacher support and training, and their success as doctoral students in the MSET doctoral program. Their responsibilities include support of the two teams of Double Eagle Interns, assisting these Interns with classroom management, curriculum planning, delivery of instruction, and creating appropriate learning environments. In addition, the Fellows share responsibility for the conduct of on-site methods courses for the Interns. Second, these Fellows are responsible for working with Double Eagle staff to support their efforts to integrate technology into classroom practice, to assist with the design and implementation of technology using curriculum, to promote the development of technology skills, and to create and maintain the school's computer lab and primary literacy program. Third, Fellows are taking leadership roles in obtaining, placing, and maintaining technology resources while helping to build staff expertise during the two year duration of the collaborative so that Double Eagle staff can assume those responsibilities at the end of the collaborative. Fellowships were granted for the two year duration of the Collaborative.

ITS Participants. One-third of the Double Eagle Staff self-selected to pursue a graduate degree in Integrating Technology in Schools (ITS). These ITS participants met the requirements of the UNM Office of Graduate Studies, criteria established for admission to the MSET Program, and are responsible for their own tuition. The ITS Program (Norton, 1994; Norton & Sprague, 1996) was adapted to offer some parts of the program on-site. These adaptations were designed to assist Double Eagle ITS Participants to assume leadership roles at the school and to play a role in the on-going staff development and curriculum design and implementation work at the school. As their graduate studies advance, these teachers will assume increasing responsibilities for staff development and technology integration in hopes that these activities will continue beyond the two year collaborative.

Report from the Trenches

Although our experiences with a school/university collaborative which focuses so intensely on school-wide reform of curriculum and instruction have just begun, we believe the following captures many of our experiences.

Placing Technology at the Center. As we embarked on this collaborative, many warned us that we were asking for too much too fast. They cautioned for a slower, more cautious, less demanding agenda of change. Our experiences say otherwise. Perhaps the role of technology has served to facilitate the change process by focusing attention on technology instead of overtly targeting more deeply held beliefs about curriculum and instruction. A school-wide commitment to technology has served to divert attention from more threatening issues to a shared, more neutral issue.

Centrality of Communication. The principal and faculty member meet often, although generally on an impromptu basis. We make sure that each of us keeps the other posted on plans, activities, concerns, and events. We both attend all events - inservices, faculty meetings, and related committee meetings. The faculty member meets regularly for weekly lunches with the Fellows. At these sessions, we update each other, plan inservices, discuss the Interns' progress, and talk about curricular activities with the Double Eagle Staff. The faculty member also teaches the courses for the ITS Participants, so is in close contact with them. When concerns are raised by any member of the learning community or communicated through any member, those concerns are addressed. Whenever appropriate, concerns are raised at meetings with the entire community so that they are made public and addressed publicly.

Centrality of Modeling. Many of the activities of the collaborative - particularly the bi-monthly inservices and the ITS course work - are abstract. Yet, it is not easy to translate theory into practice, and what seems to work best is to provide models for teachers. Thus, the faculty member and the Fellows have actually written curriculum, designed and/or located materials, and created entire units. We have then approached grade levels asking them to implement, with our support, these units. Faculty and Fellows have modeled teaching strategies, assisted classroom teachers in implementing units, and worked with Double Eagle students. As teachers actually practice and reflect on their practice using insights gained during inservices and graduate work, they are beginning to develop an image of how technology integration might actually be accomplished.

Providing Resources. Although classroom computers and printers, as well as lab computers and printers, were ordered from a community business before school started, they have been slow in arriving. The firm commissioned to provide the infrastructure after completion of the physical construction of buildings has also been slow to provide services. We have learned that our urgencies are not always those of the external vendors with which we must work. Additionally, these vendors do not always understand educational learning environments or a vision of technology integration in schools; instead, they come with experiences and perceptions more closely in line with private and governmental needs. We are learning to work with these agencies, to articulate clearly how our needs are different from their expectations, and to act in our dealings with them as business people not educators.

Perhaps our greatest frustration and our greatest victory center on the difficulties with resources. We received a small shipment of classroom computers which were placed in fifth grade classrooms. We were then promised the remaining computers within two weeks, postponed for two more weeks, and finally postponed for three more weeks. Soon, there was a strong undercurrent of frustration throughout the school. Why were there no computers for the other grades? Why were they learning so many new and exciting ways to change teaching and learning only to be denied the opportunity to try them? Perhaps it would be better to return to a school-wide lab model and give up classroom integration? The bad news was an atmosphere of frustration and a feeling that the entire project might be on the verge of imploding. The good news was that teachers were learning and were anxious to begin experimenting with new ways of teaching. A school-wide meeting which brought the concerns into the open and clarified exactly what was happening with the vendors seemed to relieve pressures. Luckily, the remaining computers arrived within a week.

Some Thoughts on the Participants. For the Interns, plunging headlong into full time teaching was a shocking experience. No one understands the demands of teaching until they try it. As we near the end of the first semester of the collaborative, the Interns have learned more than they ever expected. The incredible opportunities for situational learning keep them and the Fellows constantly talking, evaluating, and reflecting. The Interns have successfully assumed responsibility for the on-going conduct of classroom instruction. The Fellows find their most important roles with the Interns to center around curriculum planning, modeling instruction and discipline related to specific concerns, and helping Interns deal with situations that arise for which they have no experience.

The hard work and time the Fellows spent with Interns during the first two months of school has resulted in a growing self-sufficiency among the Intern teams. Fellows are increasingly able to spend less time with the Interns and more time with the Double Eagle staff. They are successfully collaborating with Double Eagle staff to design curriculum. Increasingly, teachers approach them with questions not just about hardware problems but to solicit ideas for classroom computer activities to support their curriculum. The Fellows have been able to engage grade level teachers in creating curriculum that successfully integrates classroom technology into the on-going flow of instruction.

The collaborative has been most challenging for the Double Eagle staff. Each of them had agreed, when hired, to participate in the study of technology, curriculum, and the teaching/learning process framed by the collaborative efforts, but none of them had a vision of what that really meant nor the effort it would entail. Most of them had only limited experience with the integration of technology to support curricular goals. Most of their experience with computers had centered around a weekly visit to a school-wide computer lab. Since the work of the collaborative was designed to de-emphasize a computer lab configuration and to emphasize the use of classroom computers as an integral part of instruction, teachers were confronted with the need to know more about computer hardware and software, the need to move from whole group instruction to alternative strategies like committee cycles, and the need to learn alternative ways of planning and presenting curriculum. Most of them had little or no experience with collaborating in curriculum design, and the notion of planning and implementing curriculum across classrooms is new and challenging.

Conclusion

Opening a new school is an exciting, challenging, and frustrating experience. Beginning a new school/university collaborative without precedents for this particular model and with only broad goals and even more broadly defined roles and responsibilities is equally exciting, challenging, and frustrating. Each of us - intern, fellow, staff member, graduate student, principal, and faculty - embarked on this adventure with a strong commitment to a vision that is transformed daily. Each of us brought with us our own experiences and our own expectations. When it came to bridging from a theoretical model to a model of practice and action, none of us really knew what to expect. We had all agreed to become part of a learning community and that is exactly what we have done - learn.

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Developing an Internet Enabled Network of Professional Development Schools (PDS)

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Since its inception, the Professional Development School (PDS) model has inspired the establishment of a network of associated schools as a constituent part of the four-year integrated education program for future teachers at Laval University, Quebec City, Canada. In the context of a formal liaison between the university and associated schools, the aim is to build a community of educators who would assume responsibility for the orientation, organization, implementation, and evaluation of the preservice and inservice education of teachers. The relation between the university and the associate school is therefore intrinsically structural and pedagogical in ways this paper will describe with a focus on the potential of new technologies, such as, tele-learning, to enhance the PDS model. The network is part of the Tele-Learning Research Network (TL-RN) which is one of Canada's fourteeen National Centres of Excellence (NCE).

Tele-Learning Research Network (TL-RN)

All told, TL-RN is made up of 140 researchers and their partners spread all over Canada, which includes the sub-theme on Educating the Educators devoted to exploring how technology can support learning and growth among professionals engaged in educating a new generation which, at times, is more technically advanced than the professionals themselves.

The aim of the Tele-Learning Research Network sub-theme, *Educating the Educators,* is to better prepare students for a changing workplace and society. Its organizing principle, Educating a new generation for a network and knowledge driven world, guides the action and reflection of practitioners and researchers as they collaborate in preparing teachers to join with learners in exploring the advances in information and communication technologies which are permeating these global developments.

Tele-learning refers to the professional knowledge which is acquired mainly through a network of technological media defined as complementary or linked to various other networks. In fact, these networks reach far beyond the local school or university but also include among their active members teachers, students, undergraduates and various other experts from a number of schools and universities.

Teachers have to develop the means of participating in the critical and ongoing development and assessment of these new technologies' potential and consequences for learning, creativity, collaboration, and community. A partnership among universities, governments, schools, and industry is required to bring the nation's teachers in on this process of educating the educators, in how these new technologies are changing the face of education and the way the world communicates and does business at large.

The research objectives of the tele-learning professional development school (PDS) project include: How can tele-learning tools create functional and collaborative communities of inquiry?; In what ways can tele-learning shrink the gap between sites of learning and sites of practice?; How do the uses of technology for learning change the current practices of participants? The project is testing the limits and gains to establishing virtual professional communities. The main sites are located in Quebec City, Montreal, Toronto, and Vancouver.

School-University Partnership (Quebec City)

Laval University has nearly 4,000 students registered in its four-year integrated teacher education programs. The decision to develop an infrastructure for University/School collaboration in the education of educators followed successful pilot studies, and was made by both university and school representatives. Student teachers now entirely do their field experiences and practica in associated schools. The 23 school districts in the Quebec City Region already signed an agreement with Laval University to this effect. The agreement also includes two other dimensions: professional development activities with associated teachers, and collaborative research. Laval University has assigned one teacher educator to each school during students' field experiences, and is enlarging its presence in the field. Participating schools are highlighting teacher education as one of their key activities in their school's basic orientation document, and associated teachers are groomed to work as a team.

On the whole, 35 high schools and 100 elementary schools are involved; that is, one third of all the Region's schools. Such a large participation of the schools and the meaningful collaborations contribute to the mammoth task (Darling-Hammond, 1994). As part of Laval University's priorities, the first years of the network have been generously funded. Having reached its full size, the network of associated schools now calls for continuous support to reach its goal (Holmes Group, 1990 & 1995).

As new equipment is recieved and pilot studies unfold, the likeliness of having these functions supported by advanced technologies becomes an imperative. But this creates another need in the Region, that is, to develop the technological literacy of its professional educators. Attuned to this growing need, the TL-RN teacher educators at Laval University and their school partners are contributing, during the 1995-1999 period, to the infusion of new technologies at three levels by:

1. concentrating their efforts on the establishment of two fully functioning Tele-Learning Professional Development Schools (TL-PDSs),
2. offering workshops and tutoring to educators that are integrating new technologies in their practices, and
3. providing expertise and online resources to other interested classroom teachers, and school principals.

For instance, a one-day conference held a few weeks ago brought together 350 school principals, teachers, and teacher educators involved in the development of technology infusion plans and their implementation. High school students, teachers, principals, and teacher educators involved in the TL-PDS discussed the challenges and issues related to the five pyramidal layers that they have come to identify as critically important in the integration of new technologies in the classroom. These are:

a. awareness of higher standards for education;
b. access to Internet,
c. exploration of new teaching and learning possibilities,
d. development of new routines (teaching and learning), and
e. project-based classroom management and pedagogy.

The Educating Educators team of the Tele-Learning Research network foresees a radically different teaching environment from the one that prevails today. Each of the four sites (Quebec City, Montreal, Toronto, and Vancouver) is working on becoming Internet enabled. To link the four sites in such a way as to grow as members of a virtual learning community is envisioned.

Changing the Education of Educators

The Educating Educators TL-RN team has found it imperative to put in place research on the constituents of the "new" educational situation which may enhance teacher education. They focus on six constituents for making a success of the project : the *telos,* the team of teacher educators, the technological area, the nature of the learning process, the human context surrounding the learning process, the evaluation of the tele-learning performance.

The *Telos*

The term tele-learning points to two different meanings: distance and *telos.* It is imperative for the researchers to investigate both applications of the term. Whereas the concept of tele-presence applies to a variety of information technologies, the notion of intentionality applies to each person engaged in an individual or collaborative learning project. As hands-on computer technologies provide easier access to a wide proliferation of learning resources, it heightens the necessity of self-determination. What is a learner looking for? What does this learning team want to achieve? Which image of oneself does this learning community hold? These are questions that addresses the *telos* dimension either at an individual or at a collective level.

The Team of Teacher Educators

The university-based teacher educators hold different perspectives and specialities (e.g., Cognitive Psychology, Educational Technology, English Literature, History of Education, Math Education, Social Psychology). School-based teacher educators also have specialized in different domains. They speak different languages, and the creation of a climate favorable to the exchange of ideas between disciplines and school subject matters was the first challenge. Now the task is to create an intersubjective zone of dialogue, a virtually ideal speech situation in sense, in order to sustain the moments of learning and insight.

The Technology

The use of the technological media made by teacher educators, students, teachers, undergraduates and other persons involved, is of an intensive, diversified and inventive nature (Harasim, 1995). Each category of persons concerned call upon various media to get at some information source, to do some other works and to communicate to others the fruits of the accumulated knowledge and identified zones of inquiry. Texts are exchanged as well as schemes, graphics, and other visual messages. The entire communication process (between students, between schools, between undergraduates already linked to different schools, between undergraduates and teachers or university supervisors and professors, etc.) constitutes a system dominated by complementary knowledge building and common sharing, creating therefore an environment imbued with continuous transformation.

The Nature of the Learning Process

The knowledge building which constitutes the aim of the whole Tele-Learning Program, represents quite a challenge. Rooted in a vision that forging and participating in these new community links is in itself an active engagement in the construction and testing of his or her own knowledge, the actual learning, in general, take shape or form through itineraries or projects which have a certain scope and which call upon some expertise in the area of varieties of knowledge, particularly of a fundamental nature and of skills of all kinds. Moreover, much energy is devoted to the establishment of a clear and stimulating junction between abstract concepts and theoretical frameworks and the hard facts and exigencies of reality. In the same line of thought, students are encouraged to develop a healthy critical attitude towards the program, based on their experience as students in a university or as student teachers in a school.

When reference is made to "knowledge", it grows out of the sharing and shaping of experiences in ways facilitated by the increased communication. This sharing is aimed at assisting pre-service teachers towards gaining knowledge and skills of a practical or intellectual nature, which they are called upon to master in order to accomplish the tasks and functions expected of them now or in the not-too-distant future.

The Human Context Surrounding the Learning Process

The proper learning environment operates on the assumptions that a) each person is to assume the responsibility for his/her own learning development, and b) is expected to receive an important support from peers and teachers and to be part of an elaboration process leading to greater knowledge. The cooperation between the participants is at the center of attention (Sergiovanni, 1994). The scope and complexity of the learning to be mastered encourage this cooperation but it is equally necessary to come up with imaginative and effective techniques to reinforce this cooperation.

Teaching is today more and more a collective activity; in the context of a tele-learning system, the situation is even more striking. Graduates must therefore be in a position to face that situation. The classroom is but one of the sites whence they can operate; it is understood that "to be a teacher" will also increasingly mean to be in a position to intervene with competence at the school level where his/her class is located, and within the school and other social institutions located in the sphere of his/her profession.

The Evaluation of the Tele-learning Performance

The evaluation of learning performances, be it of a diagnostic, formative or summative nature, must be consistent with what was desired as learning benchmarks at a terminal stage of learning. Priority will be given to the understanding of various types of knowledge and the mastering of skills (rather than simple memorization and ability to operate as a "jack of all trades"), the availability of the technical media will be thoroughly exploited and the pursuit of individual itineraries and the implementation of projects of a certain complexity and scope will be traced and a personal appropriation and participation in a community project will also be assessed.

Early Results

This very development, in concert with the PDSs and tele-learning systems, has a double impact in the change introduced in the training of future teachers. As a consequence, the identification of the changes which will effectively take place becomes another condition to make a success of the desired learning outcomes. Some of the introduced changes can already be identified and their impact is now being assessed.

The most obvious transformations — and very likely the most important ones — deal with the time factor and the determination of the space (training site) factor. Time is spent by the teacher-in-training in a working team composed of peers or experienced teachers. Supervision includes the works of a student using a computer to produce learning materials which form part of the circulation of ideas. Furthermore, the emphasis being put on project implementation and the cooperation between learners translates into a more flexible teaching schedule. Technical media make it possible to the student, even from his/her home, to have access to extremely voluminous documentation and to take an active participation in group discussions. Finally, the necessity for the future teachers to learn how to solve problems in a team work effort environment, and to discover on-the-spot multiple dimensions of the teaching profession, makes it a quasi-indispensable requirement that a special working place within the associated school be made available for that purpose.

The Educating Educators Team of the Tele-Learning Research Network is determined to take hold of the pedagogical advantage of tele-learning technologies and design and implement information-rich learning environments which will, in turn, lead to a better-educated generation of students conversant with the knowledge- and community-building technologies of the future.

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University Provides On-Site Technology Training for K-6 Teachers and Students: A Case Study

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Educators, from preschool to post-secondary, recognize the power of technology as an instructional strategy and content learning area. However, educators are struggling to learn the skills they need to prepare students for a world of technology and information. In response to these monumental teacher training needs, state school boards have passed mandates, offered incentives in funding, and held meetings for the encouragement of computer use by teachers. School district central administrators have designed plans for future technological acquisitions and training hired district personnel to oversee district technology needs, and have offered day-long trainings and after school workshops for teachers. In all this flurry, individual schools have been left behind as passive receivers of these initiatives. Therefore, little growth of technology skills are realized by teachers in many educational settings.

Washburn University's Educational Technology faculty and students, as well as teachers and students from Indian Hills Elementary School located in Topeka, Kansas, have embarked on a long-term teacher training project. The school's learning community (including principal, teachers, Parent Teacher Organization [PTO], site council, parents, and local university faculty) were highly involved in the designing, developing, implementing, and monitoring the project. The project began in the Fall of 1995 and is currently in its second year. The project's objectives include increasing the school's teachers technology skill acquisition and instructional integration strategies. Conventional teaching and learning roles were redefined throughout the project and often throughout the day.

The project was developed after Indian Hills Elementary Schools determined their teachers were not adequately trained to effectively integrate technology into instruction and instruct using computer-aided studies. The school's organizations (including site council, PTO, and teachers), joined efforts to formulate a plan which would assist teachers learn better how to use computers which were currently available for instruction. The school's technology includes a 30-station networked laboratory with an abundance of instructional and multimedia software.

Two facilitators have been contracted through fund-raising efforts from the school's PTO. The facilitators' functions were to assist teachers concerning instruction in the computer lab. These facilitators, both parents of Indian Hill students and certified teachers, have had previous experience teaching with technology in a K-6 environment. One facilitator teaches at the local university, Washburn University, in the area of Education Technology.

The facilitators provide instruction to each classroom in the school. Teachers are present to assist with the students as well as guide the instruction's content; therefore, teachers acquire computer skills along with their students which provides immediate opportunities for teachers to utilize their newfound skills. In addition, the facilitators provide training sessions during non-teaching times regarding specific computer applications.

The Process

The 510 students are scheduled to utilize the Computer Lab at least once a week. Once a week, K-3 graders receive 45 minutes of instruction, while 4-6 graders receive 1 hour. One facilitator assists grades 4-6 and morning kindergarten, while the other assists grades 1-3 and afternoon kindergarten. Each facilitator corroborates with the classroom teacher to design the lessons in alignment with district outcomes. New software available on the IBM network is investigated throughout the project by the facilitators and teachers in order to create developmentally- and subject-appropriate lessons.

Instruction emphasizing document development is augmented to specific classroom learning. For instance, as sixth graders study Africa, the students research a country by accessing information from computer programs and develop an African informational newsletter with text and appropriate graphics (including computer-created drawings). Although document creation is stressed during the limited time on the computer, other coursewares are also being used to support classroom instruction as time allows.

Teachers can choose to participate in the lessons as a student or they can act as facilitators. The teachers' level of expertise and comfort guide how they participate in the lesson. For many of the teachers, the lessons are the first time they have had an opportunity to learn the necessary computer skill, while other teachers wil choose to inject specific content and instructional directions in the lesson.

Higher Education Collaboration

The facilitator for grades 4-6, teaches educational technology classes to preservice education students. As a requirement of the class, Washburn University students observe and assist in the computer lab. This provides preservice students an opportunity to observe lessons being taught by the project's facilitators and teachers, as well as numerous opportunities to assist students. The field experience provides a valuable commonality for class discussion. Further, preservice students are able to preview and evaluate educational software at Indian Hills which the university was unable to provide.

Indian Hills Elementary teachers have the option of enrolling in 3 hours of graduate credit for each school year's efforts in relationship to this project. The learning they obtain during classroom lab time, their endeavors in teaching with technology, and additional trainings are requirements for completion of credit.

Future of the Project

Accepting the faculty and staff's recommendation, the Site Council, PTO, principal, and university have determined to continue the project indefinitely. As technology, staff, and scope of the project evolves, implementation strategies will change; for instance, in year two, teachers have taken on a greater responsibility for the planning and presenting of lessons, while facilitators are providing technical assistance and expertise as needed.

Each semester university students are able to provide greater levels of expertise as their technology skills are developing. The university is beginning to increase the number and variety of courses offered to the education students, thereby providing more students to become involved in the project.

Indian Hills and the university are also exploring additional ways of sharing resources. In particular, Washburn University will offer selected Educational Technology classes in Indian Hill's computer lab. Appropriate topics will include sessions on the evaluation and use of educational software. In a "trade-off", Indian Hills will use one of the university's computer lab for the development of multimedia projects. This arrangement has benefited both parties, as their teaching resources are limited; additional sharing of resources will be implemented as the resources become available and are deemed appropriate. Indian Hills Elementary will continue to be a field experience site for Washburn University's education technology classes.

Conclusion

This project exhibits a prime example of the benefit of site-based collaboration. Educational groups within Indian Hills Elementary (including Site Council, Parent Teacher Organization, administration, teachers, staff, students, and community) bonded together to resolve a need in their school. The staff training in technology is being successfully addressed because those closest to the problem are providing the solution.

Because the faculty and staff requested the year-long on-site training, lag time has been reduced between distribution and utilization of information. Participants realized it was no longer feasible to take teachers out of their teaching environment into day-long or after school training sessions, which are enormously expensive and notoriously inefficient in producing change; instead, participants are able to instead link learning to their specific subject area with just-in-time learning.

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Graduate and Inservice Education

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Though usually different in structure, inservice and graduate education may be loosely understood as providing refinement of perspectives and skills gained through teaching experience as well as through earlier undergraduate training. Furthermore, it is the venue for introducing cutting edge theories and practices. Understood in these contexts, the articles in this section describe a wide range of ways that teachers can utilize technology to increase student motivation, to raise understanding and achievement, and to enhance the total learning environment. In addition, some articles, while not specifically centered on formal programs, offer numerous suggestions for teachers in selecting, evaluating, and using technology. Equally important, all of these articles reinforce the reality that technology is an active, dynamic component of the teaching enterprise — it is no longer a debate over whether to use technology in education, but rather when and how to use it with efficiency and sophistication.

Inservice and Graduate Education Programs

Kar-Tin Lee describes the successes and challenges of postgraduate students at the University of Melbourne in Australia as they move through a program that retrains teachers in information technology and that culminates in granting a graduate diploma in Information and Communications Technology Education. The study also examines in detail the level of student involvement in the use of a Bulletin Board System (BBS) as part of their course of study. Similarly, Steven Sorg and Barbara Truman explain the methods used to research, design, develop, and implement the vocational teacher certification course over a six-week period at the University of Central Florida. The article emphasizes how students develop familiarity and confidence using the World Wide Web and e-mail, and it identifies various problems encountered in the assessment process as well as strategies developed for addressing the problems. Gregg Brownell, Jodi Haney, and Les Sternberg present an overview of the development of a Master of Education in Classroom Technology program in the College of Education and Allied Professions at Bowling Green State University. The authors also summarize the results of a needs assessment conducted within the service area of the College. Finally, Lorana Jinkerson explains a new course in learning technologies at the Northern Michigan University as part of its reorganized Master's of Education degree. The upshot of her discussion underscores that fact that course refinements will develop over time because technologies constantly evolve into newer and more effective tools.

Joan Gipe and Joan Lamare examine various ways to integrate technology into teacher education courses. Citing a rich collection of verbatim quotes from undergraduates at the University of New Orleans, the authors show that students effectively incorporate technology into their lessons when provided authentic learning experiences in a supportive environment. Steven Marx presents two similar models for technology instruction. The preservice university-based graduate program includes a unique series of courses which lead to a culminating technology mentorship, while the inservice school-based program identifies teacher needs assessment and teacher technology goals as critical issues.

As the technology field continues to evolve, more and more pressure may be placed upon the basic education media and technology specialist. Professional standards for those who work in these related fields must be reevaluated. Responding to these recommendations, Randal Carlson and John Gooden review the preparation and roles of media specialists and technology specialists in the state of Georgia. They offer suggestions to upgrade current preparation for media specialists and conclude that certification should be required for technology specialists. Barbara Helland, Barbara Summers, Richard Allen, Jill Snyder, Patrick Burns, David Zachmann, and Carl Davis discuss the merits of adventures with supercomputing (AiS), the Department of Energy's K-12 interdisciplinary educational pilot program. They highlight the teaching resources developed and various lessons learned as the program, which serves seventy high schools in five states, evolved over five years.

David Bullock and Emily C. de la Cruz examine how electronic resources can be used to expand the forms of expression and performance in today's classrooms by moving beyond traditional paper and pencil tasks. The article also examines how technology can foster increased collaboration between students and teachers and how electronic resources are prompting a redefinition of teaching and learning. Michelle Cline and Mary Starr argue that a rich sampling of educational hardware is now available for classroom use; however, many teachers, for a variety of reasons, do not use these resources consistently as an integral part of their curriculum. In addressing some of these reasons, the authors describe several types of programs where student mentors work with teachers and other students in fostering the use of computer technology in the classroom.

Carlos Solis focuses on two case studies to demonstrate that one of the most successful vehicles for introducing technology into the classroom is the use of existing teacher-developed curriculum as the cornerstone. He concludes that by making technology a construction tool in curriculum development, teachers are able to see quick results and impact in their classrooms. Aileen Johnson and Gabriela Gonzalez examine how a group of elementary school teachers in Brownsville Texas were, first, introduced to multiple intelligence theory, and second, how this generated a need for new assessment strategies. In particular, the article examines the role of authentic assessment, the content and nature of a multimedia portfolio, and the process for creating student portfolios using HyperStudio software. At Niagara University, John Murphy, Jackie McFarland, Chandra Foote, and Robin Erwin describe how they are collaborating with the Niagara Wheatfield School District in Sanborn, New York on a pilot project to introduce Niagara University graduate education students to hands-on experiences, while bringing authentic assessment and technology into the middle school's inclusion program. At the University of Exeter in England, Christopher Taylor provides preliminary findings from an inservice project wherein primary grade teachers used robotics to further students' technology abilities.

Assessment and Selection of Software

Increasingly limited resources and downsized budgets force teachers and administrators to consider carefully where, when, and why educational dollars should be spent. Both Sonny Baker and Richard Biehl demonstrate in their respective articles a sensitivity to these realities as they describe criteria for judging software. Baker presents an engaging chronicle in the use of Logo as a basis for recognizing that software products do not necessarily fulfill their claims. Similarly, Biehl expands the notion of quality assurance beyond cost, ease of use, and functional accuracy to include numerous technological and pedagogical issues.

Technology and the Global Community

In their respective discussions, Yesha Sivan in Israel, and Kara Nance and Mahla Strohmaier in Alaska, highlight technology's role in facilitating communication within the ever-expanding, global and virtual communities. Sivan argues that currently there is a lack of ability to analyze the issues of leadership fully within virtual communication. Despite this, he concludes that the juxtaposition of power and knowledge is especially relevant when it comes to leadership within virtual communities where skills like communication, vision sharing, and storytelling are all taking on new forms. Echoing Sivan, Nance and Strohmaier observe that the Information Age has afforded individuals opportunities to become members of a global community, one that presents heterogeneous populations with the capability to interact, and one where, within this interaction, cultural issues become pronounced. Further, the authors recommend that awareness and acknowledgment of differing cultures in the context of an evolving community can facilitate effective communication.

Windows to Wider Worlds

As a group, these articles portray a panoramic view of the ways that electronic technologies can and should be used to enhance multiple facets of classroom interaction. They also attest to the creative energy of so many educators who are collaborating within and across institutions to improve teaching and learning and to explore technology's potential in opening windows to wider worlds within a diverse, global community.

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Enhanced Learning Environment for Teachers: What next?

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This paper presents the experiences of a group of postgraduate students in the uptake of new technologies whilst undertaking a professional development course in information technology. Since 1990, this department has been conducting a Graduate Diploma in Information and Communications Technology Education course for practising teachers seeking to change their careers. Teachers of varied backgrounds ranging from teachers of English to physical education (some 400 of them) have completed the course to date. They are now actively engaged as information technology teachers within the secondary and primary school systems in the state of Victoria, Australia. This course was one of the first in providing participants with the requisite qualification (as prescribed by teacher accreditation authorities) for this specialist area of teaching.

Purpose and Context of Study

The specific objectives of the study were to: (1) establish the level of student involvement in the use of a Bulletin Board System (BBS) as part of their course of study; (2) identify technical and structural concerns associated with this medium; (3) ascertain learner perceptions and satisfaction in the use of such a medium; and (4) determine the types of resources required to effectively integrate this technology.

Many of the students enrolled in this course lead very hectic lives, and time for study is often limited increasingly by other obligations. Their life circumstances often impose constraints on the ability to access services in the traditional manner. Since this graduate diploma has an information technology focus, it was felt by faculty that students should be encouraged to use electronic means to communicate with lecturers and to perform other related activities. In this way students will be gaining firsthand experience of the medium.

The majority of the students were teachers completing their graduate qualification on a part-time basis. In general they worked full-time during the day and take most of their classes in the evenings, on weekends or during school vacations. These students were commuting to campus and had sandwiched all their courses into one year of full-time or two years of part-time study. This in addition to their life commitments have left them little space to manoeuvre. The trialing of the flexible mode of delivery incorporating computer mediated communications (CMC) was a direct response to the students' demands for more flexible ways of course delivery.

The Department's response was guided by research findings which tell us that the use of computer conferencing can enhance and supplement teaching and learning and provide fertile ground for ongoing learning and professional growth (Harasim, 1990; Honey, 1995; O'Gersh, & Posamentier, (1993); Schrum, 1995; Spitzer & Wedding, 1995; Weir, 1992). A number of studies have suggested that the use of this technology will allow both teachers and learners to interact with each other beyond the confines of the classroom (Casey, 1994; Kazuo, Hamalainen & Whinston, 1995; Waggoner, 1992). Teachers need to be trained to understand the basic components of telecommunications including understanding of the use of the computer, the functions of a modem, telephone and communications software, develop skills in messaging and conferencing and to become active participants on electronic networks (O'Gersh, and Posamentier, 1993). Many educators agree that effective adoption of new technologies in classroom settings requires teachers themselves not only to have the knowledge about the technology but also to have experienced successful models of computer integration in a teaching and learning environment.

One academic member was given the responsibility to set up a bulletin board system (BBS) to facilitate student-to-student and lecturer-to-student interaction. One of seven compulsory units within the course was chosen to trial this new method. Prior to this methodological change, the course had used traditional mail and fax services and telephones which lacked interactivity. The addition of the BBS to the existing combination of media which students could access immediately created a learning environment which enabled students to connect from home or work at their convenience using microcomputers and modems. However, for the majority of students who have never had the opportunity to use an e-mail system or electronic communications of any form, this proved to be a rather challenging and frustrating learning experience.

Between 1993 - 1995, a bulletin board system (BBS) provided messaging and computer conferencing facilities for students and staff of the Graduate Diploma course. In the unit used for this trial it was compulsory for students to submit their final assignment using the BBS. Students can either connect directly from home or their workplace using a modem or complete the task on-campus using the computer laboratory for access to the BBS. During the semester, assessment tasks were set where students had to upload their findings so that the information would be accessible by other students for analysis and discussion. As one of the choices of their final assessment, students could choose to write an analysis of the information presented on the BBS on a selected topic. This final analysis when submitted would also be made accessible by way of the BBS to the rest of the students in the course.

On average, over the three years there were about 120 students who participated in the use of the BBS. Because these students were enrolled in an information technology course, it was felt that they should explore and explicate a fuller meaning and understanding of using the BBS as a means to enhance learning. It was expected that these students would already possess the necessary technical skills in the use of computers to be able to use the BBS without great difficulty.

Faculty was of the view that being educated in computer information technology is more than an instrumental understanding of how a computer works or is used; it is the development of a broader conceptual framework from which a person is able to understand the issues and implications of the technology. After all, these students are teaching professionals and they would ultimately take their experiences back to their own students whom they have to teach when they complete the course.

As a requirement of the unit, it was compulsory for students to send electronic mail to the lecturer and to transfer assignment work (upload/download files) through the use of the file transfer utility. For those students with a computer and modem connections they were encouraged to connect from home, whilst for those without they had access to the computer laboratory on campus to perform the same tasks. There was no pressure for the students to purchase a modem as facilities were readily available on campus for those who wished to access them.

Students were given a manual on how to connect to the BBS. The electronic file of the manual was also available on the BBS for students to download and then print. The students were given an induction session on how to use the BBS and were provided with the telephone number for the Systems Operator (SYSOP) in case any problems arose. The role of the sysop (who had undertaken this role over and above his lecturing responsibilities in the course) was to help students overcome difficulties in their early attempts to use this electronic means of communication. This person was able to give students some technical help where appropriate.

Method

It was important to discover what experiences might be effective in encouraging students to systematically integrate technology into their private and professional lives. Equally important was the fact that the academics involved were anxiously seeking answers to many questions in order to improve this new medium in the near future.

A survey was developed to collect student responses in November, 1995. A questionnaire containing twelve questions was administered to sixty-six students enrolled in the unit at the time. It consisted of a combination of multiple choice questions, Likert-type questions and open-ended questions. Further information was obtained through informal conversations with students in the course and other colleagues.

The author is hopeful that data obtained from this study will inform researchers and provide strategies to better meet the needs of practising teachers to more effectively prepare them to infuse technology into everyday practice in the classroom.

Findings and Discussion

Within the student population there was substantial variation in the extent to which students used the BBS. Some students, particularly those comfortable with the use of the computer, tended to be very active. Others used the BBS only in a limited way, i.e. they would submit their work online and not continue to engage in the use of the BBS for conferencing purposes or to send messages to the lecturer concerned. The major findings are presented below:

1. A High Level of Awareness of Bulletin Board Systems

Contrary to popular belief, data collected revealed that in the three year period (1993 - 1995) a large percentage (85%) of students in this sample had in fact had some contact with BBSs. They were aware of its existence and in many cases knew of friends who used it. Many teachers were teaching in schools that had a BBS. Only 15 per cent of the respondents were aware of BBSs in the years prior to 1993.

2. A Large Percentage of Students Owned their Own Computers

Eighty-three per cent of these students owned a computer, whilst 36 per cent of them also owned a modem. Of the students who indicated ownership of a modem, seventy per cent of them had high speed modems which were capable of transmitting at speeds of 14400 bps or higher. However, this did not mean that they were actually using the modem as in many cases they were purchased by other members of the family.

3. Reasons for Buying a Modem

This fell into three major categories: (a) to connect to the Internet; (b) to electronically transfer files; and (c) to engage in activities on the BBS. Due to the limited extent of this survey there was insufficient information to gauge exact levels of usage of each of these categories mentioned.

4. Self-perception of Computing Skills Low

Self perception of computing skills at the time of purchasing the modem was fairly low. Twenty-five per cent indicated that they had some skills, with only 15 per cent claiming to be competent users. In contrast when asked what their present level of computing skills were 79 per cent indicated that they either had some skills now, were competent users of computing or were very competent. This is a huge rise in the level of skills perception on the part of the students over a period of three years. It is also indicative of student readiness to adopt new technologies for flexible course delivery.

5. Positive Response to E-mail Access

Response to the provision of E-mail facilities by the Department was positive. When asked to respond to a series of questions in regard to e-mail facilities, a very high percentage (88%) of the students indicated that they would like to have e-mail facilities whilst doing this course. Fifty-one per cent were prepared to pay between ten and twenty dollars to register for e-mail facilities while thirty-one per cent were prepared to pay twenty-five dollars for such a service. Additionally fifty-seven per cent were prepared to pay between ten to twenty-five dollars for telephone bills to connect to such a service with thirty-five per cent indicating their preparedness to pay fifty dollars or more.

6. Demand for Connectivity from Home

Responses to the question "What else would you like to be able to do from home?" are shown below:

Items	%
Internet access	83
Access to library/databases from home	82
Interact with lecturers	77
Send/receive assignments online	76
Access to course information	67
Engage in computer conferencing from home	52
Engage in peer interaction/group work activity	48
Student records access	35

This result shows that these students have in fact reached a higher level of competence in the use of new technology. No longer are they requesting for low level usage such as availability of wordprocessing or spreadsheet packages — they are now advanced consumers who are ready to incorporate computer mediated communications into their daily use of the technology.

7. Preparedness to Buy into Technology

Responses to the question: If courses were offered in flexible delivery modes and you did not have a computer and a modem, would you be prepared to:

Items	%
Buy them	55
Lease them	36
Work at a friend's place	4
Go to a study centre with facilities	5

Whilst students indicated the above responses, some ambivalence is evident since thirty-five per cent of those who had selected options as shown above also indicated that they would like to travel to attend conventional classes. This reveals some degree of reluctance in relinquishing the traditional face-to-face attendance mode. This feeling is strengthened by anecdotal accounts which suggest that many students still feel that a combination of both traditional and online modes of delivery would be most beneficial.

8. Problems Identified

The items requiring qualitative responses were analysed and summarised to produce qualitative themes as described and discussed below. The most frequent criticism about the program noted by students was that not enough time was given for familiarisation with the medium. Technical concerns remain the main issue for a large number of students. When asked to reflect on their initial experience of using the BBS, students recalled:

a. having spent numerous hours fiddling with the equipment trying to connect;
b. lack of immediate guidance from anyone;
c. confusion and lack of knowledge on what to do;
d. absence of clear course notes on the technical aspects of BBS connection;
e. having to resort to external help and support e.g. PC Users' group, friends, - colleagues, computer magazines; and,
f. experiencing great difficulty connecting to the BBS from external locations - lines dropping off all the time.

Much variation was detected in these open-ended responses. As is to be expected these adult learners manifested differences in their preferences and in their approaches to learning with this new medium. Some revealed feelings of great frustration and were quick to shift the blame whilst others were prepared to work through their problems to achieve mastery regardless of effort and time spent. A great sense of community was present when participants telephoned, faxed or e-mailed each other to find quick solutions to their problems.

9. Student Perceptions

In regard to the question which requested students to provide further comment on whether provision of electronic facilities is useful or necessary, the main theme appears to be that students should be given a choice of selecting the modes of study which they prefer. On the whole there is a very positive response to the use of electronic communications or computer mediated delivery of courses provided that a high level of support is available to alleviate problems such as inadequacies of software and the system's ease of use. Although students generally agreed that the use of the BBS seemed to emerge as a medium — that if integrated well into the course — can contribute significantly to a better, more student-centred learning climate, their frequent comments indicated high levels of frustration in relation to the technical and structural problems encountered.

Respondents suggested various ways to overcome problems reported above. Specific solutions included: better technical support — online help; clear instructions to guide students through installation of modems and how to connect to the BBS; several hands-on workshops for familiarisation with the medium before students have to do it on their own; standardisation of equipment i.e. faculty to recommend certain brands of modems and communications software with clear instructions for installation; and ensure that downtime was minimal. Students felt that unless these problems are alleviated, the conceptual advantages the medium has to offer will not eventuate.

Assuming that cost, technology and other impediments can be overcome in time, faculty needs to recognise that individual learners regardless of the level of technology provided, will choose to learn differently.

Conclusions and Implications

This report has encapsulated the excitement, positive perceptions of the value of electronic communications and student's willingness to pay for such services. At the same time, though, student comments reveal fairly high levels of frustration that have accompanied early attempts at making effective use of the BBS. Students realised the benefits of the ability to use electronic communications as it allows them to become actively engaged in a community of people sharing and creating information. These students were excited by the fact that they can draw on new kinds of resources to experience new kinds of learning opportunities, and to work flexibly with materials in shaping educational experiences fitted to their needs. Since it was compulsory within this course that students had to use the BBS, students really did not have a choice in whether to use this technology or not. However, despite the frustrating experience, most of them managed to cope and with the exception of a minority of students, and most are now ready to use e-mail and the Internet.

Responses to questions as indicated above reveal that a taste of this new technology has led students to demand much higher levels of access and more sophisticated use of the technology. Essentially all participating students are of the opinion that the provision for telecommunication on this campus is essential and should be implemented as soon as possible. A fundamental question, however, about the use of electronic communications still needs to be asked — how much value will be realised in practice due to its availability in educational settings. Will these students transfer their skills into their own future classrooms when they complete this course? From the positive responses obtained in this survey there is a strong indication that these students who have had some experience of the BBS will now be better placed to join the electronic communities on the Internet thus forming networks of their own to share their thoughts and ideas and to see this as a continual challenge. What is clear from this survey is that for technology to be integrated properly into the course, students must use this medium in more than one subject within the course. Using the technology in isolation will not prepare these students adequately. More opportunities must be available for students to develop their competence in this area so they can effectively model and demonstrate its use in their own professional activities.

What Next?

At the time of writing, numerous departments within the university have incorporated some form of new information technologies into their teaching. However, it is only when adequate support is provided for the so-called pioneers in the field that more extensive integration of new technologies across the curriculum of the entire department can occur. Very recently, the information generated by this study has been used to support a submission for a grant to develop courses for online delivery. This submission has been successful. The Faculty of Education has committed funds for the development of Web-based materials for delivery of three information technology related postgraduate units online to cater for the department's students in the second half of 1997. This funding will allow the creation of materials that can be used both now and in the future and will be a resource that will be expanded on as time goes. It will serve as a model for delivery of other course units in future. The success of this project will bring about the existence of a critical mass of interested academics involved actively in a shift in mindset and together the team of pioneers will be a driving force to get faculty to buy into the potential of technology for teaching.

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Learning about Teaching Through the Internet: Lessons Learned

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Summer term A, 1996, was the time frame for the University of Central Florida's first fully Web-based, distance learning course. It was not a course that had been scrutinized by curriculum committees or that enjoyed the support of media and development resources. Rather it was a little-known experiment undertaken by a faculty subject matter expert and an instructional designer. This paper describes the methods used to research, design, develop and implement the vocational teacher certification course conducted over a six week period using the World Wide Web (WWW) and e-mail. Lessons learned from problems encountered during this experience are shared along with strategies for dealing with the issues.

Background

The WWW and Internet provides hypermedia (point and click) access to instruction which is linked with hypertext. The Web combines photos, graphics, text, some audio and some video in an interactive environment. The Internet, of which the WWW is a part, has two real advantages over other media, according to Thomas McManus. "(The Internet)... combines advantages of other media so that it conveys video and sound better than a book, is more interactive than a videotape and, unlike a CD-ROM, it can link people from around the world cheaply" (McManus, 1995, p. 3). The second advantage is that the Internet is a content provider as well as a delivery system.

E-mail is essential to electronic learning and is responsible for most of the student-professor and student-student interaction. Often, e-mail messages are personal asynchronous messages, but unlike phone conversations one cannot hear inflections of voice. You do have the opportunity to see what you think before someone else sees what you said (Maddox, 1995). E-mail's asynchronous nature also affords a considerable advantage over the telephone by avoiding phone tag. Another benefit is the ability to set up a list to send mail to an entire class with one keystroke (Mizell, 1994).

Assumptions

Several assumptions were made about the learners who might take these courses. Most would be full-time vocational education teachers. As teachers, they would have access to a state-wide free e-mail system, Florida Information Resource Network (FIRN). FIRN provides local dial up in most cities and towns in Florida and also provides an 800 number. Through FIRN they could also request a free ppp connection enabling them to access the WWW at no cost. Students admitted to UCF have access to universal e-mail accounts and free WWW access with local dial up to the university network. We thought that the full-time teachers would likely have access to an Internet connected computer at their schools and some might have home computers as well. Web-based courses, therefore, seemed to be the best way to reach these learners and enable them to have access to the courses that are required for their teacher certification.

Delivery on the World Wide Web

With this in mind, the decision to design and deliver an online, Web-based course was made in December of 1995, five months ahead of delivery. The author, a vocational education professor at the University of Central Florida (UCF), had plans to teach three methods courses (in one) during the first half of the summer term. UCF was the only institution in the state that offered one of the courses. The students who take these courses are vocational education teachers, hired from business and industry to teach in high schools and adult vocational/technical centers throughout the state. These teachers complete this course as one of the four courses required for vocational teacher certification in Florida. During the fall semester, many phone calls were received from teachers around the state who needed this course to complete their certification requirements and maintain their jobs. Some were desperate because they were at the end of their temporary certification period and would lose their jobs if they did not complete their coursework before June 30. Many did not have access to the required courses from universities that are closer to them or they were not within a reasonable driving distance from a university that offered the required courses.

The author is also the executive director of the Central Florida Consortium of Higher Education, a consortium involving UCF and six feeder community colleges in the region. The Consortium was involved in an $800,000 distance learning demonstration project from the State University System. The coauthor was a communications specialist and webmaster for the Consortium and was also finishing her master's degree in instructional technology. An internship requirement would have forced her to drop her duties on the grant, but the author suggested a collaboration effort to do his Web-based course. Thus, a team effort began that was aided by the experience and knowledge gained from the distance learning demonstration project.

Research on Distance Learning

Work began immediately. A literature review was conducted on Web-based instruction, collaborative learning in distance settings, computer mediated communications and distance teaching and learning practices. The Web itself was also searched for articles, faculty homepages and examples of course materials. Fortunately several people who had journal articles published on using the Web for instruction also published their work in their homepages.

Many of the course materials found at that time reflected pages that had poor graphical design. Colors were loud, print was sometimes hard to read because of busy backgrounds and the pages lacked sophistication. The pages appeared to have been done by faculty members without institutional support of media or programming specialists. The course materials also lacked instructional design. Some pages were pure paper conversions of existing class materials written in *professorese* that were probably used in traditional courses rather than distance learning courses. Very few good examples were found on the Web. Lots examples were found on what not to do on course homepages. A literature review was written that described many theoretical practices that are useful for incorporation into the course design. These practices include the facilitation of student to student interaction (Kontos, Mizell, & Hesser, 1995; Schrum, 1995), the use of advance organizers (Olgren, 1995), and techniques of formative and summative evaluation (Murphy, 1995).

Research was thoroughly conducted on the Web for specific applicable content links. The Web is a medium, but it is also a content provider (McManus, 1995). The sites with appropriate content were organized in two ways. General content on vocational education that would be of value to all vocational educators was centrally placed on the author's personal homepage and also on the vocational education program page so that it would be available to students taking any vocational teacher education course. Course specific content links were placed on appropriate advance organizer and activities/assignments pages.

Course Design

Unlike students in a traditional classroom, students here are expected to construct their own knowledge and see perspectives in an online class. Students must be more autonomous, self-motivated and independent, although sometimes they also must work collaboratively in groups. Students must also learn about how they learn to better manage their study time. Their access to study resources is greatly enhanced with links to computer resources and other experts (Collins & Berge, 1995; Zack, 1996).

Learner Support

Course design included deliberate elements that were specifically found or not found in the literature review or Web searching. Many of the elements were designed to provide learners with support needed to be successful in an online environment. The first element was a student information form which helped us know the learners. It also helped facilitate the student-student interaction. In distance courses it is absolutely critical that this is initiated by the faculty member. It is not enough to interact with the faculty member and the content, students must interact with each other in order to build learning communities.

Online resources built into the course included study helps and critical competencies for distance learners. Courses found during the Web search made very little to no effort to support students with general education references, nor were they frank about letting students know that they must have certain skills to succeed as distance students. These skills include responsibility for one's own learning, self-discipline, time management and knowing one's own learning/personality styles.

Since we were unsure about the prerequisite skills of the teachers who would be taking this course, we planned to provide technical and academic assistance through e-mail and telephone conversations. The instructional designer/technologist provided the technical assistance and the professor the academic assistance.

Registration on the Web was an idea to which the Office of Continuing Education had to adapt. A person was hired to help create the code for Web-based registration forms. The forms were not made into CGI scripted forms, rather, individuals print out the forms and fax or mail them back with the student's signature.

Advance Organizers

Advance organizers were another design feature incorporated into our Web-based course. Advance organizers are tools that help stimulate thinking and activate prior knowledge and recall. They help the learner hang new information on their existing schema. The advance organizer for the course included a course description, course learning objectives, and expectations of students and the professor. Other advance organizers were used in the activities/assignments of the course. These included essential webbed content that answered questions of what, why, and how about the content and the objectives students were expected to learn. Links to internal materials (like handouts used in traditional classes) and to external, content specific sites were provided in these advance organizers as well. Using the Web can be very distracting with all of the information that is there and all the opportunities to take a look. Our Web course pages were designed for easy access to links that would be mostly centralized and strategically placed in the assignments. The learners in this class were adult learners without much prerequisite skill in doing Web searches so we made it easy for them to find appropriate resources.

An advance organizer for the final exam was not originally planned, but without face-to-face contact with students, it was felt that one would be helpful. Students also showed growing anxiety about the final in their e-mail communications. So one was added near the end of the term.

Humanizing the Course Pages

In a effort to help the learners feel more in touch with the professor, his personal homepage (which was used as the front door for the course) included a personal photo and information about professional interests and affiliations, and personal hobbies. The course pages, content, and assignments were all written in the first person voice so that students would feel as though the professor were speaking directly to them. A couple of additional photos were used in the course advance organizer and the final advance organizer showing the professor working at his computer and speaking on the phone.

Least Common Denominator

The course pages were designed with what we called the 'least common denominator' in mind. This meant that we designed for the distance students who only had access to a text-based browser and a slow modem. Students with fast modems and graphical browsers could view the photos and the occasional icon, however. We avoided the glitz and glitter found on some sites and only put things into the pages that had instructional value and could be viewed by the majority of students. There were no animated gifs and no frames since Netscape 1.1 was still commonly used by those with graphical browsers.

Conventions

Many of the course pages we viewed in our research had no clear identifying marks. You could not tell where you were. There was no name of the faculty member teaching the course, no reference to the institution and often few or no navigation buttons to help getting around the site.

We wanted no 'orphan' pages on our site. We included clear titles in the head section of each page because we found that distance learners in an effort to cut down on online time will print course Web pages and work from the printed page before going back online to complete an assignment. The university logo was placed on each page so the learners and others who might find the site would know where they were. Also, navigation links were placed on each page to help students get around the site easily and to connect with the central university homepage.

Evaluations and Data Collection

Courses found during our research did not appear to have much built-in evaluation. In an effort to know the learners, we designed a student information sheet that students completed and faxed in as a first course assignment. The instructional designer developed a database from the information obtained from this form and used it as an intervention tool during the course.

We wanted to receive feedback about activities along the way so we could make adjustments. One of the greatest dangers in distance courses is that instructors cannot read from students whether the work they are assigning is attainable. In a face to face class, students can whisper, draw back in fear and dismay and check with other students for the reality checks of assignment load. Not so in a distance setting. CGI scripted forms were created, finally, by the last week of the term. Students were able to click on a Web form and fill out the questionnaire regarding each activity. The form, when submitted, sent an easy to read e-mail message to the instructor.

Summative evaluation was also very important for designing future courses. The university's traditional instructor course evaluation was used, but it clearly did not apply to this new learning environment so another instrument was created. Students were required to come to campus for the final. At that time they sat down and filled out a pencil and paper evaluation. Sixty one of the seventy two students completed the final evaluations. The data gathered included student demographics, perceptions, and preferences for course delivery.

Qualitative data are also available from the e-mail records and comments provided by students. These data show student learning community development and individual student growth in written communications skills.

Course Development

The effort made to design and create the Web-based course was a team effort of two individuals. There was no institutional support because the institution was not adequately aware of what was being done. No safety net existed. The equipment used was also crude. A bumped up 386 computer was used with 120 MB hard drive to create the pages. The media involved were minimal. There were a few pictures and minimal icons. No supporting print materials were made. A flyer was made describing the course requirements and was mailed to the state vocational/ technical center directors and to school district directors of vocational education. About 1800 teachers on FIRN were sent an e-mail copy of the flyers. A month before the class the phone began ringing. It did not stop until a few days before the class.

Course Implementation

An optional orientation was conducted on a Saturday during the early afternoon. Thirty five books were ordered but over 75 people showed up. Students brought their spouses who were more technologically advanced. Others brought their children. One student flew in from Pensacola and another stayed overnight in a hotel. The 72 students who registered for the course were instructed to make an e-mail distribution list of all the students in the class from an e-mail directory Web page within the course. The professor wanted to receive a copy of all the mail sent out in the course and instructed students to send a copy of all e-mail communications. Within three weeks he had received about 1200 e-mail messages. No e-mail protocols had been preestablished to instruct students to make sure they sign their name or put in a meaningful subject line. In an effort to head off trouble and be in a position to intervene, the instructional designer created a database from the student information sheets that students faxed back to campus. The database enabled sorting by geographic area, software users, and most importantly, by Internet service provider. The AOL users formed the largest single group and the database helped to get information to them to solve technical problems they encountered.

Students called when they had technical problems and some took the time to write up pointers that could then be distributed to everyone in the class. A few students stopped by to get help in person. One student called the designer on his cell phone after 10:30 at night to troubleshoot what he was doing on his computer. Some students became lost and had to be called to identify the problems they were facing while taking the course.

Breakdowns

Several things happened unexpectedly during the delivery of the course. All required intervention or changes in procedure by the professor.

The bookstore had assigned a staff person to take phone requests from distance learners and to take credit card information and ship books in a timely manner. A glitch occurred when that person went on vacation (during the first week of the class) and we found that no one else in the bookstore knew how to handle these requests. One student was three weeks into the five week course before receiving the text.

Most students, especially those who were new to e-mail and the WWW, expected instantaneous responses to their e-mail. Their expectations could not be met and were not practical. Many sent a second e-mail message within a day of their first message asking if it had been received since they had not received an acknowledgment from the professor.

With 72 students enrolled, the professor was overwhelmed with e-mail and assignments to grade. Giving timely feedback became a real problem. E-mail sorting and management systems had to be developed to make course delivery more efficient.

Course Data

The final course evaluations revealed that the students were mostly adult learners between the ages of 20-50. They were mostly Caucasian, split almost equally between males and females. School was not the only thing going on in their lives as 87% worked full time. The educational backgrounds revealed a range of education. Three people had general equivalency diplomas and twelve had masters degrees. The teaching specializations covered a range of welders and automechanics to business professionals. Over half the class had good computers, 486s or better, and 62% were accessing the course from home.

Prerequisite skills were sorely lacking. Over half the class had seldom or never used e-mail before taking the course. Almost 75% had seldom or never surfed the Internet. Despite this fact, almost 70% of the students read their e-mail once or more a day. The interaction broke down in the professor's ability to keep up with the e-mail traffic. Students would have preferred to receive reassurance that their papers were received and get them graded in a timely fashion. The instructor could not reply to all the e-mail and grade papers adequately for 72 students. Students reported that the Web pages were clear and almost 75% of the students said the course format met their learning needs. Surprisingly, 76% said they preferred the WWW format rather than the traditional every other Saturday face to face sessions. This was their preference despite their technological tribulations and how students reported not feeling as connected to the instructor as in a face to face course (43%).

Lessons Learned

We found that the background research done on distance learning, instructional design, and Web-based instruction was critical to the successful implementation of this course. Also, having a team to develop and implement the course was extremely important. These beliefs were borne out by the acceptance by the students of the course components, format, and style of the course pages. Students said that this form of course delivery met their needs (74+%).

The use of e-mail is invaluable for creating a learning community among students; however, used alone, it can quickly overload a mailbox and overwhelm the faculty member. The ability to autosort messages is needed and students should to be instructed on netiquette. Many students felt that they should get a response within 24 hours. A more realistic time frame is 48 hours.

Another very hard lesson learned was the importance of backing up files. The professor's computer got a virus one week before the class and crashed requiring the hard drive to be completely reformatted. At the time, he did not have a home computer. The aggravation that may have been prevented was considerable. The class proceeded on time, but some planned course management was lost forever. During the course of the class, over 1800 e-mail messages were sent in. Ironically, because the institution did not know the significance of this distance course the professor did not have sufficient memory allocated to his e-mail account. While he was away at a distance learning conference, the UNIX web server did an autopurge and ate about 800 files containing evaluation data. Needless to say, some excitement was had restoring those files.

A problem commonly associated with traditional distance education is the lack of opportunities for collaborative work, debate, dialogue, and conversational learning (Kaye, 1989). E-mail creates some of the push, but yet not enough pull. The limitations of e-mail were clearly shown in this Web-based course. The use of asynchronous computer conferencing, especially through the Web browser itself, holds much promise. Computer conferencing, while still limited, has been shown to create learning environments where learners are actively engaged (Mason, 1990; Berge & Collins, 1995; Dawson, 1995). The technological ability of the software program combined with the facilitation of the faculty member allows for the creation of learning environments that foster trust, collaboration and cooperation (Collins & Berge, 1996).

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Developing and Implementing a Master of Education in Classroom Technology

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Beginning in the 1980's, computers and technology gained prominence as a viable and necessary part of education at all levels. Through reports such as *A Nation at Risk* (1983), where computer competence was cited as a fourth basic skill, and the Educational Testing Service's national report on computer competence (Martinez & Mead, 1988), educators increasingly began to see technology as an important part of the schooling experience. Because facility with technology is seen as an important and empowering experience in the world, students are seen as needing competence with technology in preparation for their life after formal education (Marshall & Bannon; 1988, Naron & Estes, 1986; Gilder, 1993). Further, during the 80's and early 90's, technology came to be seen as a vehicle for school restructuring and as a way to stimulate the learning experience in a variety of ways, including from a constructivist perspective (Bruder, 1992; Obrien, 1991; Papert, 1980; Papert, 1993). As these education-based interests grew, teacher educators (through organizations such as the Society for Information Technology and Teacher Education, and the International Society for Technology in Education) became increasingly active in attempting to establish formal means for preparing both inservice and preservice teachers to use technology with students. Most significantly, guidelines in computer education for teachers were developed by the International Society for Technology in Education and adopted by the National Council for Accreditation of Teacher Education (ISTE, 1992; NCATE, 1992, Thomas, 1993).

Within the state of Ohio, the need for both providing access to technology to K-12 students and school personnel and for training teachers has been translated into a major state program, SchoolNet, with current cumulative funding at approximately 500 million dollars. The SchoolNet program provides help to districts in wiring school buildings, teacher training in technology integration, and in purchasing equipment.

In the midst of all this interest and activity regarding technology and education, institutions of higher education must continually ask, "What can higher education add to the mix of opportunities available to teachers to help them become adept at integrating technology into education?" The establishment of the graduate program outlined below is seen as a partial response to this question and as a way to help answer the national, state and regional cry for teachers comfortable with, and knowledgeable about, integrating technology into the classroom.

Spring '95 Northwest Ohio Survey

As part of designing the program a regional survey was performed within our Northwest Ohio service area. During the spring of 1995, a survey instrument was developed and mailed to 100 randomly selected schools in Northwest Ohio. The intent of the instrument was to gather descriptive data useful in program planning, and also to provide data to the SchoolNet Northwest Ohio Service Providers group in planning regional SchoolNet activities.

Survey packets containing a cover letter to the principal plus six sets of 1) the survey instrument; 2) a cover letter to teachers; and 3) a prepaid return envelope, were sent to the principal of each school. The principal was asked to complete the survey and to also distribute the remaining five packets to teachers in the building. A follow-up mailing was done 10 days after the initial mailing, while a reminder postcard was sent 7 days after the follow-up mailing. The return rate for the project was 61% (n = 366).

Respondents Inclination Towards Learning About Classroom Technology

Seventy-seven percent of respondents report that they perceive that teachers in their district have a positive attitude toward classroom technology, while 90% report this as true for administrators (Please note that for this section responses of "Agree" and of "Strongly Agree" have been combined.). However, only 17% report that they perceive teachers in their district as being skilled in using technology and only 14% perceive teachers in their district as being skilled in integrating technology into their student's learning. Seventy-one percent of the respondents believe that it would be valuable for some teachers in their district to complete a Master's degree in classroom technology, while 70% believe that it would be valuable for some administrators in their district to complete a Master's degree in classroom technology.

As a group, respondents appear very much interested in learning about classroom technologies. While 96% of respondents express an interest in learning about classroom technologies, 70% report an interest in taking courses or workshops in classroom technology to earn graduate credit, while 62% report an interest in taking courses or workshops in classroom technology to earn Continuing Education Units (CEU's). In terms of earning a graduate degree, 26% report an interest in earning a Master of Education degree, while 18.4% report an interest in earning a Master of Education in Classroom Technology. Interestingly, when asked if they are interested in earning a Master of Education in Classroom Technology if they receive support such as tuition waivers, release time from school duties, etc., the percent interested in earning such a degree more than doubles to 38.7%.

It appears obvious that interest in classroom technology runs high in our service area and that both teacher's and administrator's attitudes toward classroom technology are seen as positive. It also seems obvious that respondents believe that teachers in their district are not skilled in using technology and are not prepared to integrate technology into their student's learning. Given all this, respondents recognize the need for qualified people (those with a Master of Education in Classroom Technology) to be available within the district. However, they also recognize that gaining this expertise is time consuming. Although almost one in five express an interest in such a degree, that interest rises to greater than one in three when they are offered the possibility of gaining support in seeking the degree in the form of tuition waivers, release time and so on.

One way that higher education can assist in bringing more technology integration to the schools is by educating the leaders in classroom technology within a given district. These leaders will be individuals with the relevant technical skills (to the extent outlined in this program) who have an in-depth understanding of the research and pedagogical content necessary to be successful in this area. They will be individuals who can make a real difference in both the lives of teachers and students in their district.

Respondents Specific Desires Regarding Topics in Classroom Technology

While it was not possible to build a user profile based on interaction with demographic data gathered, since there were no significant interactions, it is possible to present descriptive information regarding desired education, attitude towards technology, interest in classroom technology education, and format of training desired. Table 1, Column A shows topics desired regarding classroom technology for the top ten topics by percentage of respondents answering either 4 (Some Need) or 5 (Strong Need). Table 1, Column B shows topics desired regarding classroom technology for the top ten topics by percentage of respondents answering 5 (Strong Need) only. Please note that the topics derived from the survey are strongly represented in the Master's program presented in this document. These topics reflect not only the expressed needs of the teachers surveyed, but also the recommendations of various groups (cited earlier) and the perceptions of those currently engaged in classroom technology education both regionally and nationally.

The Program

Given the data derived from national reports, etc., the following program was designed. Please note that the location of this program in the Department of Educational Curriculum and Instruction (EDCI) is by careful choice. The application of technology in education must have as a major concern decisions made about education -- decisions made about what is taught and how it is taught. Pedagogical decisions must drive any adoption of technology in education. Technology must not drive pedagogical decisions. For this primary reason, the program presented here is located in EDCI, the primary teacher education unit in our College and the unit responsible for issues regarding what is taught (the curriculum) and how it is taught (instruction). Also, for technology to be successful in the schools it has to be seen by teachers as integral to education — not as a separate add-on. Please note that the program below builds upon the recommendation of the ISTE report, (ISTE, 1992) and subsequent NCATE guidelines (NCATE, 1992).

Master of Education in Classroom Technology

The Master of Education in Classroom Technology is intended to educate leaders in the area of classroom technology. These individuals will be capable of working within their local Community of Practice and within the regional, state and local areas of which they are a part to support and develop the integration of technology into the learning experiences available through schools and the community at large.

While this program develops specific technical skills, the theme of the program is the continual development of the integration of technology into the school setting from a curriculum and instruction perspective. The relationship between choices made about how technology is used in learning settings and the effect of those choices on what is learned (and how it is learned) is seen as one of the major themes of the program. Two other major themes are: 1) the educator as change agent; and 2) the exploration and

Table 1.
Respondents Specific Desires Regarding Topics in Classroom Technology for Top Ten Topics

Column A		Column B	
Integrating technology	90%	Integrating technology	62%
Use technology to teach problem solving	86%	Word processing	59%
Use technology to teach Management functions	85%	problem solving	49%
Assessing the use of technology	83%	Assessing the use of technology	47%
Accessing and using the Internet	82%	Management functions	47%
Accessing and Using Multimedia use	81%	the Internet	47%
Creation of multimedia based classroom materials	80%	Multimedia use	44%
Word processing	79%	Create a product (data base, multimedia, etc.)	43%
Create a product (data base, multimedia, etc.)	78%	Desktop Publishing	42%
Adaptive technology	77%	Drill and Practice	40%

(Note: Column A represents combined responses of Agree and Strongly Agree as a percentage of all responses for the item. Column B represents only responses of Strongly Agree as a percentage of all responses for the item. Percents have been rounded. An underlined topic in Column A means that the topic also appears in the top ten in Column B.)

application of concepts and practices that will allow the teacher to use technology with students in active (as opposed to passive) learning settings. Specifics of the program follow.

Courses for the Master's of Education in Classroom Technology: (33 semester hours). Note: This is a version of the EDCI Plan A option. In this specialization, students will complete EDCI 638 - Seminar on Classroom Technology and Learning, which includes a significant paper based on a project completed during the course. Students may also opt for a version of EDCI Plan C option and complete a Master's Thesis as specified in the Graduate Handbook. In that case, students will take a minimum of 33 semester hours, will not take EDCI 638 - Seminar on Classroom Technology and Learning, and will instead take EDCI 699 - Thesis Research, for a maximum of 12 hours.

Please note that this program comprises a required core of 21 semester hours with 12 semester hours of suggested additional classroom technology courses. In consultation with the program advisor, other relevant courses may be substituted for up to the full 12 semester hours of these suggested courses. Depending on a students background and goals, relevant graduate courses may be substituted from units including, but not limited to, the College of Technology, Computer Science, the College of Music, and other courses offered in the College of Education and Allied Professions. Substitutions must be approved in writing by the program coordinator prior to the student beginning the course. A listing of required and suggested courses follows.

Required Core:

EDCI 631	Survey of Computers in Education (3).
EDCI 632	Classroom Technology Planning in Education (3)
EDCI 633	Hypermedia for Educators I (3)
EDCI 611	The Curriculum (3)
EDFI 641	Statistics in Education (3)
EDFI 642	Research in Education (3)
EDCI 638	Seminar on Classroom Technology and Learning (3)

Suggested:

EDCI 634	Hypermedia for Educators II (3)
EDCI 635	Classroom Technology, Problem Solving, and the Curriculum (3)
EDCI 636	Networks for Learning (3)
EDCI 637	Distance Learning and Education (3)

Course Descriptions

Required:

EDCI 631 - Survey of Computers in Education (3) On demand. Survey of computers in education with hands-on experience. Introduction to word processing, spreadsheets, data bases, computer assisted instruction, the Internet and e-mail. Methods of incorporating the computer in various subject matter areas. Introduction to pedagogical issues regarding classroom technology.

EDCI 632 - Classroom Technology Planning in Education (3) On demand. Introduction to creating, implementing and evaluating technology plans. Consideration of curriculum, instruction, hardware, software, wiring, personnel, training and funding issues. Concepts and skills for configuring computer systems and local area networks; relationship of local area networks to wide area networks; wiring issues.

EDCI 633 - Hypermedia for Educators I (3) On demand. Introduction to Hypermedia including the creation of Hypermedia based materials for both presentation purposes and student interactive use. Introduction to instructional design principles. Prerequisite: EDCI 631 - Survey of Computers in Education.

EDCI 638 - Seminar on Classroom Technology and Learning (3) On demand. Investigation of relevant topics and readings in technology and education. Preparation and presentation of a piece of research in technology and education. Prerequisites: EDFI 641 - Statistics in Education, EDFI 642 - Research in Education, EDCI 633 - Hypermedia for Educators I, and an additional six semester hours in classroom technology or other approved technology-related courses.

EDCI 611 - The Curriculum (3) - Sources of curriculum: foundational bases for contemporary curriculum; forces that shape design and development of curriculum; and factors relating to implementing, modifying, and evaluating curriculum.

EDFI 641 - Statistics in Education (3) - Statistics as a tool in education and research, descriptive statistics, transformation of scores, sampling and probability, linear correlation and regression, introduction to statistical inference, and basic tests of significance.

EDFI 642 - Research in Education (3) - Identification and evaluation of research problems, research designs, use of library resources, data gathering, and writing research reports. Prereq: EDFI 641.

Suggested:

EDCI 634 - Hypermedia for Educators II (3) On demand. Continuation of Hypermedia I including in-depth coverage of scripting, use of digital cameras, camcorders, and videodisks in creating multimedia materials, and further development and application of instructional design principles. Prerequisite: EDCI 633 - Hypermedia for Educators I.

EDCI 635 - Classroom Technology, Problem Solving and the Curriculum (3) On demand. Investigation of technology as a means to teach problem solving in the curriculum. Coverage of Logo and extensions of Logo, as well as other software to develop problem solving skills. Emphasis on a constructivist approach to using technology to develop students' problem solving abilities. Prerequisite: EDCI 633 - Hypermedia for Educators I.

EDCI 636 - Networks for Learning (3) On demand. Intensive investigation of and experiences with tools to access, and resources available on, the Internet. Creation of Web pages. Applications across the curriculum. Investigation of relevant issues regarding privacy, censorship, commercialism and proprietary rights. Prerequisite: EDCI 631 - Survey of Computers in Education.

EDCI 637 - Distance Learning and Education (3) On demand. Introduction to the theory and practice of distance education. Experience with teaching in a distance learning environment. Comparison of distance learning to other forms of education.

Currently, the program is offered to part-time students (the population identified with the greatest need for the program) in a format that can be completed in thirty months. Students start by taking two courses during a six-week summer session and progress through the program as a cohort. Students then take one course in each of the fall and spring semesters, continue through another summer, fall, and spring cycle, and then finish with a summer, fall cycle to complete all eleven courses. (Students may deviate from this cycle if they substitute an approved course for one of the four suggested courses.) The suggested sequence encompassing all courses listed above follows.

EDCI 631	Survey of Computers in Education (3)
EDCI 632	Classroom Technology Planning in Education (3)
EDCI 633	Hypermedia for Educators I (3)
EDCI 634	Hypermedia for Educators II (3)
EDCI 611	The Curriculum (3)
EDCI 635	Classroom Technology, Problem Solving, and the Curriculum (3)
EDCI 636	Networks for Learning (3)
EDFI 641	Statistics in Education (3)
EDFI 642	Research in Education (3)
EDCI 637	Distance Learning and Education (3)
EDCI 638	Seminar on Classroom Technology and Learning (3)

Conclusion

This program was officially approved in October, 1996. So great is the need for this degree specialization that a group of 24 students started the program in the summer of 1996, fully aware that the degree at that time was a proposed program and was still working its way through the approval process. Students have reported a very favorable reaction to the program to date.

In a later report, we will detail specific collaborative activities (including a summer internship project) and ongoing evaluation activities, all aimed at both maintaining and enhancing the usefulness of the program. The timeliness and high quality of the degree specialization outlined above demonstrates another way that institutions of higher education can contribute to the further development of the integration of technology into the schools. By affording the opportunity for practitioners to gain both in-depth technology skills and a deeper understanding of how technology and pedagogy can interact to the benefit of students, both formal and informal leaders will be available in the schools and will help students gain from purposeful interaction with technology.

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LEARNING TECHNOLOGIES: A COURSE TO FOSTER CREATIVE AND DIVERGENT THINKING

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From 1870 to 1970, classrooms didn't change much. From 1970 to 1995, classrooms have changed in many ways. However, from 1995 to 2015, the change will be even more dramatic. By 2015, few students will actually travel to school. Many will stay home and access the classroom from their home media center. Textbooks will not exist in the form we have known them - they will now be on CD-ROMs. Science experiments will all be interactive on computers allowing students to truly experiment rather than just follow a "recipe" for a procedure. Handwriting will be all but obsolete. Libraries will no longer store large, heavy books but will have all information on databases ready to be accessed from anywhere in the world. Keyboards will change because voice-activated writing will be the norm. Since we will spend so much time sitting at the computer, we will have to have exercise equipment at our fingertips so that we can walk a treadmill while we wait for the Internet to download a file. Lunch breaks will be eliminated in favor of exercise, and food will be taken while we work. The food will be non-fat and manmade to reduce our intake of fats and cholesterol. Teachers won't have to do playground duty, but take their turn in the computer lab assisting students from hundreds of miles away, solving their distance retrieval problems. I won't be teaching then - technology will have outdistanced my education - but I will visit my grandchildren's classroom via my home media center to advise the students of how school was BT (before technology).

Learning Technologies: A New Course With New Directions

As part of the reorganization of the Master's of Education Degree at Northern Michigan University, a new course has been developed and made a requirement of all Master's candidates. This new course, ED 583 Learning Technologies, will be the focus of this paper. The class has not been offered yet, but will be beginning in the summer semester 1997. This course is intended to prepare teachers to meet the challenges of a technology-infused learning environment.

Learning technologies can open intellectual doors, empower learners, enliven instruction, and even change what and why specific content is taught. This course is designed to foster creative and divergent thinking regarding the application of learning technologies to the processes of teaching and learning. The intent is to discuss and analyze how newer learning technologies are changing the teaching / learning environment. Emphasis will be upon the effects with as well as the effects *of* learning technologies. Change theory in relation to teaching and learning with educational technologies will be taken into account as well as the concept of learning technologies as 'partners in cognition' and distributed intelligence (Thornburg, 1992).

Course Research Base

Traditionally, human cognition has been seen as existing solely "inside" a person's head, and studies on cognition have by and large disregarded the social and physical surroundings in which cognition takes place. Recently, however, research in cognition has forced us to reexamine our preconceptions. Aspects of research that will be used in this course concern the concept of human cognition that is distributed among individuals, knowledge that is socially constructed, and information that is processed between individuals and the tools (technologies) provided by the culture.

Change theory in society, and in education, relates directly to the diffusion of innovations including learning technologies in school settings. As Thornburg (1992) states, "The only thing constant is change." Change in the non-school world has been increasing at an astounding pace, partially due to technological advances. Many of these advances are communication advances, ways in which information is disseminated, manipulated, and stored. Effective communication is a necessary base for education and schools are essentially communication facilities. Therefore, research in this broad area will be addressed in the course.

Much discussion about teaching and learning with technologies has focused on the question of how technologies can be used to facilitate education. However, technology relates to education in other ways. Teaching and learning take place in a sociocultural context, the nature of which is determined as much by technology as by anything else. To the extent that the purposes of education are determined by the context in which it occurs, technology, by virtue of its role as an agent of social change, is a force in shaping them. Technology also affects the content of education, because among the objectives of education is that of making understandable the world in which we live, and we live in a technological world.

Finally, learning technologies, both the actual physical devices and the processes whereby they are incorporated, have always been a part of teaching and learning. How, and to what extent, these technologies have and will continue to effect teaching and learning will be the overall framework for the course discussions of distributed cognitions and change as described above.

Course Goals

The primary goal of the course is to stimulate, challenge, and confront the student's preexisting knowledge, attitudes, and behaviors about how learning technologies interact with, reshape, and support student learning styles and preferences, the teacher's teaching style and preferences, the social environment of the classroom, and the instructional design and content of the instruction. Underlying goals include extending the students' knowledge of the teaching and learning possibilities of educational technologies for enhancing and supporting student and teacher cognition. In addition, students will recognize the implications of educational technologies for teaching and learning now and in the future, as well as understand the diffusion of innovation in education.

Course Objectives

Upon completion of the course, the student will be able to:

1. articulate both the pros and cons of utilizing a variety of learning technologies in teaching and learning,
2. evaluate research on teaching and learning with learning technologies,
3. project the appropriate use of learning technologies into current and future teaching and learning situations,
4. make research-informed decisions when adopting learning technologies in their classrooms,
5. plan for and be open to continual change in the teaching / learning setting,
6. examine and situate learning technologies for enhanced student cognition, and
7. analyze learning technologies for ways teaching and learning may be done differently.

Course Content Outline

The course content is intended to reflect new learning technologies in relation to traditional, contemporary, and emerging issues in education. These include but are not limited to cooperative learning, interdisciplinary and thematic instruction, and multiple intelligence theory.

Instructional Approach

Teaching strategies will include, but not be limited to, the following: readings, presentations, whole class and small group discussions and debates, written assignments, and electronic communications. The following two scenarios suggest the direction of the course.

Scenario A: Reflections. Looking back over your own life as both a student and a teacher, describe what a student does and what a teacher does. What does the classroom look like? What adjectives do you think of when you hear the word school, classroom, student, teacher, school work, learning, teaching, technology?

Scenario B: The Principal Story. This is a story which you will discuss. I am your principal. You are all third through sixth grade teachers. We are meeting to inform you of a death of a citizen, Mr. Smith, in our school district. As you know, Mr. Smith was very wealthy, had no family, and was a little eccentric. Well, he has left all of his estate to our school district with one stipulation - we can only spend his money on technology and technology related items. That means we cannot buy more books or desks, hire more teachers, or build more rooms. We can, however, buy new furniture to hold the technology, hire new teachers to help us learn to use the technology, etc. In other words, everything we do with his money must somehow be related to utilizing technology.

There will be enough to put a computer on each teacher's and student's desk, as well as one for each of you to take home. In addition there will be a loan-home computer for each family in the district who has a child in school so that you may give homework to be completed on the computer. Families who do not currently have telephone lines into their homes will have them paid for so the students can access the homework line and the Internet. There will be an abundance of technology to work with both in school and at home for both the teachers and the students. Third grade teachers will no longer teach cursive writing. Instead, everything that your students have done in the past with cursive writing will now be done with keyboarding and word processing. Fourth, fifth, and sixth grade teachers will do likewise.

What are your thoughts, comments, concerns, feelings, etc. about this scenario? Or you can get broader in your thoughts - that is, look at all sorts of changes in the current curriculum as we move into using more technology in classrooms at all grade levels and in all subject areas. What are you concerns? What are your dreams? What do you think we can do away with in the current curriculum? How do you see what students learn and what the teacher teaches will change as we get more technology in schools? How does using technology for teaching and learning change what is necessary to learn? How does the delivery of information change in the classroom?

A Work in Progress

Further course refinements will occur both prior to as well as during the semester. More changes should occur once the course has been taught. True to the course goals ED 583 should continually evolve over time, never quite finished as technologies constantly evolve into newer and more effective tools.

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Preservice Teachers Integrating Technology Into a Corrective Reading Course

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The need to incorporate technology into our teacher preparation courses has become so self-evident that we are now faced with the question of how to accomplish this goal. The need for technology-using teachers is beginning to receive more attention in accreditation standards, in state certification programs, and in reforming and upgrading teacher education efforts. But according to *Teachers and Technology: Making the Connection*, the report by the Office of Technology Assessment (1995), state policies and leadership vary widely, as does the implementation in colleges of education. Additionally, there has been virtually no connection between reforms in colleges of education and reforms in the K-12 schools, nor are there many incentives to make those linkages. Our research attempted to address some of these findings, specifically regarding technology and teacher preparation and modeling by teacher educators.

Description of the Project

During the summer semester (1996), the course instructor and coauthor of this research decided to expand technology usage in her section of a corrective reading course. This course is the final required reading course for elementary preservice teachers before they begin student teaching. Part of the requirements for this course involves each university student tutoring one K-12 reluctant reader, referred to in our program as a client. The whole language philosophy guides the literacy activities. Prior to this summer, technology was incorporated into this one section by using several CD-ROMs with only one computer-on-a-cart rolled into the classroom for each class, but more integration of technology was needed. With the assistance of the coauthor, a doctoral student interested in helping faculty integrate technology into teacher education courses, we developed ideas for authentic uses of technology.

Review of Literature

Reviewing the literature, it was apparent that a number of considerations should guide our design. In the theoretical framework of Bruner (1960, 1966), learning is an active process in which learners construct new ideas or concepts based upon their current and/or their prior knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. We recognized that most of the students had taken, or were taking, a general introduction to technology course whereby they learned productivity tools, for example, word processing, spreadsheet, and database management, some graphics, some exposure to e-mail and an introduction to the Internet.

Additionally, we wanted to use technology that was not only nonthreatening, but that had proven effectiveness. Johnson (1996) described the success she had in incorporating e-mail into a reading methods class. She felt that the combination of real life application and effective instructional practice increased the likelihood that these preservice teachers will use the technology in the future. Brovey (1996) also indicated how his use of e-mail and e-journals provided preservice teachers with purposeful computer-based experiences and led to more responsiveness between his students and him.

Matthew (1996) pointed out the effectiveness of using CD-ROM storybooks to enhance the literacy experience of young children and the lessons learned by the preservice teachers while observing the youngsters interact with the multimedia. Land (1996) demonstrated the efficacy of integrating the Internet into his education course. His home page organizes web resources into categories that are appropriate for his students.

Both Dertouzos (1991) and McKenzie (1994) have shown the importance of availability and accessibility to successful employment of computer technology. The location and the number of machines per person are critical factors affecting usage. Until the advent of the graphical user interface browsers, the man-machine interface of the Internet was anything but user friendly. Busy students and teachers will find struggling with unreliable hardware or difficult to use software unrewarding, and will consequently refrain from using it. Because we did not have a state-of-the-art Netscape lab to use until the end of the 1996 spring semester, this research could not have been carried out before the summer semester.

Since usage of e-mail, e-journals, interactive multimedia CD-ROMs, and the Internet, have been found effective before, we decided to use a combination of these technological applications in our program. We felt that a combination of all of these approaches would give the students additional tools to use with their teaching strategies. For example, in order to show the usefulness and application to instruction of e-mail, both authors e-mailed the university students regularly, and in fact, we even e-mailed messages to the clients. The clients were also given a choice of having an e-mail pen pal in another state. Although not required to use e-journals, the university students were encouraged to do so.

Participants

The class was composed of twenty female students, nineteen undergraduates, and one graduate student working on elementary education certification. Eighteen students were majoring in elementary education, one was in middle school, and one was a special needs preservice teacher. Nine students were 18-25 years; six were 26-35 years, and five were 36-50 years. Three identified themselves as African-American, thirteen as Caucasian, and one as Spanish-American. Although three students left this field blank, they appeared to be Caucasian, bringing that total to sixteen.

Research Setting

The course was conducted in three separate buildings, the College of Education (COE), the University Computer Center (UCC), and the Learning Resource Center (LRC). The corrective reading course is designed to teach students how to implement various strategies for assessing and teaching reading, and to provide university students practical experience in tutoring a client. During the summer, the course met twice weekly for about three hours per day for six weeks including the tutoring experience. Both before and after the students tutor their clients, there are discussions about strategies to help their clients become better readers.

The students met their clients for a total of fifteen contact hours spread over five weeks, meeting twice weekly for an hour and a half each day. For two hours per day during the first week of class, the university students met, without clients, in a twenty station IBM Netscape lab in the UCC. This training was for introducing basic e-mail and Internet. In addition to showing the students how to use this technology, a further purpose was to get them thinking about how they could integrate this technology into their teaching. Although no effort was made to directly teach technical vocabulary, equipment and software were named as they were used. An integral part of the lab is the LCD panel that allows the students to see on a large screen what commands to enter into the computer, and what the results of those commands look like. The CD-ROM software that the students used with their clients was installed on six multimedia pentium computers in the LRC.

During the five weeks that the undergraduates worked with their clients, they were given the opportunity to use the twenty station lab for a half-hour each class period. This meant that the clients had an opportunity to use this technology for at least one hour per week or for five hours for the session. Students were not required to use the lab, since science, writing, art, and math centers were set up in their regular classroom. The undergraduates made use of the technology as their comfort level increased, and as the needs and interests of their clients required it.

Data Sources

A survey was given on the first day of class to assess the students' levels of technology familiarity, usage, and their general attitudes toward technology. This survey was readministered on the last day of class to allow for pre-post statistical analyses. In addition, students' e-mail dialogue with the instructors and their weekly entries in a technology journal provided narrative data that would be used to document changes in knowledge and attitudes regarding technology.

Results and Discussion

Although twelve of the twenty students indicated they had computers at home, only ten had modems, and most used computers only to do word processing. By the end of the semester, their computer usage included finding lesson ideas on the Internet, conducting online database searches, using CD-ROMs in their lesson plans, and regular and continued use of e-mail. One interesting observation was an increase in the language of technology that occurred within e-mail dialogue, journal entries, and during informal conversations with other students and the instructors. Another observation revealed their initial e-mail to be full of typographical errors and strange letter and word spacings. By the end of the semester, as students became facile with the editing feature, much of their e-mail looked as if it were done with a word processor.

Examination of the pre-post survey items indicate positive changes in familiarity and usage for computer LCD projection panels, CD-ROMs, modems, local area networks, wide area networks, computers in the classroom, database searches, New Orleans Freenet, Internet, Netscape, and e-mail.

In Their Own Voices

The most meaningful way to indicate the changes in attitudes toward technology by the students is to examine their own statements. Students were required to keep weekly anecdotal notes of their tutoring session, including their reflections about technology usage. Additionally, they wrote a technology reflection included as part of their final portfolio. The following are excerpts from these documents categorized into three sub headings which are: client changes, student attitudes — beginning/ending, and increased student technology knowledge.

Client Changes. The following is a good illustration of the positive effects integrating technology into lesson plans had on the writing process for one student's client. The client was a very reluctant writer at the beginning of the semester. The following is from the tutor's anecdotal notes:

> I am amazed at the willingness to write that M. expresses now that she is typing her book rather than writing by hand. She obviously prefers the keyboard to pencil and paper and I can't say that I blame her. Another thrill for her is seeing how nice her book pages look when they are printed with the laser printer. She says it looks like a real book and of course I tell her that it is a real book.

In her final reflection about her client, the student had this to say about the client's self confidence as a direct result of this course:

> M.'s family purchased a computer this summer. She felt comfortable enough to show her family how to browse the Internet sites. What a confidence builder that must have been for the youngest family member to be able to show the way! ... Hopefully, her home computer will be a source of writing pleasure.

The following indicates a remarkable change in the attitude of one client toward computers. In her anecdotal notes about technology, for the week of June 6, 1996, this student noted about her client, "O. hates the computer! I tried to find info about the sanddollar with him through Netscape, but he didn't want to look at the computer. He didn't even want to read e-mail." Continuing, for the week of June 23, 1996, she said, "O. loved working with *Seaside Adventure [1995]*. He did not take his eyes off the screen. He laughed and danced like never before." By the end of the course, she stated, "O. has advanced so much on the computer. He works it all by himself - taking complete control of it. He can even control the mouse." This is an excellent example of why we need to try different computer applications. Although O. did not respond to the Internet, his attitude toward computers completely changed when he found software that met his needs.

The following excerpt from another student's anecdotal notes displays the progress made by one of the clients that was typical of clients who came to the class with little or no computer skills. For the week of June 18, 1996, she wrote, "After using the computer in the UCC, she demonstrated very little knowledge of the mouse and keyboard." For the week of June 20, 1996, she wrote, " L. was amazed that we could receive mail through the computer. L. wrote a letter inquiring about a pen pal. She enjoyed typing on the keyboard." The student concluded her anecdotal records with this comment,

> I have included the letter to B. [her pen pal] that L. has typed and sent through e-mail. The reply that L. typed and sent to Joan [coauthor of this research] is also included [in her submittal with her portfolio], to demonstrate that L. has gained knowledge of writing, typing, and sending a letter/reply through e-mail.

Student Attitudes — Beginning/Ending. Some students entered the course expecting it to be taught in the usual fashion, and were upset in the beginning when they found out they were going to be using computers. The following, from a student's final technology reflection, demonstrates her initial attitude:

> I was very frightened at first, when we began talking about using the computer in our lessons with the students. ... I must admit that I was frustrated and felt overwhelmed at times, however with more time I know that I will get more comfortable with the computer. ... I feel that as a teacher I should have access to and knowledge of how the Internet works.... I feel grateful to have this opportunity to get training and learn how the Internet works and the many uses there are for teachers.

The following, taken from a final reflection, is a wonderful illustration of how some students felt at the beginning of the class: the fear of failing, the fear of looking foolish in front of a child, and the change that occurred over the semester.

> I have resisted the computer ever since it was first introduced to me, simply because it seemed too difficult. ... At the beginning of this semester I was completely freaked about having to use the computer every class period, and to make matters worse I had to have a 9 year old student with me. I was sure that I would make a total fool of myself, not to mention the fact that I would be completely embarrassed to let a child see that I did not know what I was doing....
>
> I have learned more about the computer this semester than I ever thought possible. ... Oh what fun I have had, learning about this overwhelming piece of equipment that I have abhorred all these years. ... I cannot wait until I can go buy my very own computer, with Windows!! Internet, here I come!!

Increased Student Technology Knowledge. The enthusiasm for using technology that the students gained by watching the effect of technology usage with their clients can be seen in this excerpt from a student's final reflection:

> This summer has given me a new perspective about using the Internet in my classroom. I had heard about the Internet but this was the first time I had used it. I found it to be very helpful with gathering information for lessons and catching my student's interest in learning about new things. ... The ideas and lesson plans available are great, having the students write back and forth to other students is just amazing. The student becomes so involved in writing and reading on the Internet it is just great. As for the CD-ROMs I have worked on the computer in the LRC lab, I found them to be very informative and interesting not only to the student but myself as well.

The following is representative of how students felt about themselves as they mastered the technology, used the Internet from their home computer, and realized that they could learn from their clients

> One of the areas that I have truly grown in this semester is in the area of technology. ... I have Kermit [the only telecommunications software program supported by the UCC] up and running and have been using e-mail, surfing Lynx [the only browser that UNO students have access to from home] to surf through Yahoo, and ERIC. I now have a better understanding about using CD-ROMs. I am now pretty good at e-mail .... I am really pleased that I finally got "hooked up" [to the VAX from home]. ... I feel that is quite an accomplishment. I have learned a lot about computer technology from both my teachers in this course and from my client, S. So it is important to realize that our students are not the only ones who do the learning. I feel I am off to a good start and am looking forward to the future.

The above was a typical example of how proud the students felt when they were able to use the Internet from their home computer.

Although students are required to take a computer literacy course early in their curriculum, many of the students were still only in the word processing stage of computer literacy. Since they had no authentic uses for some of what they learned, many forgot what they had learned. This can be seen in the following, and again it is tied into the client's learning also:

> This was the first semester that I had so much time and availability to use the computers. I am very grateful for the experience. I learned more this semester than I did when I took Computer Literacy 1000. ... I also believe this was a good experience for my student. ... She especially enjoyed the CD-ROMs.

> I got my greatest joy out of receiving and responding to the little notes from Dr. Gipe and Joan Lamare. Every semester that I had an account I was never able to access the e-mail again and so my notes all went unread. But this semester was different.

> As for the pen pal, that was very exciting. ... it was quite exciting to communicate via the computer. I feel like I have made great strides towards becoming computer literate and will continue to do so in the future.

Challenges

We would be remiss if we were to leave the impression that all proceeded smoothly. The major obstacle to overcome was the logistics of conducting this course, especially since there was no Netscape lab in the College of Education building. Because of this we had to conduct the technology part of the course in two other locations, away from the regular classroom located in the COE building, the University Computer Center and the Learning Resource Center. Consequently, for the technology component, there were times when the class met in the UCC and times when it met in the LRC. If there had been a Netscape lab in the COE building that also ran the CD-ROM software, the students and clients would have had more time with the technology, and less travel and interruption time.

Since this was the first time the course was conducted with an emphasis on technology, there were some course delivery problems; for example, we gave out too many handouts at first, and didn't allow enough instructional time before the students had their clients. Because of switching locations so frequently, some students forgot to bring their earphones when we met in the LRC. Even though the LRC had multimedia computers, there were no speakers, since it was an open lab and the computers were used mostly for word processing.

Conclusion

Although we anticipated a positive change process, it was fascinating to observe it. Some of the students were intimidated by computers originally, but, by the end of the course, most of these students were making full use of all of the technology. Many students indicated they will use technology available to them during their student teaching experience. We attribute this willingness to use technology, as well as an increased technology vocabulary, to the fact that students had authentic experiences using technology.

In conclusion, we would like to present the voices of two students, taken from their final reflections. The first student wrote about her own personal growth and development as a result of this course. The second student reflected on the impact that this technology had on her and her client. The first student wrote:

During the course of the summer I have grown tremendously with my computer knowledge. I have grown comfortable with the Internet, e-mail, and CD-ROMs. At first I was very hesitant to accept why I was being forced to learn the computer and why I was being forced to use it with my student, much less in my classroom. My whole outlook is different. I now feel that I must grow with technology and become technologically literate if I am to become a teacher in the 21st century. I can use the Internet to gain access to lesson plans and information for my lessons. I was not aware of the amount of information that I could obtain through the use of the computer.

The e-mail part of the computer is such an advance in technology that I don't know how we survived without being able to communicate through a screen and keyboard. My student was the real driving force behind my knowledge and enjoyment with the e-mail system. I feel very confident with the system that I could use it on computers other than at UNO.

My first thought about CD-ROMs was "Why didn't I find out about these sooner?" I will definitely use them in my classroom given I have the resources to do so. They are so easy to use and the children enjoy them. Lots of learning and teaching can be done with CD-ROMs. ... To sum up my experience on the computer — FANTASTIC AND ENJOYABLE, not to mention enlightening.

The second student reflected:

The most important aspect that I learned was the different attitudes/reactions that I as an adult have towards computers versus that of a child. During the sessions I struggled with using the computer because I felt so computer ignorant. I knew that the computer was benefiting B., but I felt so dumb because I did not know what I was doing. ... B. had no problem using the computer. She loved the CD-ROM programs. She especially liked reading the new information on various sea creatures. This was beneficial to me because I was able to observe some of her reading strategies.

This is the first class that has allowed me to experience computer technology with a student. I think this is extremely significant ... computer knowledge is essential. Therefore I think it was very important for me to have had this experience because I was able to explore the use of educational computer programs. ... Through watching B. this summer I can see the impact the computers have in relation to student learning. Computers allow learning to be challenging and at the same time fun.

In as much as this was only one class, this project has shown that undergraduates can effectively incorporate technology into their lessons when provided authentic learning experiences in a supportive environment.

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Effective Technology Instruction for Inservice Teachers: New Practices, New Results

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Traditional technology inservice instruction has fallen under much criticism lately, much of it justified. Fifteen years after microcomputers began entering the schools, America's schools have become a technology-free zone" (Rhodes, 1996, p. 45). One of the main reasons for this is the lack or inadequacy of teacher training in technology. Technology training for teachers has had several major shortcomings: short and infrequent training; lack of follow-up; lack of classroom access to necessary tools; outdated instructional designs; and many others. However, better organized and ongoing inservice instruction could become an effective tool for getting teachers to start using technology with their students.

CPDT

My experience working for the University of Texas at El Paso (UTEP) under a Texas Education Agency Center for Professional Development and Technology (CPDT) grant pointed to a style of inservice that could prove truly effective. This grant provided computer hardware for schools and one semester of training to support the use of technology by teachers and students. In the three years of the CPDT grant, 17 schools received 24 computers each, along with scanners, printers, and in some cases digital cameras and LCD projection panels.

The grant also funded three technology specialists, including the author for six months, who were responsible for initial setup of equipment, technical support, and teacher training. This support lasted for one semester after the schools received their equipment. In all, seventeen schools participated in the grant, for a total of 408 computers placed in classrooms through the course of the grant. A typical setup in a school put three computers per classroom, with a Stylewriter printer, scanner, and in some cases a QuickTake camera. This was considered a minimum setup to support innovative uses of technology in the classroom.

A Model for Effective Inservice Instruction

The following is a framework for inservice instruction, which can be easily replicated in any school or district where technology is being underutilized, or not used at all.

I started with a needs assessment, determining what teachers knew about technology and what they wanted to learn. In seeing this type of survey used, both in my experiences in my two CPDT schools and in other schools, one common response is that teachers who don't use computers don't know what they want. The key here is to find out who's interested in learning, then tailoring the training to suit them. After looking at the surveys, I set up a series of monthly training sessions after school. This was organized in concert with the principals and on a volunteer basis. Classes lasting from one to one and one-half hours took place immediately at the end of the school day.

I set up two different programs: one school was already very technologically rich, and while some people still needed basic training, there was a desire for some more advanced classes; the other school was relatively technology poor, and I provided a set of courses on the basics. Based on teacher responses to the survey, the focus of the first training sessions in both schools was on Macintosh basics and ClarisWorks.

One key to any success I had in getting teachers to attend these sessions was the success of the first session. In both schools I used a variation of a math activity called M & M Math. This is a fun spreadsheet activity that many teachers are already familiar with, includes giving out candy at the end of a long school day, and teaches something they can go back and use immediately in the classroom. Also, Texas standardized test for elementary students requires the students to make and analyze spreadsheets and graphs starting in the fourth grade, so it related directly to their curriculum. But the most important fact may be that the teachers had fun using the computer, and this led to many returnees at later sessions. Other ClarisWorks sessions involved learning the graphics tools, and a session on making and using databases in the classroom.

At the technology rich school, some teachers were interested in more advanced programs and activities. This school is also a microsociety school, students in grades 4 to 6 work for a company or official body. This led to student and teacher interest in programs that would help their companies. The companies were already keeping their accounts in spreadsheets, but the computers we provided also included Quicken 5.0. I held a Quicken training session for teachers, and went back the next semester to provide one for the (student) financial officers of four companies. Several teachers also wanted a session on PageMaker, attended by about six. While these sessions were not as widely attended as the more basic ones, they reached a group of teachers already more amenable to innovative uses of technology in the school.

Based on my experiences, I would offer the following outline for an effective inservice program in technology. It is intended to be flexible. I only mention specific pieces of software when I have used and seen them used effectively in the classroom. All sessions are almost 100% hands on.

Table 1.
Technology Inservice Model

Week #	Topic	Content	Audience
1-2	Computer Basics	Navigation, creating and saving files, terms, using software	Novice-Beginners
2-5	ClarisWorks	Spreadsheets, graphics, databases, slide shows, page layout	Beginner-Advanced
5-6	Using Multimedia	CD-Rooms, videodisks	Beginner-Intermediate
4-6	Multimedia Authoring	Kid Pix Studio, Hyper-Studio	Intermediate-Advanced
1-6	Telecommuni-cations	e-mail, World Wide Web	Novice-Advanced

All sessions must be taught with an emphasis on curriculum, and should include handouts with lesson plans, articles and activities to help teachers immediately integrate the content of the sessions into

Graduate Level Programs in IT

The previous section described my work with CPDT and suggestions resulting from that experience and others. This section will deal with instructional technology courses offered at the university level, and will offer a framework for a course of study designed to produce teachers who use technology effectively and innovatively in the classroom and who become technology leaders in their schools.

I have taught instructional or educational technology classes at New Mexico State University (NMSU) in Las Cruces and at UTEP. At NMSU I was responsible for designing and implementing the curriculum for several sections of the undergraduate and graduate educational technology course required of everyone in the teacher education program. This included selecting, or in most cases creating, the printed course materials. These classes were frustrating because there was no follow-up to see if these students actually became technology-using teachers. Based on evaluations, the vast majority of the students found the courses helpful, and seemed motivated to use technology in the classroom, but without following their progress in the schools there is no good way of evaluating the effectiveness of these courses. My current job at UTEP provides a welcome solution to this problem.

Challenge Grant

The College of Education at UTEP in partnership with the Socorro Independent School District received a federal Challenge Grant in educational technology. This grant has five parts: staff development; connectivity; e-mail mentors; parent centers; and evaluation. I am one of the four instructors hired or given release time to work on the staff development component. Within this section of the grant, courses are offered for inservice teachers leading to endorsements or Masters degrees in instructional technology.

All participants in the program take the same four educational technology courses in consecutive semesters. Those seeking a Masters take an additional four education courses, and have a two semester practicum in technology mentoring. For endorsement students, the mentoring is part of their coursework. The mentoring portion is designed to use the grant teachers to begin the infusion of technology throughout the participating schools. Each teacher in the program is required to mentor three other teachers in instructional technology. The program is designed to create classroom teachers who are innovative users of technology in the classroom, and who are technology leaders in their schools.

Participants enter the program in cohorts of approximately twenty; two cohorts started in January 1996 and are finishing their third technology course while a third cohort was started in the fall of 1996. The cohorts are team taught by the four professors hired under the grant, two technology specialists and two curriculum specialists. The effectiveness of the team teaching is difficult to judge at this stage for several reasons. First, the initial curriculum specialist did not come on board until midway through the second course. Second, one of the technology specialists left after the second semester and was replaced by the author. Finally, the second curriculum specialist wasn't approved Until this fall, and because of scheduling problems is concentrating on helping the teachers in the classrooms. With the new cohort, which hasn't had to deal with this turmoil in staffing, the team teaching model seems to be working very well, though upcoming evaluations will of course tell us more.

As we see what is actually possible in our ' classrooms, our vision of the technology courses changes. The structure of the program provides a unique opportunity to build a series of four technology classes, each connected to the other, to create expert technology-using teachers. However, it is also an unusual model, the same group of people, the same professors, for four consecutive classes. While teaching many of the basics will probably remain the same, the shape of later courses could take on a more innovative look.

The first technology course actually looks much like the inservice model provided above. The main difference, of course, is time; classes meet three hours once a week for sixteen weeks. This time allows for an in depth study of all aspects of the curriculum; there is time for basic instruction, group and individual projects, and a clear focus on integrating the subject matter into the classroom. The first two cohorts, now finishing their third semester, are writing web pages, creating curriculum projects in Digital Chisel and HyperStudio, using telecommunications in a variety of ways, and beginning the process of mentoring in their schools.

One trend that may already be appearing is the growing technological literacy of teachers entering the new cohorts. The group entering this past fall clearly has a higher initial level of technological literacy than the first two cohorts. They will probably being doing advanced multimedia authoring and designing web pages in their second semester. This will provide the opportunity for some innovative approaches to curriculum that could help ensure the integration of technology into the classrooms of cohort participants.

By the third or fourth semester, instruction could take place mostly in the field, with perhaps monthly class meetings to discuss progress, activities, and future plans. This would put the faculty out in the schools, observing and assisting in the integration of technology into the classrooms. Site visits are one way of being sure our students are translating instruction into their classrooms, and would provide a valuable assistant to teachers wanting to try innovative projects, but justifiably nervous of taking on such projects alone.

The following table suggests a possible course of study modeled on the Challenge Grant example.

Table 2.
Model Instructional Technology Curriculum

*S	Subjects	Concepts
1	Basic hardware and software; integrated application programs; basic telecommunications; basic authoring	Teaching with technology; one computer classroom strategies; lesson planning with technology;technology integration techniques
2	Advanced multimedia authoring; advanced telecommunications; graphics	Innovative technology and telecommunications activities; creating content; crossing curriculum barriers
3	Mentoring; individual area of focus;classroom lesson observation; curriculum design	Structural change; parent and community involvement; peer training
4	Mentoring; classroom observation; individual area of focus; reflection paper	Technology infusion; grant writing;upgrading curriculum

** S = Semester*

The main point of this outline is to present as much flexibility as possible while making sure all participants get the necessary basic skills and strategies to continue to grow on their own after the program's end. As different technologies rise and fall, content will obviously have to change; but it seems safe to say that there are certain basic skills that will continue to be necessary and useful introductions to technology, and these constitute the bulk of the first semester. The remaining three classes offer a growing independence, and increasing focus on activities in the K-12 rather than the university classroom.

Lessons Learned

From my experiences at both universities, I have determined a few essentials for successful training. A one to one student computer ratio is essential for all students to learn the basics. Some things just need to be done individually, and without that capability, some students fall behind. At both universities, I have taught with more than one student to a computer, and this was the most common complaint of all students.

There needs to be adequate projection ability, preferably with the lights on. A weak projection panel or room that can't be darkened make it difficult, if not impossible, to effectively demonstrate new activities to the class. Large monitors can be used if the classroom is small enough, and any method that keeps the lights on is preferable for keeping students' attention and facilitating discussion during demonstrations or presentations.

Instruction needs to focus on the curriculum needs of the teachers and be immediately transferable to the classroom. Just as with any other training, if not used fairly quickly, technology instruction is forgotten. Basic troubleshooting skills are also important, so that a simple freeze does not bring everything to a halt. One of the reasons for keeping the curriculum flexible is to allow adjustment to the changing needs and abilities of the participating teachers.

Conclusions & Recommendations

University Instruction

The next several years will begin to tell whether the model of graduate instructional technology classes being tried under the Challenge Grant will be effective. One problem we have faced early is schools not having the technologies in place to support work done in the lab at UTEP. A commitment from participants' schools to make the necessary technology available should be considered. Educational technology programs should consider having laptop and/or desktop computers available on a limited basis for checkout for those teachers who do lack access at their schools.

Inservice Instruction

To effectively implement technology on a widespread basis, every school needs a technology coordinator. This person should have a background in education and technology, not just computer science or engineering as has happened in the past. The tech coordinator should have main responsibility for teacher training, tech support, and instruction (Pearson, 1994). They should not be responsible for maintaining and running a lab or a schoolwide network, though they probably will be.

Inservices need to be on a regular basis, and ongoing throughout the year, preferably at least monthly. Classes should be an hour to one and one-half hours in length, especially if held after a regular school day. Parts of the plan outlined above could easily fit into staff development days if available. As in the university program, instruction needs to be immediately useful and usable in the classroom.

The ideal combination is a technology coordinator in each school and a college or university nearby capable of offering several classes or even formal programs in instructional technology. This will be a slow process, so it.

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Helping Teachers use Technology: Redefining the Support Roles

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Without question, the amount of technology in our schools is expanding rapidly (Bluhm, 1988). But with this expansion comes new requirements for training users and installing and maintenance of the equipment (Odvard & Kinnaman, 1994). At the same time, schools are being squeezed for funds to support new mandates and to expand the technology base (Halstead, 1992). An initial look at the personnel who may be charged with the responsibility of supporting these new technologies produces several likely candidates — the technology specialist, the media specialist, teachers, students, and outsource providers. Can school districts support the new wave of technology that is coming into our schools with the current support structure? Is personnel training planned and supported systematically? This paper addresses these questions by contrasting the expanding and changing roles of the two major support providers, the technology specialist and the media specialist, who seek to better support the new technology boom that we see in our schools

The technology specialist and the media specialist are not the only sources of technology support for today's schools. Other sources of support may be important in some instances, but may not be as widely used. Teachers and students have traditionally been sources of expertise in special circumstances, especially those requiring knowledge of local facilities, requirements, or abilities, but they are limited in the amount of time that they can provide in order to support others who need help with technology. Teachers with a strong interest in technology may be given a reduced load so that they could provide technical support to the faculty; however, these occurrences are rare. Outsourcing of support and training, while currently rare in schools, is becoming fashionable throughout American business and industry and may be the wave of the future.

With the introduction of computers and multimedia technology to the schools, the need for technology specialists, a position which has been evolving over a period of years in Georgia, is greater than ever. But the nature of the duties depend greatly on the school district — its structure, management style, and vision. The state of Georgia provides some, but not full funding for the position. There are few limitations on the use of those funds and there is no certification requirement for the position.

The media specialist, however, has a long and rich history of function in the school. Beginning in the early 1900s as a librarian, the media specialist has evolved through audiovisual skills coordinator roles to what today is a three tiered responsibility. According to *Information Power* (ALA & AECT, 1988), the media specialist is charged with promoting reading, viewing, and listening by young adults; providing information skills; and helping teachers in the design, implementation and evaluation of instruction. In addition, the media specialist is trained in Schools of Education nationwide to perform those three tasks and is certified by states to hold school positions.

Methodology

In an attempt to contrast the support roles for technology growth, a team of researchers visited schools in rural southeastern Georgia. These visits were part of a larger study in Georgia under the auspices of The Council for School Performance designed to investigate the effect of Georgia's lottery on technology in the schools statewide (Dolan, Jones, & Henry, 1996). The Council selected 21 schools from 14 counties in the southeast region to participate in this study. The schools were highly rural in nature reflecting the character of this region. Only one school was located in an urban setting. The schools consisted of four high schools, six middle or junior high schools, and eleven primary or elementary schools. Included in the twenty-one were four "Model Technology Schools." These schools had been given supplemental state funding through a competitive grant process for the acquisition of new technology.

The Superintendent of each school system was initially contacted by the Council and asked to participate in the study. The level of cooperation from the schools was remarkable, despite extremely heavy workloads and other visitations and testing scheduled for February and March 1996 — the site visit time. Each school was eager to participate and provided excellent support for the visits. Each building principal was asked to identify a visit coordinator which was usually the media specialist or technology specialist.

A typical site visit was extended over two day period. The visit began with an orientation to the building and principal, media specialist, and technology specialist interviews. Administrative matters were reconciled on that day and observations of technology used in classrooms, special purpose laboratories, and the media center were begun. On the second day, the researcher and a graduate assistant conducted student and teacher focus groups. The second day also served as an opportunity to clarify responses from the first day's interviews and to complete the observations. Interview and focus group data were recorded, transcribed, and analyzed using a qualitative data management program. The coding of data focused on, among other categories, perceived and actual technology support supplied by media and technology specialists.

Discussion

Media Specialist

The media center, sometimes still referred to as the "library," has become the "technology hub" of each building because of the services provided there and because the media center is most frequently the site within a school where new technology is first introduced. Therefore, media specialists are expected to keep up with the constantly changing technologies that affect how the media center/ library functions. The role of the media specialist has evolved into one of the primary supporters of various forms of technology. However, the level of support given by media specialists to teachers in the area of multimedia technology varies according to training, comfort level, and interest of the media specialist.

Media specialists seem to see the bulk of the change when it comes to new technology. Due in large part to recent statewide educational funding initiatives, every library in the state is automated. New equipment and software required that all books be entered into a database and new procedures developed for accountability of volumes. Additionally new data resources, principally CD-ROM technologies, World Wide Web (WWW), and the Internet environments make searching for information a complex, multifaceted skill. Information search and retrieval strategies had to be addressed with students, faculty, and staff. These technology-related requirements significantly affected the media specialists' workload.

New equipment exacted a time toll, too. Media specialists were quick to reveal the additional burden that technology could put on an already busy person. The following comments indicate the frustration felt by some of the media specialists:

"I feel I need more training on IBM's. I had Macs here in the past. I need to learn to use so many things - there is a learning curve. I need to know how to use the IBM's so I can use it to help others...[It is difficult not] having the time to keep up."

"...started this 32 years ago; now everything is different."

"I got my masters in 1982. We didn't have any computers then -- even at Georgia Southern."

"[I recently] got my masters and everything was done on computers; ...had a multimedia presentation course."

The media specialists were at the forefront of the technology wave. The media center was typically the first place in the school to be equipped with the new technology. Teachers who frequently were intimidated by the technology, and students who are not, now look to the media specialist as a primary source of expertise. The technology training that the media specialists receives varied according to district, personal interest, and state and local mandates. There seemed to be a great gap between media specialists who were trained and certified a decade ago and those who were more recently certified. Media specialists were encouraged to update their skills with some limited formal training and help from the Regional Educational Services Agencies (RESA), a state funded agency designed to assist schools in a variety of education-related issues. But, there appears to be no systematic program of professional updating of skills. These skills could be and sometimes were updated by local college or university courses or inservice training, but this was inconsistent from person to person and district to district. Media specialists have to be able to pass those skills on to teachers and students so that these skills may be applied in teaching and learning situations.

Technology Specialist

The level and kinds of support provided by the technology specialist depends on the district's size, how technology is organized and staffed, and the availability and workload of the technology specialist. The organization and staffing for technology varies greatly from one system to another. In most school systems, technology support is the responsibility of a single individual who is assigned to the central office and provides services to all buildings. This individual is usually available to a particular building once or twice each week and provides on-call services. There are some systems, however, where there is a central office administrator who has system responsibility for technology and has a staff of several technology specialists assigned to multiple buildings to provide daily and on-call services.

Therefore, unlike the media specialist who spends time at just one school, the typical technology specialist divides time among several schools and functions as part of the central administration for the school system with duties that usually call for working with teachers from all grades at several locations. The technology specialist is the one who advises the administrative staff and school board on technology related issues and is a member of most school technology committees. In addition, the technology specialist takes the lead in matters concerning technology planning, frequently installs new technology when it arrives at the school, trains teachers on how to use new equipment and software, and assists teachers with the integration of multimedia technology into the curriculum.

Because there is no statewide certification or qualification standards for this position, it is not surprising that technology specialists have very different preparations for their jobs and a very different foci when it comes to deciding what should emphasized. Technology specialists, as a group, were highly credentialed and motivated to help the faculty use technology for teaching and learning. Most had an Educational specialist degree, which is a terminal degree beyond the Master's degree. They do not see their primary role as one of direct interaction with students. They see their impact on student learning through improved teaching methods and multimedia integration. Technical training for the position was almost always informal - learned in previous positions in business, industry, or education; or through personal interest.

Three different types of technology specialist preparation became apparent. The first is the super-media specialist. This person had been a media specialist, frequently for a number of years, and became interested in new technologies as they were developed. This individual has minimal formal training in technology selection and use above that required for the media specialist. This technology specialist views the position as a coordinator - a medium in which information and expertise is shared throughout the school district. One technology specialist summarizes it best: "... 10 years as a media specialist ... was the only applicant ... was interested in technology, and was active in the schools." The super-media specialist concentrates on "people skills and technology knowledge."

A second group of technology specialists sees their role as a technologist. They typically have received their training in technology in business or industry. They may have various degrees and professional certifications, but likely are not media specialists or trained in math/science. They view themselves as "primarily a support person through hardware training and repair." They see themselves as "hands-on person(s) ...(with) solid technical backgrounds."

A third group of technology specialists concentrates on instructional and curricular matters. These technology specialists are more likely to have degrees in curriculum (usually mathematics or science) and have come directly from the classroom due to a personal interest in technology. They view themselves as needing to "be available for staff development or demonstrations in the classroom." They "work with teachers on problem solving strategies," "work with teachers on instructional strategies," "check lesson plans," and "do actual teacher evaluations."

All technology specialists combine the traits of the three aforementioned types, but in varying degrees. Large systems were able to hire a number of technology specialists who had varying interests and talents. This is clearly an ideal situation, but limited funds prohibits this in most systems in southeast Georgia. In fact, the technology specialist position, in most school systems, was only made possible because of lottery funds. This addition was continuously applauded by teachers, principals, and media specialists.

Table 1 provides a comparison of the technology specialist with the media specialist on a number of important support and training issues.

Table 1.
Comparison of Media and Technology Specialists

	Media Specialist	Technology Specialist
Technology Training Source	Informal, inservice	Informal, business/ industry- ls
Degree	Masters	Education Specialist
Certification	Yes	No
Support Responsibility	Building	District-wide
Primary Role	Interacting with students, teachers, & building administrators	Interacting with faculty and administration

Summary and Recommendations

The data showed that teachers receive primary technology support from the technology specialist and the media specialist, although in some buildings, teachers received support at various levels from their colleagues and students. But, almost every school relied on external, state agencies for support in technical areas and especially for training in complex technology uses.

Media centers were automated throughout the region, and were the "hub" of the schools' technology programs. The media specialist, because of physical presence, was looked to for support in many schools. This individual was forced to assume this quasi-role as technology person, sometimes with little or no training. This may detract from other duties. The lack of adequate preservice, postgraduate, and inservice technology training impacts the ability of schools to fully integrate technology into the curriculum. Because, there is no state certification requirement for technology specialists, they possessed varying skills, capabilities, and interests. This uneven preparation resulted in unequal technology leadership across the region. Schools with strong technology programs had concerned and involved leadership from the technology specialist, principal or superintendent, and probably all three.

Schools in southeast Georgia have markedly increased the exposure of their students to technology in the past three years. However, the effectiveness of this exposure has varied according to access, infrastructure, funding (federal, state and local), teacher training and support, and leadership. Technology training has not been shown to be a priority for local school districts when measured by either funding levels or results. One issue that needs to be addressed in order to improve teacher training and support is certification of the technology leaders in the schools. States should review the certification requirements for media specialists so that they reflect the knowledge and skills necessary to run a technology enhanced media center and should require certification of technology specialists. In addition, technology skills and curriculum integration should be an integral and meaningful part of teacher preparation programs at both preservice and postgraduate levels. The State Department of Education, educational service agencies, and local colleges and universities should provide technical and curricular support to schools districts trying to implement technology integration. Media and technology specialists can make a difference in the schools, but a system-wide change program must be instituted to provide the full effect that technology can make in education.

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AiS: Integrating Mathematics, Science and Technology in Precollege Classrooms

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During the first three years of the Adventures in Supercomputing pilot, the number of schools wishing to participate in the AiS program far exceeded the resources available to accommodate all that applied. Rather than choosing the *best and brightest* for the AiS program, the selection of AiS schools was based on diversity of the target population of students and teachers, and the anticipation that a school's participation in AiS would effectively infuse new technology into that school.

Each school in the program received a dedicated digital connection to the Internet, computing time and space on a central compute server, technical support through consultants in each state, four Macintosh computers with appropriate software tools, and a color printer. Key components of the AiS program are the summer institutes and follow-up workshops in which teachers receive training in

1. computer networking,
2. computer programming (Fortran 90, C, and C++),
3. computer graphics and scientific visualization,
4. mathematical modeling,
5. project development,
6. implementation of the AiS curriculum, and
7. system administration.

As noted above, the AiS curriculum was structured to introduce students to computational science, in which supercomputers are used to run simulations that rely upon mathematical and physical models.

As part of the AiS curriculum, students engage in extended projects which require them to pose hypotheses, devise methods and procedures for solving problems and draw upon a wide variety of resources including hardcopy and electronic sources, computer simulations, and human experts. Each year, institutions in the five AiS states have hosted a statewide exposition where students present their projects to other students and teachers.

An integrated curriculum is a very important component of the AiS approach. Students discover the relationship between math and science as they use computation as a tool to investigate science-related questions of interest to them. Their reports and presentations foster the development of excellent communicative skills. Students and teachers have responded very positively to this approach of an integrated curriculum.

In a letter stating support for the Adventures in Supercomputing program in Iowa, Principal Lindsey Beecher cited the following benefits of the program:

1. spurring technical growth in the district,
2. giving disadvantaged students motivation through experiences with ground breaking technology,
3. changing the curriculum in many courses - greater emphasis on students creating their own knowledge,
4. giving technological knowledge to staff enabling better utilization of technology,
5. exposing students and staff to a wealth of information not previously possible, and
6. expanded opportunities for students to interact with their community by enhancing communications.

During 1994, the Center for Children and Technology (CCT) completed their initial assessment of the AiS program (Honey, McMillan, Tsikalas & Grimaldi, 1995). The assessment focused on the second-year AiS schools because teachers in these schools had one year of experience using the curriculum and technology. The evaluation of the AiS program was designed to assess student learning as evidenced in the final project presentations, and systematically to examine variations in learning based on a range of demographic and contextual data. Two central findings emerged from CCT's assessment. First, a substantial number (51%) of AiS students fell into an *Integrated Knowledge Cluster*, demonstrating mastery of their computational areas of inquiry; this was the highest of the three clusters categorized by CCT. Second, there was no evidence of a gap in achievement based either on gender of race.

The assessment conducted by CCT in 1994-1995 extended their previous evaluation of the program and indicated that the program reached a diverse group of students, ethnically and socio-economically, and included many girls (Honey, McMillan, Tsikalas & Light, 1996). Another indicator of success of AiS was the amount of new technology introduced into the schools as a result of AiS program - the schools and teachers in the program have leveraged DOE's initial investment to raise three times that amount in new equipment, grants and in-kind contributions!

Over the past five years, the Adventures in Supercomputing pilot program has evolved to encompass an interdisciplinary approach to project-based curriculum using the techniques of computational science. In order to examine the success of the AiS program, it is necessary to understand how the state coordinators adapted the rapid changes in technology and applied the assessment results to shape the program. This can be illustrated by studying the evolution of the program components as the program matured.

Program Components

Classroom Environment

The Adventures in Supercomputing program is a derivative of an earlier pioneering program developed by Dr. John Ziebarth in Alabama (Ziebarth & Carruth, 1992). Ziebarth and his coworkers were successful in attracting students to computational science by using a supercomputer as an attractor. In that early program, students accessed the supercomputer via a dumb terminal. As an extension to Ziebarth's program, the AiS state coordinators defined a classroom environment that mimics the computing environment at a Department of Energy laboratory where K-12 students and teachers use a 56kbs Internet connection and personal workstations (four Macintosh computers) to access shared central computers. This represents an evolution from dumb terminals to smart terminals and enables students and teachers to post-process their model results locally, using graphics packages such as Spyglass Transform. The scientific visualization component is an essential feature which allows the students to interpret the results of their computer simulations. As a result, excellent projects have been produced by students. In addition to providing computing facilities for students and teachers in the AiS program, the computing resources at the laboratories or universities also support network services such as e-mail accounts, World Wide Web servers and listservs.

The design of the AiS pilot program was such that participating AiS schools relied heavily on local DOE laboratory or a local university for such computing and networking resources. Early in the development of AiS, we recognized that this model would work in the pilot stage, but would not scale as increasing number of schools joined the AiS program. During the past year of the pilot program, the AiS coordinators redesigned the classroom computing environment to encourage schools to assume the responsibility for networking costs and to introduce multitasking, multi-user workstations into the participating schools. These workstations empower teachers and students by moving more of the key advanced technologies to their local environment, thus reducing their dependence on a central site. Since cost, ease of maintenance, and compatibility are important issues in the schools, the workstations are actually high level PCs running Linux with Fortran 90 and C compilers.

An important feature of having a Linux (Unix) workstation on site is the ability to provide network services locally. This includes WWW servers and pages, e-mail, disk caching of important web pages, and netnews. The provision of these services locally enhances performance by providing a much higher stream rate (10 Mbps) and greatly relieves network traffic, allowing the Wide Area Network to be used to maximum advantage for other purposes.

Teacher Training

The first AiS summer institute was held in 1992. Training modules for the teachers concentrated on the rudiments of computational science: Unix commands, Fortran programming, scientific visualization via Spyglass Transform and network tools. In the pre-World Wide Web world of 1992, teachers could only retrieve information available on the Internet by using such network programs as ftp, gopher, and WAIS. At the first institute, very little time was devoted to preparing teachers to integrate AiS into the classroom. Teachers were required to develop course outlines, but project development was only discussed briefly. During the first year of the AiS program, the Research Institute for Studies in Education at Iowa State University conducted an initial assessment of the AiS pilot program (Fulton & Sweeney, 1993). One of their recommendations highlighted the lack of consistent guidelines for the program: "Teachers expressed high management concerns as measured by the Stages of Concerns Questionnaire. These concerns did not diminish from pretest to post-test. The lack of specific program expectations might be one explanation for this lack of change... ."(p. 19)

The results of the AiS assessment conducted by the Center for Children and Technology in 1993-1994, which focused on AiS teachers from the first institute, further emphasized the students' and teachers' lack of understanding of the computational science project components. The foundation for CCT's assessment was the videotaping and scoring of a subset of student computational science projects. Assurance that the coders of the videotapes understand the AiS goals and objectives as they make judgments of students' performance is essential. For that reason, coders are selected from the AiS teacher pool. The scoring scheme for the videotapes is based on an earlier videotape coding scheme developed at CCT (Hawkins, Bennett & Collins, unpublished). The scoring rubric involves five dimensions, each of which are scored on a scale from 1 to 5, where 1 represents poor work and 5 represents outstanding work. The five scoring dimensions used are:

Understanding: To what extent do students demonstrate knowledge in their area of inquiry?

Critical thinking: To what extent are students able to reflect about the challenges and problems they encountered in their project and the larger implications of their work?

Clarity of presentation: To what extent are students able to effectively communicate their ideas to others?

Teamwork: To what extent do students work collaboratively on substantive aspects of the project?

Technical competence: To what extend are students able to apply programming skills to analyze or investigate their areas of interest?

As mentioned above, based on the five dimensions of scoring, the 1993-1994 videotaped presentations manifested three distinct clusters. The three clusters were characterized as follows:

Integrated knowledge: Students in this category were successful in applying computational techniques to a well-defined set of questions and were successful in combining a substantive body of knowledge about their project subject area with a real understanding of the methods of inquiry they used to investigate their problem. They exhibited high scores across all five dimensions, but their understanding score was particularly high. Over half (51%) of the students videotaped were in this category.

Procedural knowledge: Students in this category had average to above-average scores which were relatively consistent across the dimensions except for a distinct drop in the technical competence dimension. These students basically fulfilled project requirements, but displayed little ability to reflect upon or explain the implications of their work. For example, students in this cluster had a difficult time explaining how the mathematical model they used helped them address or solve their problem. One third of the students were in this category.

Fragmented knowledge: Students in this cluster had average to below-average scores which varied the most across the dimensions and this was the only cluster that had an understanding score that was lower than the critical thinking score. These students were unable to develop a well-defined problem that could be translated to a computational model. Consequently, the students in this cluster were not able to gain a substantive understanding of either the content or the mathematical and programming components for their project. The mean scores in this group exhibited more spread than those in the other two groups.

Based on the recommendations of the assessments by RISE and CCT, the coordinators involved experienced AiS teachers in redesigning and teaching the third summer institute. During that summer institute, computational science modules (programming, network resources, and scientific visualization) were introduced in the context of project development. Modules on team building, mathematical modeling and exemplary AiS computational science projects were also introduced. More importantly, current and new teachers in the AiS pilot program were required to develop a number of computational science mini-projects during the two week institute.

Results of refocusing the 1994 Summer Institute and the teachers' growing experience with the AiS curriculum were apparent in CCT's assessment conducted in 1994-1995. The videotaped results were again grouped into clusters. However, the clusters did not exhibit the same characteristics as in the 1993-1994 assessment. The profiles of the three 1994-1995 clusters were almost identical across the five scoring dimensions which is contrasted with the 1993-1994 clusters where the clusters exhibited different profiles and scoring levels. Students in the 1994-1995 study had consistent scores across understanding, critical thinking, and clarity, relatively higher teamwork scores, and slightly lower technical scores. The 1994-1995 clusters differed from each other in the level of the mean scores that they include: the High cluster (37% of students) reflects above average to outstanding scores; the Middle cluster (35% of students) reflects scores midway between average and above average scores, and the Low cluster (27% of the students) includes average to slightly below average scores. As CCT states in their 1994-1995 report:

> This change in the character of the clusters, coupled with a decrease in the number of other significant variables, suggests that teachers and students in AiS are gaining a clearer and more substantive understanding of what constitutes a successful AiS computational science project. As teachers continue to become more familiar with the curriculum and adapt it to their strengths and interests, and as the course becomes a familiar part of the available

curricula in participating schools, teachers will continue to build, based on experience and growing expertise, a more fully developed understanding of the elements that are necessary to good computational science research. (p. 74)

The summer institutes for the past two years of the program have continued to support project development and assessment rubrics for the classroom. Since no new schools have been added since 1994, the teachers continue to gain more experience with the AiS curriculum and with emerging technological tools.

Curriculum

In 1992, researchers at Oak Ridge National Laboratory began work on a graduate level electronic Computational Science textbook (http://csep1.phy.ornl.gov/csep.html). Researchers at Ames Laboratory in 1994 began a complementary project, focused upon developing an archive of interactive undergraduate computational science curriculum modules (http://uces.ameslab.gov). In 1995, AiS coordinators formally packaged their summer institutes as a set of materials that support and enhance high school computational science education, available via the World Wide Web (http://ais.cs.sandia.gov/AiS/textbook/textbook.html). This AiS textbook articulates a curriculum that encourages students to work in teams and develop logical thinking skills, and, as well as a curriculum which emphasizes oral and written communication skills, is learner-centered and presents a multi-disciplinary approach to solving real-world problems. Like the later summer institutes, the AiS textbook presents the computational science curriculum in the context of project development, team building, and mathematical modeling. The authors of the textbook have created a supplementary online teachers' manual that contains a set of lesson plans which also meet mathematical and science standard objectives. The textbook is currently being tested by the AiS teachers in the five states.

Conclusions

The AiS pilot project was designed prior to the introduction of the World Wide Web. At that time very few schools had phones in the classroom and even fewer schools had connections to the Internet. AiS schools received a direct, digital Internet connection, networked machines, and access to central computing resources at the host institutions. Today, states are developing and implementing technology plans to connect their schools to the Internet, and correspondingly, schools districts are struggling to provide technology in the classroom. Over the past five years, the AiS program has addressed many of the problems facing school administrators today and can serve as one example of integrating technology into the K-12 schools. The great success of the program is evident in the understanding the students have manifested through the integrated approach to learning and is encapsulated in the saying of R. W. Hamming, "The purpose of computing is insight, not numbers."

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GOING ELECTRONIC: MODELING A PAPER"LESS" CLASSROOM

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Integrating media and technology use into statewide educational programs is a priority in the State of Oregon. The School of Education at Portland State University (PSU) is actively participating in this endeavor by providing preservice and inservice programs with increased emphasis on the integration of media and technology. As Oregon's only urban university, our mission addresses the importance of learning across the lifespan as a means of meeting our communities' educational needs. Toward that end, this paper will address the following key issues as the relate to teacher preparation in the State of Oregon:

- How can electronic resources be used to expand the forms of expression and performance in today's classrooms by moving beyond traditional paper-and-pencil tasks?
- How can electronic resources facilitate a redefinition of teaching and learning in classrooms?
- How can technology facilitate a shift toward more collaboration between students and teachers?
- What does research say about the impact new technologies have on teaching and learning?

Rationale

There has been a long history within technology in teacher education supporting the notion of integrating technology into the curriculum (Copeland & de la Cruz, 1991; Daugherty & Boser, 1993) with varying degrees of success. Despite increased training in the uses of technology, teachers face numerous barriers when putting their ideas into practice within the social and cultural contexts of their schools.

One of the benefits promoted by early advocates of technology was the efficiency of electronic data transmission and communication. Lancaster (1985) and Swan (1993) revisited the prediction that we would become a 'paperless' society. Clearly, that prediction has not come to fruition. Why not? When considering the concept of "paper'less'ness," one must consider the importance of changing the way we think about communication. Mainstream American culture highly values and privileges the written word - more specifically, the **printed** written word (Keller-Cohen, 1996). Despite the increasing variety of means to access information and communicate with one another, the symbolic importance of print in American culture has not diminished.

Such cultural privilege is also reflected in many traditional schooling practices: standardized tests which focus on verbal and analytical skills; textbooks as main sources of knowledge; and reliance on written work, e.g., essays, papers, and written exams as means for evaluating student achievement. By acknowledging such regard for the printed word and placing it central to the teaching and learning process, other forms of expression are minimized and even excluded. In doing so, we then privilege those students who can successfully demonstrate their knowledge through reading, interpreting, and creating printed text. This places a growing proportion of our population, whose strengths lie in other forms of communication and expression, at the margins of teaching and learning in schools.

The teacher preparation program described in this paper attempts to broaden definitions of teaching and learning to include multiple forms of expression. By diversifying the repertoire of instructional resources in a paper"less" classroom to include visual, electronic, audio, and multimedia, we hope to accomplish a number of goals: the student-teacher dialectic is downplayed, and both students and teachers become learners; learning becomes an active, learner-centered process; learners will have access to a repertoire of resources which are representative of a wider range of human endeavors beyond their own spheres of experience; and learners will have increased opportunities to demonstrate their knowledge and expertise in a variety of ways.

One of the goals of our graduate teacher education program is to identify ways in which students can authentically engage in activities using technology in their roles as students, prospective teachers, and practicing professionals. Following Hansen's (1993) model for technology teacher education curriculum, we have based our program on three elements: (1) purpose (experiential learning, personal development, technological enlightenment); (2) content (professional knowledge, curriculum development competence, pedagogical knowledge and skill, technological foundations); and (3) process (planned reflection, classroom instruction, individualized and group learning, technological method).

Background

The Graduate Teacher Education Program (GTEP) at Portland State University involves students working together as a cohort throughout their five year program. Each cohort is guided by a team of faculty and focused on a specific theme. Among the cohorts started in the fall of 1996 is a secondary group (Teaching and Technology cohort) focused on the uses of technology in teaching. As we've developed the program for this group we have placed an emphasis on using electronic resources. We realize that it is unrealistic to expect students in our program to be completely electronic. We have provided opportunities to experience teaching and learning which incorporate the use of electronic media in conjunction with traditional instructional resources. We are moving in the direction of using a wider variety of resources, while decreasing our dependence on paper/print resources -- a paper"less" classroom.

The Teaching and Technology Cohort has been fortunate to participate in a US West and National Education Association (NEA) sponsored grant called Oregon US West/NEA Teacher Network (Teachnet). Pairs of our preservice students have formed teams with teachers working in schools throughout Oregon. All communication has been electronic, using web pages and electronic mail (e-mail). Team members have been asked to share information about themselves and their educational programs, then explore the Internet and share their findings. Discussions have been guided by a series of assignments posted on a web page for all to access (http://otn.uoregon.edu). Similar teams exist at each of Oregon's state colleges and universities. One unexpected benefit of this program has been that the teams link cohort members living in a metropolitan setting with practicing teachers working in rural Oregon. This has given our students a much broader perspective of teaching in general.

Program Components and Modeling

Most students' initial exposure to the use of technology in teaching and learning is through an integrated Instruction and Technology course, taught by a team of faculty (for more details, see de la Cruz & Bullock, 1996). During this course, students are introduced to many of the technologies they will encounter in schools, as well as some which are still on the horizon. They learn how to use these technologies to both create and present media. An emphasis is placed on appropriate uses of media and technology as they enrich contemporary models of teaching and learning which focus on the family, community, and workplace as places of learning (O'Neil, 1995). In addition, students learn the fundamentals of developing instructional units, designing lessons, and creating assessment tools. During this course, students collaborate to develop their first term projects (e.g. work samples, community studies) and present them using appropriate technology.

Students learn to communicate via electronic mail, participate in listservs, access newsgroups, and create web pages to enhance communication and collaboration. These forms of communication continue throughout the program. By nature, they allow us to limit the amount of paper used in class. Assignments, syllabi, schedules, and readings may be accessed and shared electronically.

The Instruction and Technology course is only one part of our overall effort to integrate technology throughout our curriculum. The program's Teaching and Learning class takes advantage of a new hall on campus with state-of-the-art technologies. Other content area courses draw attention to appropriate software, software evaluation, and designing instruction which includes media and technology.

We have used with a variety of electronic resources over the past few years, and found some to be very effective in increasing the amount of communication between cohort members and faculty. For one of our first experiments, we had students save assignments into their own personal folders on the School of Education network server. Faculty could then access the assignments from their offices. They could also leave additional assignments in special folders for students to copy or review. Students immediately learned how to work with a computer network, and how to save their documents in a format their instructors could open and read. Since the network is only accessible from School of Education offices and labs, access was limited.

Our next step was to use e-mail for some of the same purposes. Students sent their assignments, daily journals, and questions to faculty via e-mail. This allowed students and faculty who had computers at home more flexibility with regard to when they worked on or responded to assignments. Faculty also found that the amount of communication with students increased, and comments about assignments tended to be more detailed. At the same time, the need for "paper" assignments decreased significantly. E-mail has also been the primary source of communication between students working on the Teachnet project and their "teacher partners" in the field.

The more we used e-mail, the more possibility we saw for increasing communication. Our next step involved setting up two listservs. One is used by all GTEP cohort students, while the other is for the cohort working specifically with the Teachnet project. Both listservs are used by students and faculty in a variety of ways: cohort business, information sharing, planning student get-togethers, seeking advice, general announcements. Preliminary data suggests that the amount of communication between students, as well as students and faculty, has increased. We are just beginning to evaluate the quality of the communication to see if it has helped to increase "connectedness" and learning.

One of our newest endeavors in going electronic has been the use of web publishing to share course information and assignments. Students in our Instruction and Technology class can access the class syllabus, schedule, and list of assignments via the Internet. We've even included links to some Internet sites as starting points for research. Students in the Teachnet project have taken this a step further by setting up a cohort web page with links to their own personal pages and other useful Internet sites (http://131.252.56.87/TandT/TandT.html). We are already getting feedback from students suggesting that they like the ability to access class information electronically when they need to, and many are enjoying the opportunity to "publish" information about themselves on the web. Some are already planning to make a web page version of their resume available to potential employers.

In addition to "networked" electronic communication, students are using multimedia applications such as Microsoft Powerpoint and The Digital Chisel (Pierian Springs) to create presentations rather than written papers for class assignments. Students were introduced to these applications when faculty used them for presentations in various classes. Subsequently, students attended workshop sessions on each application, and have begun using them for their own presentations (we've even had one group of students create presentations for faculty who are unfamiliar with the software). We've established a working relationship with Pierian Springs Software, a local company, and plan to try out a new "electronic portfolio" template they are developing. In addition, we've purchased a CD recorder so that students can eventually create their own CD which includes various versions of their portfolios, resumes and work samples.

Implications for the Future

In establishing program goals which expand the effective use of technology in education, multiple forms of expression and performance are being perceived as critical elements of effective practices in teaching and learning. These opportunities for learning have contributed to an overall decrease in the amount of "paper" needed for communication and assignments. They have also allowed us to increase communication, incorporate multimedia elements into presentations, and set up links to resources beyond the School of Education. The Teachnet project, in particular, has encouraged an increased awareness of the resources available on the web, and talk between preservice teachers and teachers in the field. The opportunities for sharing and learning from each other have been enormous.

The potential for a broader definition of technology in teacher education seems compelling when examining preliminary data from this cohort experience. We are continuing efforts to incorporate state-of-the art technology into the curriculum. Future enhancements include desktop video conferencing, expanded web page development and access, and more discipline-specific applications in methods courses. We hope to eventually institute many of these components at a programmatic level, so that all preservice teachers going through this program will benefit from such experiences.

Moving toward a paper"less" classroom motivates students to effectively use technology and provides increased opportunities for collegial interaction and collaboration. This encourages students to seek out curriculum material from a broader variety of resources. By modeling a paper"less" classroom as part of students' teacher education program in the ways described above, the program provides support for student teachers as they experiment with expanded visions of teaching and learning.

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A Winning Combination: Students as Technology Mentors for Teachers

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There are a variety of exciting and stimulating educational technology materials available for classroom use. Access to the Internet provides a host of opportunities for exploration and resources on an endless variety of topics for students and teachers. Software tools are being developed and implemented that enable members of an educational community to manipulate and display data and think about concepts at a higher level (Becker, 1994; Marcinkiewicz, 1994). However, all of these technological resources are only as good as the classroom teacher. Given the nation's interest in improving education for students, the lack of attention to teachers is ironic, for at the center of effective use of instructional technologies by students are those who oversee the daily activities of the classroom—the teachers. . . . Educational technologies are not self-implementing, they do not replace the teacher. (Office of Technology Assessment (OTA), 1995, p. 1)

Numerous studies have been conducted and a variety of articles have been written describing the amount of technology available in the classrooms and what teachers are doing, or not doing, with this technology (Becker, 1994; Marcinkiewicz, 1994a). Most of these reports make similar recommendations on improving the situation by providing more equipment, more teacher training and support, and more time for teachers to implement the technology into their curriculum. Few recommendations address specific methods of implementation. Most remedies include spending more money or restructuring schools, solutions that may not be practical (Becker, 1994; Marcinkiewicz, 1994a).

This paper proposes a solution to the problems classroom teachers face in dealing with the technology available to them. The solution involves the element of the educational system in which teachers have the most knowledge and experience — the students. Student mentors collaborate with teachers as technological support in the classroom. Questions that can be asked about technology are: What kinds of technology are available in the classroom? Amidst all this technology, where does the classroom teacher fit? Is the classroom teacher using the technology that is available? What kinds of support do classroom teachers need? What can be done to provide the necessary support?

Availability and Use of Technology

Supply of computers is high, but teacher demand is low. Despite the amount of technology available, teachers are ultimately responsible for its use in the schools. Simply having more technology does not in itself persuade teachers to use it. Often these teachers are inadequately prepared for implementation. Only five percent of U.S. teachers met the majority-of-standards criterion on a national survey that sets the criteria for exemplary use of computers by classroom teachers (Becker, 1994). Marcinkiewicz (1994b) surveyed 170 teachers and found, although half the teachers surveyed used computers, only eight percent used computers as an integral part of their curriculum and 48.5% felt they were expendable.

There are numerous reasons cited for lack of computer use by teachers: anxiety due to lack of self-competence and efficacy, discomfort with lack of familiarity about technology, lack of good software for computers, lack of access to or wasteful spending for equipment and materials, no single best choice of media for all instructional needs, lack of support personnel, and fear of change (Becker, 1994; Chin & Hortin, 1993: Ely, 1993; Hannafin & Savenye, 1993; Marcinkiewicz, 1994b; OTA, 1995; Swan & Mitrani, 1993).

The implications of the use of technology for improving the preparation of novice teachers or enhancing the continuing professional development of inservice teachers are rarely considered. When teachers' needs are discussed, the focus is often on providing short-term, one-shot training to familiarize teachers with a specific application or general computer literacy (OTA, 1995).

On a national scale, one would have to conclude that computer-based instruction in the U.S. schools and universities has had minimal impact. . . . However, where deliberate efforts have been made by individual teachers or entire institutions, one would have to say that, in those circumstances, the teachers and learners will never be the same again. They have gained new skills, new perceptions of how to learn, increased motivation, and renewed enthusiasm for teaching and learning (Ely, 1993, p. 55).

Exemplary Use of Technology

A study conducted by Marcinkiewicz (1994) suggests that the adoption of computer use may occur incrementally or hierarchically as described by instructional transformation. Instructional transformation, a theory by Hooper and Reiber (1995), describes a teacher's use of computers in terms of five progressive levels;

1. **familiarization**: the teacher becomes familiar with the computer;
2. **utilization**: teacher begins to use computers during instruction;
3. **integration**: the computer becomes critical to instruction in the classroom (at this level the teacher is aware of changes in his/her role in the classroom);
4. **reorientation**: due to that awareness, the teacher restructures instructional activities to enhance computer-teacher-students interactions, and,
5. **evolution**: there is constant evaluation and tuning of the implementation of technology in classroom instruction by the classroom teacher (Marcinkiewicz, 1994).

Exemplary computer-using teachers would be functioning at the integration level or higher. Along with the level of computer use, there are many other elements that are essential in developing exemplary computer-using teachers. Educators who have high levels of self-competence and efficacy are more likely to be exemplary computer-using teachers. Innovativeness is another factor that contributes to a teacher's level of computer use. Exemplary computer-using teachers adopt innovation as a way to keep current with and have access to increasing amounts of technological information (Marcinkiewicz, 1994a, b).

There were some variables found in exemplary teachers' backgrounds compared to other teachers. Exemplary computer-using teachers spent twice as many hours personally working on computers at school than did other computer-using teachers. These teachers also had more formal training in using and teaching with computers. They reported having training in more areas than did other users (Becker, 1994).

In classrooms, exemplary practitioners directly address curricular goals by having students use a wide variety of software, including simulations, programming languages, spreadsheets, database programs, writing tools, and electronic bulletin-board communications software (Becker, 1994). Becker found four characteristics of teaching environments that seem to be conducive to promoting exemplary use of computers:

- the existence of a social network of computer-using teachers at the same school;
- sustained use of computers at the school for sequential activities, that is, where computers are used to accomplish a goal other than learning, for example, writing and publishing, industrial arts, or business applications;
- organized support for computer-using teachers in the form of staff development activities and a full-time staff member in the role of computer coordinator, and
- acknowledgment of the resource requirements for effectively using computers, for example, smaller class sizes and funds for software acquisition (p. 303).

Student Mentor Program Descriptions

What means are available to support the transition of non-computer-using teachers to teachers who integrate computers in the classroom? Some schools are utilizing the technological knowledge of their students. These students are technology mentors to teachers and other students in the school. Two examples of successful technology mentor programs are described below. Following the examples is a list of ways in which the use of students as technology mentors can assist teachers in becoming exemplary computer-users.

Example #1. A team of researchers at the University of Michigan have been conducting research at a local high school through a grant from the National Science Foundation. The researchers and teachers have created a technology rich, investigative-based, science program (Huebel-Drake, Mouradian, Stern, & Finkel, 1995) This paper focuses on the support teachers and students have received as the amount of technology equipment has increased and the use of the technology in the classroom instruction has evolved over the past three years. The technological support provided to meet the teachers' needs is an integral part of the implementation of this program.

The first year of the program, there were 18 AppleTalk computers being utilized by the students and staff. There were 21 ninth grade students in the pilot science program. Support was provided by one graduate student who had a dual role of technician and researcher.

The second year, there were 70 computers utilizing Ethernet connections. In addition to work in school, students in the science program were allowed to borrow the computers to use at home. As the amount and use of technology, along with the number of participating students increased, the support needed for the classroom teachers increased. At this point in the program, the role of the researcher became separate from the technician' role, and a graduate student was hired to be the technician in the school for approximately 30 hours a week. Two high school students who were interested in technology became interns to the technician.

The third year of the program involved all incoming freshmen. At this time, there were 110 computers distributed in three rooms. The majority of the computers were portable and they were connected to a web server. Support was provided by the same two students who were interns with the graduate student the previous year of the program. Those two students were paid to work for two weeks before school started to make sure the computers were repaired and ready to go. During the school year, the student technicians continued to be paid for a few hours a week.

The student technicians' responsibilities included: keeping 100+ powerbooks loaded and running smoothly, managing the file server, accounts and connectivity, fixing problems with the network, answering questions and troubleshooting during class sessions, and providing support for teachers. In addition, they trained several new volunteer interns. The goal of the new interns was to become future technicians for the program.

Along with the training received from the technician at the university, the students' technical knowledge derived from prior experiences. One technician's knowledge had been fostered by playing with PET computers in second grade, curiosity with Apple IIs computers in fifth grade, taking a BASIC class at a local hands-on museum, and messing around with computers on a daily basis.

Example #2. Last year, after coming to the realization his students possessed skills teachers needed, a high school teacher started an after school training class with 10 student volunteers. The students were instructed on a variety of skills and techniques that might be useful for elementary teachers such as creating web pages, building tables, and using hypermedia programs. The goal was to assist the teacher as he/she worked with the students in the classroom.

The students were placed in elementary schools in small groups of two or three, visiting their school once a week during the time they were scheduled for their technology class at the high school and sometimes after school. The original plan was to start in one teacher's class and then move throughout the building assisting the entire staff. Unfortunately, there was a scheduling problem at the school so the students spent their entire training experience with one class. The student mentors were trying to work with the teachers during the school day. Although it was not the intended goal, the high school students became tutors to the elementary students as well as mentors to the teacher. All individuals involved, students and teachers, profited from the experience.

For example, one group of technology mentors comprised of three females, were placed in a second grade classroom and worked with the students using Hyperstudio (1995). The mentors brought a laptop computer with them and used two other computers that were available in the school. They worked with small groups of about eight second graders. The end goal was to make a class portfolio that included the second graders' voices, photos, information about each individual, and the events that were taking place in the classroom throughout the year.

The technology mentors enjoyed the time they spent working with the students in the classroom. They were amazed at how much the second graders already knew about the computers and how the software worked. According to the technology mentors, they learned just as much from the students as the students learned from them.

Even though the mentors enjoyed their experience working with the students, they reported that they felt frustrated by their lack of work time with the teacher. The teacher did not possess as much knowledge nor did she feel as comfortable using the computers as did her students. The support given by the mentors was advantageous to the classroom teacher in that the second graders were able to create an end product (Hyperstudio document). However, the classroom teacher did not acquire the technological skills necessary to reproduce this type of product independently.

Benefits for all. Interviews with the participating classroom teachers and student mentors contributed to devising a list of benefits for all participants (teachers, students, and mentors) in the case studies described above. The teachers found the mentors to be helpful in the classroom; there were more hands to help students, they lent credibility and value to the lessons, and provided immediate assistance with technology problems. The teachers became familiar with technology, appreciated the kind, gentle, patient instruction, and gained awareness of and respect for the vast amount of knowledge held by the mentors.

The classroom teachers also noted the students in their classrooms benefited from positive interactions through this cross-age and peer tutoring environment. The students found the lessons to be more credible because the activities became self directed, they gained power over the computers, and they received instruction from teachers (mentors) who had a different perspective and who were gentler, more sympathetic, and "cooler".

The mentors felt they also reaped rewards from this opportunity in many ways: they felt helpful, boosted their self-esteem, provided an opportunity for practical application of skills, looked great on the resume, and helped with communication and assimilation in to an adult world.

Technology Mentors: Support for Classroom Teachers

Teachers spend the majority of their working lives out of sight of other adults. If they are to successfully incorporate a new and complex resource like computer software into their teaching practice, they must have access to other people from whom they can learn. These resources could be either experts who have already mastered the resource or a community of teachers- learners who pool their efforts and share their exploratory findings (Becker, 1994). Technology mentors in the classroom provide teachers with experts who have mastered many of the skills teachers need. As these mentors move from one classroom to another, they create a community of knowledgeable teachers and students which increases the pool of learners twenty fold. Technology mentors assist in creating environments that are computer active and rich in resources, on-site support, and motivation for teachers.

Computer Active Environments. Schools are considered to be exemplary when there are a greater number of computer using teachers (Becker, 1993). This will happen if student mentors work with teachers and student in the classroom. Even if the teacher is not directly involved in the mentoring process, technology mentors promote the type of environment needed for exemplary use of computers. The classroom students become empowered, bringing the classroom teacher along with them.

Resource-rich Environment. Exemplary teachers practice in a resource-rich environment. Technology mentors assist in providing a resource-rich environment. Becker (1994) also found that exemplary computer using teachers had lower class sizes. Even though the number of students in the class do not decrease, the presence of technology mentors in the classroom increases the teacher-to-student ratio.

On-site Support. Exemplary teachers work in schools that invest heavily in staff development and on-site staff support for computer-using teachers, often by providing a full-time staff member designated as a computer coordinator (Becker, 1994). This type of support does not meet the needs of classroom teachers because one person cannot supply the needed daily personal support. Technology mentors, available on a daily or weekly basis, supply the necessary personal support for the teacher.

Motivation. As mentioned earlier, the adoption of computer use may occur incrementally or hierarchically as described by instructional transformation. Student mentors help this developmental process occur at a faster rate by providing a greater amount of personal support and instruction for the classroom teacher that is specifically tailored to meet the teacher's needs. Self-competence contributes to a teacher's pursuit or avoidance of computer use. Innovativeness (one's willingness to change) contributes to the level of computer use. Marcinkiewicz (1994) suggests as technology continues to change and expand, it will be increasingly necessary to help teachers adopt innovation as a way to keep current with and have access to increasing amounts of information. Technology mentors will be able to support teachers in their quest to be innovative. Teachers who have had technology mentors in their classrooms commented that the mentors know the "latest" in technology and are adept at how to use it. The teachers also used technology, such as Hyperstudio, that they would have otherwise avoided without support from the mentors.

Conclusion

In order to integrate computers into their current programs, practicing teachers will have to work beyond their current professional expectations. They will need to be highly motivated to see a reason or need for using technology. Self competence is highly related to achievement and learning situations. This suggests that if teachers are expected to integrate computers into their teaching, computer integration needs to be considered as achievement and teachers should be cast as learners. Practicing teachers assume the role of learners only when they participate in extra education, such as inservice or other staff development programs (Marcinkiewicz, 1993). Teachers become learners on a continual basis when they participate in the technology mentor/teacher program. Staff development in this manner would be progressive in nature. As the technology mentor/teacher relationship unfolds, the mentoring can accommodate planning time with the teacher. The teacher is the curriculum expert, and the student is the technology expert. The teacher can share what the expectations are for the students in the classroom, and the mentor can give suggestions for innovative use of technology.

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Teacher Professional Development: Two Case Studies of Curriculum-driven Training

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At schools, educational software and hardware find their way into classrooms through school-budgeted acquisitions, grants, donations and parents' efforts. This surge in educational technology has spurred the need for training strategies that will effectively develop teacher's abilities to incorporate these technologies into curriculum. Thus, in many instances what schools lack is not so much basic hardware, but teacher training (OTA, 1995). The Office of Technology Assessment concludes that among the most urgent policy changes is the provision of high-quality preparation of staff (p. 42, 1995). More specifically, *Teachers and Technology: Making the Connection* (OTA, 1995) reports:

> One of the most clear findings of the OTA case studies ...is that even very highly motivated teachers require substantial amounts of time—often over a three to five year period—before they feel fully versatile with a complicated new technology and are able to expand technology tools to fit their particular teaching goals. (p. 41)

What are the optimum methods for providing the current teaching workforce with the needed intellectual framework and specific technical skill sets to keep pace with the infusion of technology hardware and software in K-12 classrooms? McCraw, et al. (1995) have suggested that one of the most successful ways in which to integrate technology and curriculum is through thematic units. Papert (1993) proposed that people learn more effectively when they are involved in construction processes that are related to objectives that are meaningful in their lives.

In our work with teachers through the Center for Technology in Teaching and Learning at Rice University, one of the most successful vehicles for introducing technology is the use of existing teacher-developed curriculum as the cornerstone. Weaving together technology with teachers' curriculum-driven needs offers opportunities for "just -in-time learning" that often produces short-term and long-term results, while enabling teachers to attack the technology learning curve in a less-threatening atmosphere.

The Context

The two case studies presented are anchored in experiences with a technology-rich K-8 school attempting to absorb and manage change on a massive scale. In the fall of 1994, *The Rice School/La Escuela Rice* in Houston, Texas opened its doors to 1300 students. One of the school's distinguishing features was the generous gift from Compaq Computer Corporation of 1100 workstations and six servers over a three year period. This hardware was coupled with the donation from Southerwestern Bell of a fiber optic connection directly to Rice University for Internet access. The school's technology infrastructure was designed to allow each station to connect to up to six servers. Furthermore, the design of the network allows students, teachers and staff members to have personal disk space. Deploying this amount of technology in this building required effort and planning, but the bigger effort was to make the system a useful teaching tool and to provide teachers with the capability to work and dream independently with these technologies. The purposes of the programs described below were several:

1. to develop and effective model for integrate technology into curriculum;
2. to stimulate teachers to embrace technology solutions when appropriate, and
3. to become proficient in their execution.

When The Rice School/La Escuela Rice opened in 1994 it had set three main goals in the development of its educational programs: a) to provide children with a multi-age educational system, b) to provide children with an education that would allow them to function in a bilingual society, and c) to provide children with a technologically rich environment that would promote new ways of learning and collaboration between students and teachers. The teacher population was recruited with these goals in mind. Given that it was impossible to select teachers with experience and training in *all* of these areas, the resulting population was composed of individuals who run the gamut of having no exposure to computers to individuals that have used them extensively.

Between the opening of the school in 1994 and the middle of 1996, technology training was competing with numerous other demands for professional development such as multi-age grouping techniques and dual language learning. The initial technology training focused on meeting the teachers need for "personal and administrative uses" of computing for activities such as electronic mail within the school, word processing, and grade book reporting and the basics of the operating system (at that time, Windows 3.1). Every week sessions were offered and individuals self-selected the training they felt appropriate for their needs.

This "cafeteria-menu" approach to training programs met with very limited success for at least two reasons. First, the priority level for the training was low both from an administrative and teacher viewpoint, with the classes being frequently canceled in order to have teachers attend other school functions. This stemmed from the numerous demands of starting a new school with ambitious goals and competing priorities for teacher time. Second, the training was not tied to particular instructional goals, rather to a more general notion of computer proficiency.

In the Spring of 1996, an alternative to this style of training and with the slight diminishment of other competing demands for teacher time, the Center for Technology in Teaching Learning initiated two different approaches to professional development in technology.

Both programs stressed *voluntary participation, intensive contact* with CTTL technology specialists, and *validation by the school administration* of the time and effort needed by the teachers participating in these programs.

Curriculum Driven Approaches

Galileo's Web. Galileo's Web was supported by CTTL to explore the possibility of adapting and incorporating world wide web-based educational resources that were designed for higher education into middle school education. This project included a middle school elective course, entitled Special Projects, that was taught throughout the spring of 1996. Over 120 students were enrolled in the course which was collaboratively taught by a teacher who specializes in gifted and talented education and the author. The students were a multi-age group of sixth through eighth graders.

The learning and exploration were centered on Galileo Galilei's life. Both the teacher and the students used a web site created under the direction of Dr. Albert van Helden in the History Department at Rice University for one of his courses. *The Galileo Project* [http://www.rice.edu/Galileo] was the starting point for exploration. It was created in an effort to provide users with a hypertext information source about Galileo and the science of his time. This resource has been used successfully and is continually updated for undergraduate education at Rice University.

Prior to beginning the semester, the teacher was approached by members of the Center for Technology concerning her willingness to develop a prototype course and experiment with technology. The teacher had autonomy to work with the technology support group and was free to experiment. With a background in and strong track record in interdisciplinary teaching, she welcomed the opportunity to enrich her course with technology, but was apprehensive about her lack of computer knowledge. Assured that she would receive personalized training and that she could progress at a her own comfort level, she accepted the challenge.

The teacher laid down a curricular plan for the whole semester. This plan included themes and activities that would be carried out in a traditional classroom. The initial units were executed and enhanced with technology. All of the student created projects were developed and executed with off the shelf technologies such as word processors, drawing programs, graphical VRML tools, web browsers. In addition, students created multimedia libraries for personal use by harvesting objects off the world wide web. Time was allocated in class for cooperative learning groups, to plan and execute projects, for student-teacher consultations and for independent pursuits. Added to the mix were visits to the class by Dr. van Helden and Dr. Patricia Reif, a Rice University professor of space physics and astronomy. Information gathering combined world wide web browsing with access to related books and video resources which the teacher brought into the classroom.

In the initial stages, the teacher required a great deal of support and individual training. The author worked closely with her and projects were done as a "team" effort. Within six weeks, the teacher was completing projects on her own and taking a leadership role in the instruction and support of technology used in her projects. And by the end of the semester, the teacher felt strongly that technology she had "pushed beyond the 'dark ages' of instruction without technology." The class projects and lesson plans can be viewed at *http://www.rice.edu/armadillo/Rice/Galileo*

Project Constellation. Based upon the small, but successful experiences in *Galileo's Web*, there was thought about how to scale-up the technology infusion process to reach a greater number of teachers and students at the same school. What were the successful characteristics of the working relationship that could be applied to more teachers. Upon reflection, there seemed to be a number of positive elements deserving of replication:

1. The teachers should begin with a curriculum plan that *they* wanted to teach.
2. Technology support should be offered on a one-to-one basis, in addition to more general training that could be offered in group sessions.

3. Technology support needed to begin by "guided practice" with the technologist facing the same classroom environment as the teacher.
4. The teachers should be encouraged to move at their own pace in experimentation.
5. Reflection and evaluation should be an on-going process to keep the project on course, given the increased numbers of persons involved.
6. There had to be buy-in from the school administration with full acknowledgment that technology training time would not be usurped for competing purposes.

In the fall of 1996, eighteen 18 teachers were recruited through a self-nomination process for a semester long "technology support program" named Project Constellation (http://cherokee.cs.rice.edu/Constellation). The project derived its name from Chiron, the mythological centaur, teacher of the gods, and the Centaur constellation. This name was chosen as part of the idea that teachers trained in this group should become guiding lights for students and other teachers. The final selection of participants was left to the instructional technologist. The main criteria for selection were previous experience with computers and grade level they taught. An attempt was made to recruit a cross section of the teachers and areas that they teach. The development of Galileo's Web had a positive impact on this program since it was used as a prototyping system to then develop Project Constellation. Furthermore, Galileo's Web became a very visible project at the Rice School/La Escuela Rice and exemplified for others the kinds of achievement and developments that are possible with this kind of training.

Participants in Project Constellation had from six to twenty-five networked computer stations in their classrooms, depending on the ages of their students. Classrooms from kindergarten through second grade had four computer stations and classrooms in the eight grade had one computer station per student.

Training and support. Training and support for this program came in several ways. The CTTL instructional technologist met all the recruited teachers for two hours every week for project development. The group sessions also included three Saturday sessions of six hours. Group training sessions included project based software instruction, cooperative project development, teacher lead discussions of articles on teaching with computers, and group sharing of success formulas and frustrations.

The program focused on construction targeted at curricular needs. Product rather than technological details was at the center of this program. The approach was similar to the one proposed by Resnick (1996) in his proposal of distributed constructionism. Participants worked with software that enabled them to create with materials and activities with minimal acquisition of new skills. Their worked was shared with others in the group and with their students. In the process of sharing and teaching, participants reengineered their work and learned from each other. For example, in the process of learning how to use and produce web based instructional materials, teachers used 'What You See Is What You Get' editors that allowed to quickly construct resources and concentrate on content rather than on mastering technological feats. Support materials that facilitated construction, such as web based graphics libraries and basic templates, were created for the teachers to minimize repetitive labor with no learning value. Teachers could discuss constructions through the establishment of web based threaded discussion groups and listservs.

Teachers in Project Constellation also had access to the instructional technologist during one and half hour sessions once a week. These sessions were reserved for one on one training and project discussion. Every participant in this project had a regularly scheduled session and both the instructional technologist and the teacher respected this time.

Understanding the common time and resource constraint facing today's teachers, CTTL provided them with slip accounts, electronic mail accounts and web space. These allowed them to explore the Internet from home and communicate with each other and the instructional technologist using laptops provided by the school.

Project Constellation benefited not just from the experiences derived from Galileo's Web, but from itself. Since training takes place in two rounds of 18 teachers each, experiences and lessons learned from the first round can be applied to the second. Also, the achievements of participants in the first round serve as a showcase that attracts others to the second round.

Impact on the teachers and the school. Project Constellation impacted teaching and technology at The Rice School/La Escuela Rice at several levels. It allowed teachers to construct and create units using computers and the world wide web "in close correlation with themes and topics that [were] being studied in the classroom". During the course of the program participants became reflective about the role that computers play in the classroom and moved from the "learning about computers" mind set to a "using computers to learn" attitude. In this process teachers saw technology in their classroom as "tools that enable children to learn". Some of them expressed the "need to improve placement of computers in the classroom" as they became part of their daily activities.

Participation in this project also brought about teacher involvement in the technology decision making structure of the school. While in 1995 teachers rarely attended sessions of the committee that oversees technology at the school, 1996 brought an active participation in this committee. Project participants also served to attract students in the middle school recruitment efforts as their work in Project

Constellations was showcased in an effort to attract new applicants.

Teachers and students collaborated in project development and construction. For example, in the QuiltingABC project (http://www.rice.edu/armadillo/Rice/QuiltingABC) three K-2 teachers worked with their students in the production of an electronic quilt. This quilt, a shared unit that is accessible through the World Wide Web, contains digital art squares created by the children and electronically "sewed" together by the teachers. Each square links to a more detailed rendition of that section as well as to a scanned self portrait and autobiographical notes created by the author of the square. This project was part of a unit on communities which explores the role of quilts in American culture. It included readings, exposure to quilts that were meaningful to the children's teachers and mathematical exercises based on quilt patterns.

Examples of developed activities include the Quilt Project for a kindergarten through second graders and the Colonies Project. The Quilt Project was based on the role of quilts as part of a community study. Teachers stressed the importance of the quilting traditions on American culture. Quilts were brought into the classroom, children designed quilt squares following mathematical principles and worked on paper quilts. At the same time, they developed an electronic quilt (http://www.rice.edu/armadillo/Rice/Quilt) with digital drawings which were electronically "sewed" together and linked to scanned self portraits and biographical notes.

At the other end of the student age spectrum, eighth grade teachers developed the Colonies Project (http://www.rice.edu/armadillo/Rice/Colonies). The object of the Colonies Project was to have teams of students develop imaginary colonies which included maps, clothing, monetary systems, simple machines and means of communication. This project was developed by three teachers in this group and implemented by a team of five. The teachers used the world wide web to deliver problems and information on how to create a colony. The web was also used to allow the transmission of sample work by student teams and to provide students with means of electronic contact with the teachers leading the project.

Establishment of the Working Relationships

The development of both projects involved the participation of administrators, researchers, instructional technology specialists, network administrators and teachers from CTTL and The Rice School/La Escuela Rice.

The initial agreements were reached between CTTL directors, CTTL staff that would be involved in program development, and the school principal. A contract that outlined the responsibilities of both institutions was put together and signed. CTTL provided training, materials and Internet access from home for the participating teachers. The Rice School/La Escuela Rice blocked out time for teacher development, provide teachers with laptops to allow them to access the Internet from home through CTTL sponsored slip accounts. Teachers with perfect attendance to training sessions also received a day off.

The CTTL instructional technologist defined clear and solid working relationships with the participants. At the beginning of the programs he explained to the participants what would be expected from them and what he would provide in their partnership. Project participants agreed to keep electronic journals for a year and to allow the instructional technologist to document their work in the classroom as well as their classroom environment. Participants also agreed to complete questionnaires as needed by the instructional technologist. The relationship between instructional technologist and teachers in both programs had a common thread: the establishment of a strong and trusting partnership in learning. In both cases, the teachers had access to the instructional technologist outside the training environment, and in both cases the instructional technologist worked with the teachers at a tutoring level. The instructional technologist, while being a member of the CTTL staff did not keep an office at the Rice University. Instead he was deployed at The Rice School/La Escuela Rice full time. He helped the teachers at many levels, including hardware troubleshooting, serving as a voice for teachers in school policy discussions that involved technology and education, by researching electronic classroom materials that would support ongoing activities and by setting up and creating applications that were useful to teachers.

Trouble Spots

The implementation of these programs face several challenges. On one hand, teachers are attempting to change the way they teach and learn while trying to meet state requirements for essential elements that are not always compatible with innovation. Furthermore, all these activities were carried out on an already heavily loaded schedule making thoughtful reflection, practice and exploration difficult for them. Second, these programs were carried out in an environment where the administrative sections of the school are the product of a traditional educational systems with little exposure to information technology. Problems encountered here were often related to specific infrastructure commitments needed for both programs' foundations. It would appear to be necessary, after reviewing these two programs, to devote time and develop programs aimed at bringing school administrators to the forefront of educational technology. It is important that administrators understand the true meaning of their commitments to educational technology programs. In future projects progress and results could be improved by establishing regular meeting times, progress reports and working sessions with school administrators, in the same fashion that teachers were guided in their development.

It was also difficult to keep participants active in journal keeping. Journals, which were supposed to serve as a tool to document change in attitudes toward technology were kept used on an irregular basis and in general were used more as a vehicle for complaining about other school officials. Therefore journal requirements were removed half way through the program and regular administration of questionnaires was used instead.

What Makes the Difference

The most important aspects in the success of these programs were the development of an instructional system that made learning about technology meaningful for the professional goals of the participants in learner centered environments (Norman & Spohrer, 1996). By making technology a construction tool in curriculum development teachers were able to see quick results and impact in their classrooms. "Project Constellation was my first opportunity to use resources available through the Internet to actually develop activities which I could use in my classroom with my children immediately" . Equally important was the fact that teachers knew that the CTTL information technologist would be present at the school for support and consultation, as well as for individualized training. "I realize that the individual sessions that we receive are so valuable". The participants also regarded the individualized training sessions as an important aspect of their learning. Finally, providing participants with the ability to access Internet services from home helped them work, explore and learn better than they had been able to do before, when they only had access to computers at school. Teachers' schedules at schools are often time overloaded. They need to be provided with the opportunity to learn after hours, without expecting them to own a home computer or to have to pay for Internet services. The CTTL sponsored accounts and laptops provided by the school were key elements to facilitate this effort.

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Multiple Intelligences Multimedia Portfolios in Elementary School Contexts

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Russell Elementary School, site of the multimedia portfolio project described in this paper, is a Professional Development School that is collaborating with the Lower Valley Center for Professional Development in a Texas Education Agency funded project. A major initiative undertaken by the campus this year has involved all teachers in training in multiple intelligence theory and classroom applications. As teachers learned more about this theory, they realized that they must also adopt a new evaluation process to enable students to demonstrate the ways in which they were using the different intelligences in their learning. This paper will describe the role of authentic assessment as a tool for evaluation, the content and nature of a multimedia portfolio, and the process for creating student portfolios using HyperStudio software.

With the increased emphasis on alternative forms of assessment to complement pencil and paper tests and standardized assessment tools, teachers are currently exploring ways to allow students to document their accomplishments and growth. Assessment based on multiple samples of student work generated in meaningful contexts is of vital importance as a tool for evaluating student learning, communicating that information to parents, and involving students as partners in the evaluation process. These new multi-faceted modes of assessment assume even greater importance in classrooms that are implementing a curriculum designed to foster learning by engaging students' multiple intelligences. When students demonstrate their learning using one, or more, of the seven intelligences identified by Gardner (1983, 1991), traditional forms of testing and assessment are no longer appropriate.

During the fall semester, all elementary teachers were given training in Gardner's theory of multiple intelligences and in learning to identify each of the seven intelligences (verbal, logical-mathematical, spatial, bodily-kinesthetic, musical, intrapersonal, or interpersonal) and assess their students' multiple intelligences. In this way, we are able to build on children's stronger intelligences and to provide instructional activities that address each intelligence, thereby allowing all children to learn in the way that is most effective for them. However, the multiple intelligence approach to teaching and learning requires us to implement assessment procedures that are multifaceted and based on student products, portfolios, video or musical productions, exhibitions, panels, and samples of problem-solving. Portfolios seem to provide the most effective way for students to document their learning and growth. In fact, we are particularly impressed by the value of portfolios in involving students in reflecting on their own learning and growth, in selecting the products, works-in-progress, and other samples of materials that document their ability to use the different intelligences as a means of learning. As a tool for authentic assessment, portfolios possess certain distinct advantages. They provide for ongoing evaluation offering a more clear perspective of student progress and treat each student as a unique human being. By concentrating on the abilities of each student, on what s/he *can* do, and on what s/he *is accomplishing.* Students also become reflective learners by selecting items to include in their portfolios and in explaining why these items are important and what learnings they demonstrate.

The decision to use HyperStudio software to create students' multimedia portfolios was based on its user-friendly features that allow children to continuously document their learning activities and progress. HyperStudio portfolios are more than just a collection of papers for them and their parents to shuffle through; they can incorporate sounds, graphics, narrations, still photographs of projects, scanned images of selected work, writing samples, and works-in-progress into this electronic record. The portfolio becomes a living document that belongs to the student who makes decisions about which work best demonstrates growth and progress toward self-selected goals. Even more important, in the context of multiple intelligences, students can select works in which they demonstrate effective incorporation of a specific intelligence in their learning processes. By allowing students to reflect on work they have completed, they view themselves as successful contributors. Students set personal goals and help develop a standard for excellence, seeing themselves as valued members of the class. Participation also helps develop responsibility as students are continuously involved in updating and editing their own portfolios. Finally, at year's end, HyperStudio allows the portfolio to be copied to videotape and taken home.

These portfolios are highly personalized representations of student-selected work, achievement, performance and personal interests. Although student-selected content varies widely among the children in the classroom, some unifying structure was provided by the teacher. Obviously, students also needed to have familiarity with computers and possess some prerequisite computer skills in order to be able to use HyperStudio for the production of their own portfolios.

Prerequisite Computer Skills

Before using HyperStudio, children need certain competencies in using the computer as a productivity tool. During the early fall, children have become familiar with Claris Works word processing, learned disk management procedures (such as: saving/opening files on their own disks), become accomplished at accessing CD-ROMs for information and pictures to incorporate into reports, and developed competence in scanning graphic images into files. Students are comfortable using pull-down menus and know how to enhance their work with audio narrations using the Macintosh built-in microphone or sound clips and how to use story boards to plan the sequence of screens for their presentations. They have also had many opportunities in using the KidPix2's clip art, paint and transition tools to create and illustrate their original writings.

Training in HyperStudio merely required the acquisition of a new set of vocabulary and skills. Using the HyperStudio Tutorial and Addy, the guide dog, children learned the terminology and conventions that are essential to creating products with HyperStudio (Gross, 1995). One important learning is the understanding of the concept of stacks and branching using buttons that is a different model from the usual linear page-after-page book model. Students also learn to use the Bibliography Template to categorize and describe the cards in their stack that represent each type of presentation, i.e. text, graphics, sound, video, and animation. The elements of design become important as children learn how to select backgrounds, borders, animation options, and text and button styles to complement their projects. Since these third-grade students were already comfortable with computers, they quickly learned to use the basic features of HyperStudio. In fact, some more technologically adept students even learned to use hypertext links to tie together cards in their portfolio stack.

Portfolio Development and Content

Students used teacher-developed guidelines for portfolio content, for organizing and sequencing its content, and for using self-evaluative criteria to create oral or written descriptions accompanying their selected products (or works-in-progress). Each portfolio began with an introductory autobiographical sketch that set the stage for the selected content of each portfolio. Each autobiography includes personal background, place of birth, information about the student's family, personal interests/hobbies, and reflections on their preferred, or stronger, intelligences.

The Teele Inventory of Multiple Intelligences (1992) was administered to each student, and after the responses were scored, teachers discussed the characteristics associated with each intelligence and how people demonstrate the intelligences in their everyday life and in school activities. (Armstrong, 1995, p. 26-31). Children learned about the importance of each intelligence in their success in school and become skilled in identifying times they are using the different intelligences. They also learned that all human beings favor certain intelligences and that other intelligences are rarely used (dormant). These understandings were important to the children as they began to select samples to represent their effective use of at least four different intelligences for inclusion in their HyperStudio Portfolio.

After several class discussions about portfolios and examination of portfolios created by other classes, students were encouraged to identify examples from the portfolios that reflected the use of a student's linguistic/verbal intelligence. With the teacher's guidance, they then generated a list of reasons why that particular item was a good way of showing how the student had used his/her verbal intelligence. Finally, they dictated a short description as to why they thought this work was a good sample to illustrate the student's verbal intelligence using the following stems:

I chose this work because ...

I think it shows how I use my verbal intelligence because ...

One thing I learned about myself when I did this "piece of writing" (description of selected example) is that ...

Children then worked in groups to select a different example to reflect musical, spatial, or logical-mathematical intelligence and created a description to justify their selection using the given stems.

In order to help students understand how they might observe themselves or others demonstrate their bodily/kinesthetic, interpersonal and intrapersonal intelligences, they suggested actions and activities that children do at school, on the playground, or in other community settings that would be good examples of using one of the three intelligences. Following the discussion, students were asked to choose a classmate and write a few sentences describing a time when they observed him/her using a bodily/kinesthetic, interpersonal or intrapersonal intelligence. These short "MI biographies" were read aloud and became models for short "MI biographies" that were written for each child portfolio by at least one classmate. Children then selected the "MI biography they wanted to include, which in some cases was saved as a sound clip read by the author, and in other cases was typed, or scanned, into the HyperStudio stack.

Guidelines provided by the teacher helped the students with ideas about what to put into their MI Portfolios. Students were given the following suggestions as to what types of samples might be included to represent, or describe, each intelligence:

1. Verbal-Linguistic Intelligence: preliminary drafts of writing projects, best samples of writing, written descriptions of investigations, poems, jokes, journal excerpts, audiotapes of reading or storytelling, or samples of word puzzles solved.
2. Logical-Mathematical Intelligence: best samples of math papers, rough notes from computations/problem solving processes, final write-ups of science lab experiments, samples of logic puzzles or brainteasers created/solved, or samples of graphic organizers.
3. Spatial Intelligence: photos of projects, diagrams, flow charts, sketches, mind maps of thinking, and samples or photos of collages, drawings, paintings.
4. Musical Intelligence: lyrics, raps, songs, rhymes written by student, audiotapes of musical performances
5. Bodily-kinesthetic Intelligence: samples of projects actually made, photos of hands-on projects, photos or written descriptions of pantomimes, charades, impersonations, videos of physical exercises or games, or illustrations using body language/gestures.
6. Interpersonal Intelligence: descriptions or photos of ways in which student interacted with others, letters to/from others, photos/write-ups of cooperative learning projects.
7. Intrapersonal Intelligence: descriptions of feelings, personal ideas, goals, and objectives, responses to interest inventories, notes of self-reflections about work or learning.

These suggestions seemed to provide enough direction for students that they were able to make reasoned choices as to what they wanted to include in their portfolio (or write about for an MI biography for a classmate). In order to encourage student's critical evaluation of the materials they might include, a maximum stack size of 20 cards was imposed on their work. They were further limited by the memory available on the Macintoshes that were in the classroom. These restrictions helped to guide students during the design process. When they were given their 20 large index cards that served as their storyboards, they used them to provide a visual schema of what they wanted to include, how they wished to organize the stack, and how cards would be linked together. Obviously, a great deal of shuffling and modifying went on as they began to create their portfolio stack, but the results were gratifying not only for teacher and students. Through their involvement in the Multimedia Portfolio Project, the students' self-esteem grew, and they were thrilled with visible evidence of their knowledge, abilities and growth in using each of their different intelligences.

Conclusions

HyperStudio portfolios have met the teachers' need for manageable and portable portfolios. The project served many valuable purposes for students as they: 1) became more reflective and strategic in the use of the different intelligences to enhance their learning; 2) learned to be selective in choosing items to include; 3) used evaluative rubrics and criteria to justify the inclusion of the selected items; 4) developed their organizational and written communication skills; and 5) experienced the joy of sharing their accomplishments with their peers and families.

An important benefit to these students is that the portfolio structure designed by the teachers promotes the development of critical thinking, organizational and written and oral communication skills. Children also experience a real sense of ownership in their portfolios while learning to evaluate their strengths and weaknesses and to describe their products in terms of their growth and increased competence. Teachers and students alike have found multimedia software to be a valuable tool that allows students to keep a year long visual record of products demonstrating their knowledge and proficiency in various areas.

As schools move toward forms of authentic assessment across the curriculum and grade levels, multimedia portfolios provide an effective medium for students to identify specific ways in which they are demonstrating their learnings and growth through their activities and products. These products can then be placed in other formats such as computer files or videotapes and shared with parents and others as permanent, portable records that can accompany them throughout their school careers. Teachers found that portfolios foster student reflection and encourage better home-school communications when parents have tangible records of their children's accomplishments.

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The Potential and Problems of District-Funded Technology Inservice

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The United States has been involved in a massive effort to increase the use of computers into curriculum and instruc tion (Office of Technology Assessment, 1988). Several recent studies (Strudler, Quinn, McKinney, & Jones, 1995; Willis, Willis, Austin, & Colón, 1995) show that one of the problems with integrating technology into any curricula is the teacher in the classroom. There are a number of reasons for this: computer illiteracy, computer phobia, disinterest, lack of equipment, or other problems. Teacher inservice can help teachers overcome computer illiteracy and phobia, but may not always help teachers integrate computers into their curriculum. Inservice programs that include a full-time, site-based training program, focusing on the individual needs of the teachers have a better chance of achieving the desired outcome of technology and curriculum integration (Pappillion & Cellitti, 1996).

This study reports on a collaborative effort between a university teacher education program and a public junior high school in a program to integrate technology into the school curriculum. The university-public school partnership had defined inquiry and professional development as two of its primary functions, so they were jointly committed to helping teachers develop new curriculum that integrated technology into the curriculum (O'Neil, 1992; Broughy, 1992). Participants had discussed the importance of defining problems for students to solve as a part of the inquiry process. They also agreed that the problems needed to be authentic and real-world in nature. Learning had been discussed as an ongoing process of construction, generation, and creation of meaning enhanced by interaction with other learners in cooperative and interdependent efforts. The validity of learning should be constantly tested against and internal sense of reality and worth. Good teaching and leading is a creative process, demanding the constant injection of new information, new perspectives and new energy. Assessment should downplay paper and pencil, short answer as well as norm referenced tests that compare students to each other in favor of authentic performance, reflecting how knowledge is tested in adult work and civic settings. Portfolios of students' best work should be jointly created by students and teachers (Wiggins, 1992).

Research Design

The focus of this research project was a district funded inservice program aimed at developing curriculum that integrates technology into instruction that includes the problem solving process. An earlier project began in a school with only one teacher being mentored by a university professor. The professor spent time helping a classroom teacher learn to use computer programs that were available at the school. The teachers and students were introduced to a spreadsheet program as a tool in data collection and analysis problems. The students were then placed in groups of four and asked to design and complete a problem that would require the collection and analysis of data. The professor worked with both the students and the teacher to select the problem and analyze the data (Wentworth, 1996).

Because of this work, a grant was awarded to the school to inservice all teachers in the use of computer technology as a part of problem solving in the classroom. The professor, as part of a larger program of teacher education, was also involved in the supervision of student teachers in this particular school. The teacher education program was changing this same year to include university course work for the student teachers to be done at the school. The professor spent at least two full days a week in the school working with student teachers and with classroom teachers on the development of their integrated curriculum. Having the student teachers in some of the classrooms allowed teachers freedom to develop lesson ideas and help in the computer lab with other teachers who did not have student teachers in their classrooms. Along with the integration of technology in the classroom, the teachers were placed in teams to integrate across subject areas. As teachers produced lessons that integrated in this way they provided them to the district.

Both the teachers and students kept research logs of the projects from conception through final report. The researcher kept an account of the types of problems designed by the teachers, the discussion about the data required to answer the question, the use of technology to solve the problem, and the final analysis and representation of the data. Throughout the project, the researcher interviewed the teacher and students about their work asking questions to get at their problem solving and their views about the use of technology as part of the problem solving process: how did they select the data to collect, how did the technology aid in the analysis of the data, what conclusions were drawn from the results. The researcher also keep a journal of frustrations and successes experienced by the teachers and students.

Results

Initial problems arose with the district-funded project that had not occurred with the mentoring of only one teacher. The district office did not fund the project for software because a large company was going to donate it to all schools in the district. This was a different software package than the teacher had learned and used previously. However the university professor was familiar with it. Four months into the school year the software was still not available, and the school learned that it was not to be donated, but would need to be purchased. Software was not licensed on all machines initially so work could not begin as early as had been hoped. The new computer lab was not wired on schedule which also delayed the inservice. Some teachers were unwilling to participate in the project because it was not required by the district or principal. However, once the initial inservice took place most teachers were excited to begin designing curriculum that would include the technology they had seen.

In spite of the many problems beginning the project, several lesson plans were created and implemented by the teachers. The university professor and the school teacher had learned from their experience that defining the problem presented to the students was a key element to successful integration projects. Teachers were encouraged to think of a specific question to ask students. This helped focus the data collection, investigation, and analysis. The inservice was done with groups of teachers by departments that would naturally have similar content.

This was not a complete integration process. It was felt that more complete integration would come after teachers had become familiar with the software and exposure to inquiry learning. Two examples of a questions to ask students to begin the projects were:

1. You were very interested in the weight lifting at the Atlanta Olympics. You thought about the size and weight of the participants and the amount of weight they lifted. How would you determine which weight class lifted the highest weight as compared with their body size? Which person would you declare as the "strongest man on earth" based on this?
2. You are interested in how the Olympic games will effect the area of Salt Lake City in the year 2002. What areas of change do you expect to find? What data will you collect before the games? What data will you collect after the games? What predictions will you make based on the information you can collect about the Olympic games in Atlanta?

Question 1 integrates both mathematics and physical education. Question 2 integrates social studies and mathematics. Teachers collected data on these questions and then began to define questions for their students as examples. As the teachers implemented these in their classrooms, the students began to ask their own questions. The teachers were excited to see students engaging in inquiry in this way.

Conclusions

District funding made possible on-site inservice program for all interested teachers. Teachers worked on the same software and began together, so they supported each other across the learning curve. Teachers were able to consider integration of their content areas as they included technology in their curriculum. Having a university professor at the school helped the teachers initially try the technology. They worked together with the students to learn the software, and then to determine how it could enhance the curriculum. As the year progressed, the professor spent less time teaching how to use the technology and began to help teacher rethink instruction and content. New types of problems were considered because the technology could help students investigate and seek out answers. Having a teacher at the school who had been through the process was a great benefit as well. She was able to help other teachers when the professor was not at the school. She supported their ideas, and helped them prepare work that integrated content areas.

Both students and teachers enjoyed experimenting with the technology. They worked together to define questions that had significance for the content of the curriculum. The questions were complex and interesting, requiring many days to complete. Teachers and students worked several days defining the problem and deciding on the data required to answer the question defined by the problem. Teachers and students felt like co-investigators and learners. The teachers began to feel confident in their abilities to use the technology. The began to trust the students to learn specific content as they defined their own problems.

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Graduate Teacher Education via On-site School Partnership

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Niagara University, Lewiston, NY, and the Niagara Wheatfield School District, Sanborn, NY, are collaborating on a pilot project to introduce Niagara University graduate education students to a hands-on experience in a real world work environment while bringing authentic assessment and technology into the school district's Edward Town Middle School Inclusion program. Faculty specialists in authentic assessment from the School of Education at Niagara University are assisting five middle school teachers in building authentic assessment into their classroom curriculum. During the 1996-97 school year, a succession of five person teams of graduate students will work alongside the middle school faculty. A portion of the middle school student activities will be placed on electronic portfolios.

Problem and Issue

Much of the instructional scheme and curriculum used by the middle school faculty was designed for a pre-technology era and needs extensive rewriting to meet twenty-first century New York State Education Department standards. Niagara Wheatfield sought outside assistance from Niagara University to provide the expertise for curriculum renovation — specifically, the incorporation of authentic assessment. Niagara University graduate education students sought a real world work experience to develop their pedagogical skills.

Purpose of Project

The project provides a dual constructivist learning environment — for the graduate education students as well as for middle school students and their teachers. The project provides for the professional preparation of graduate education students by hands-on training at a technologically rich school site. The overall project goal is to seek dramatic improvements in instructional methods other than lecture, recitation, and seat work using the graduate students as a catalyst for change. The goal for the graduate students is their construction of knowledge about a new approach to accountability — authentic assessment, and the use of technology in the approach. Authentic assessment techniques will produce student portfolios (for the middle school students and the graduate students) which will be developed and stored using computer and CD-ROM technology.

Review of Literature

In their collaboration, Niagara Wheatfield and Niagara University have surveyed and continue to survey a wide range of expertise. Below are selections of the most representative works. Since Niagara Wheatfield and Niagara University are seeking innovation, the lesson learned by General Motors at the GM Hamtramck plant provides a sobering starting point. Simply, there is no magic bullet. General motors tried to use automation, a technology fix, to bypass other production and organizational problems (Murnane & Levy, 1996). The plan ended in disaster with production down and organizational problems unsolved. The lesson for the Niagara team — use the study to approach all the factors: the on-site location, the new technology, the philosophical approach, and the ongoing organizational environment.

The Niagara partners want the Niagara graduate education interns to control their own learning in a real world work environment. The philosophical approach to the project is Constructivism with Columbia University providing suggested models to make constructivist activities effective. Importantly, the Columbia authors sensitize the team to the fact that the graduate students will be handling complex ideas whose mastery will require a significant degree of practical experience (Reibel, 1996).

The Niagara team is looking for strong models of teacher training in a constructivist, technology rich environment, especially sites where a partnership supported an extensive ongoing investment. The answer may be ACOT, Apple Classroom of Tomorrow. In the mid 1980's, Apple Computer Corporation responded to a question of what happens to students and teachers when they have access to technology whenever they need it. Apple initiated a program of selected Apple partner school sites (the ACOT sites) and created ACOT teacher development centers. Apple assembled teams of university researchers, Apple personnel, and teachers to evaluate the program activities. Over the next ten years, the ACOT project produced evidence of the advantages of a constructivist learning environment and models of new teaching strategies (Apple Computer, 1995). Researchers looked for support for constructivism where technology was considered a knowledge building tool. They found that participants' progress evolved through developmental stages: Entry, Adoption, Adaptation, Appropriation, and Invention. At each stage, the dynamics of constuctivist learning called for different kinds and levels of emotional support, collaboration, technical assistance, and instructional sharing from colleagues (Sandholtz, Ringstaff, & Dwyer, 1991).

Finally, the Niagara team focuses on evaluation. If individuals are to be charged with the responsibility of their own learning, charge them with the responsibility for carefully collecting and selecting work they feel best represents their growth according to set standards. Constructivism leads to authentic assessment. Technology provides a perfect vehicle for capturing and storing the selections (Whitby, 1995). The literature suggests that constructivism can guide portfolio development. Teachers, graduate interns, and middle school students must explore the possibilities of portfolio construction while gaining an idea of what a portfolio may be. The work of Arter and Spandel provides a good grounding on the definition, design and purposes of a portfolio (Arter & Spandel 1992).

Design and Purpose of Study

This case study is a preliminary effort to record the activities of the participants. The next stage will be building hypotheses and conducting experimental research comparing the professional progress of graduate education students participating in the project with that of graduate education students not participating in the project. By professional progress it is meant the knowledge and hands-on skills of integrating authentic assessment and technology into a middle school Inclusion environment.

This study is designed to be a work in progress. It will provide an opportunity to observe activities, gather data and determine facts and variables. Since this study takes place in an environment subject to drastic change, we seek an opportunity to determine as many variables, independent and dependent, as possible. This study may turn out to be a troubleshooting guide.

Data Gathering

The case study will observe graduate students moving from theory to application and from old methods to new. Not all data gathering methods have been finalized. The following grid in Table 1, designed by Apple Corporation's ACOT teams (Apple Computer, 1995), will be adapted to guide data collection on observations and interviews of graduate students and the five middle school teachers, and classroom activities. It matches seven focal areas against how activities or behavior inside an area match traditional instruction modes (teacher centered — accenting learning of facts) or newer construction approaches (learner centered — stressing inquiry and learner invention). Since it is expected that the participants, including the graduate students, will vacillate between old and new approaches, it allows observers to catch such vacillations in time to provide support (Dwyer, Ringstaff, & Sandholtz, 1991).

Table 1.
Observation and Interview Evaluation Grid

Focal Area	Instruction	Construction
Classroom Activity		
Teacher Role		
Student Role		
Instructional Goals		
Concept of Knowledge		
Demonstration of Success		
Assessment		

By collecting data over an extended period of time, the study can utilize the Apple ACOT developmental stages to capture data on the evolution of beliefs about learning and teaching and the consequences of these changes on classroom practices as shown in Table 2. (Sandholtz, Ringstaff, & Dwyer, 1991).

Table 2.
Developmental Stages and Consequences

Phase	Behavior
Entry	Little inclination to change instruction mode
Adoption	Adopt technology to support traditional approaches
Adaptation	Venture beyond traditional approaches
Appropriation	New instructional patterns and questioning of old patterns
Invention	Pedagogy approached developed by teacher

Evaluation

The graduate students will be evaluated through the following criteria:

1. Third party observations of their progression through technology skill stages as outlined by the ACOT developmental stages: Entry, Adoption, Adaptation, Appropriation, and Invention.

2. Their own personal electronic portfolios reflecting (a) their best efforts in showing knowledge of models of teaching strategies and new ideas, and (b) their assistance in the production of student portfolios reflecting the middle school students' best efforts.

Conclusions

This case study will not lead to identifying a specific cause - effect or independent - dependent variable relationship. No conclusions about causes and effects will be made. It will permit gathering observations and facts that will help direct attention to independent and dependent variables for a future experimental study. This case study will provide background for decisions on improving facilities and equipment at the site, classroom setups, participant preparation, scheduling, data gathering schemes, communication among participants, and support of faculty.

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A Model of Staff Development Using Control Technology

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The author, a Lecturer in Education at the University of Exeter, was asked by a group of teachers in a local primary school to support work they were doing to better address technology issues. The purpose of the research was twofold: to develop a model to change practice in a school, and to enable the teachers involved to incorporate the use of Information Technology into their teaching by using a form of Control Technology. A secondary advantage from the project was the opportunity for the author to develop ideas in Design and Technology, which is his teaching commitment, and to work intensively with groups of children in school as a part of a program known as "Recent and Relevant," whereby tutors in the institutions involved in the initial training of teachers work in schools to keep up-to-date.

Definitions and Clarification

In Britain, the term *technology* is used in a number of different ways in the context of education. Information Technology (IT) is the use of electronic, microprocessor or computer based technology. Design Technology (D&T) refers to the process of designing, making and evaluating artifacts. Both of these subjects have foundation subject status and are statutory parts of the English National Curriculum (HMSO, 1995, *IT in the National Curriculum*). Control Technology (CT) refers to the use of a computer or microprocessor to control machines, models or events, (such as a simple robot) generally by means of the use of switches and sensors. Both D&T and IT have been previously identified as areas of weakness in British schools by the Office for Standards in Education. "The most disappointing feature at KS2, however, is the frequent lack of progress beyond KS1 levels of attainment... . Pupils are often not confident with control, which is often absent after KS1" (HMSO 1995, IT , A Review of Inspection Findings). "The D&T subject knowledge and experience of teachers needs to be more extended, especially for those teaching Years 5 and 6" (HMSO 1995, D&T, A Review of Inspection Findings).

CT Project

The primary school project was cross-curricular in nature and provided opportunities for children to work cooperatively while using math to solve problems and constructing circuits. The initial ideas for the project were based on a curriculum pack developed by Cornwall Local Education Authority (LEA). However, this included few opportunities for the use of IT. The school's initial proposal was that the children would construct lighthouses and the researcher would help them to interface their models to a computer, and program them to flash when it was dark. As four classes were involved, spanning an age-range of three years, it was proposed that the idea of lighthouses be broadened to also include road safety, with the idea that the Year 4 children work with programmable floor robots, the Year 5 children construct lighthouses, and the Year 6 children also work on road safety but construct their own traffic lights and motorised buggies rather than using a floor robot. To assist this project, the school was loaned a buffer box and software, an ideas pack on Control Technology (NCET, 1989), and a floor robot for the length of the project. This would enable the classes to fulfil the Controlling strand of the National Curriculum to "create, test, modify and store sequences of instructions to control events" (HMSO 1995, IT in the National Curriculum).

The traffic lights and lighthouses were interfaced to the computer (an Acorn BBC Master, similar to an Apple II) using a Buffer Box made by Deltronics. This buffer box would protect the computer from damage and also act as a 6 volt power supply. A piece of software called Contact was to be used, which permits the computer to access eight output ports and eight input ports. This was closely related to Logo in terms of language and structure; however, the school had not used Logo previously. Although all this technology was rather old and obsolescent in terms of design, the BBC computer was well equipped for control work, by virtue of having a number of built-in interfaces and readily available, simple software. This work also did not require large amounts of computer memory, fast processors or sophisticated windows based software. The floor robot to be used with the Year 4 class was called PIP (Programmable Interactive Plaything) from a firm called

Swallow Systems and functioned much like a floor turtle except that it had its own built-in computer which allowed it to be programmed with a subset of Logo. A rechargeable battery meant that it could be recharged overnight and it was sufficiently robust to function effectively in a classroom environment.

Procedures

The researcher received an outline of what the school wished to gain from the project, and how it was to be undertaken. He then negotiated with a team of four teachers who covered Years 4, 5, and 6. Using a form of assisted self-development, he agreed to give support to the teachers by participating with them in the planning process, and by providing them with a limited amount of classroom support (i.e., working with one group of children from each class). Resource materials for the children were also provided. The teachers were encouraged to observe the targeted small groups and participate as the children tried out the researcher's ideas for themselves. The teachers were then encouraged to extend these opportunities to the rest of the class.

The total time given to the school was approximately twenty hours. Data was collected by means of direct observation. In addition, copies of children's' work were collected. The researcher kept a notebook of observations as the project continued. The teachers involved were interviewed towards the end of the project to see if they perceived any change in practice.

Preliminary Findings

At the time of writing, the research has been completed in the school, but the data gathered has not yet been fully analysed. Observations suggest a high degree of motivation amongst both teachers and pupils. The floor robot has been a particular success, with the children in the class using it to extend their knowledge of angles and estimation of distances. They programmed the robot to move round the roads, waiting at Stop and Give Way signs. The children in two classes with the Year 5 and 6 pupils have undertaken more involved model making, constructing motorised vehicles with remote controls, and their teachers have found the time and energy to extend the introductory sessions so that bare chassis could be decorated to make cars. Traffic lights have been constructed and interfaced to the computer, with the children programming them to work in the correct sequence and to change when a switch is pressed. One class constructed lighthouses with two electric circuits so the lights flash and there is a sound signal (a buzzer) to warn of fog. One group got as far as interfacing their lighthouse to the computer, programmed it to flash, then added a light sensor so that the light flashed when it was dark and went out in the daylight. There was no sensor suitable for detecting fog, so an intermittent buzz was programmed and manual switch was used to activate the program.

The teachers indicated that they felt they had gained considerably from the project, and there had been noticeable learning gains among the children involved, particularly in the areas of problem solving, constructing circuits, craft skills (using tools etc.), and sequential thinking. Pragmatic constraints (staff illness, lack of time, and the need to rehearse for a Christmas production) limited the amount of follow up that was possible, and prevented the teachers from continuing the activities with all groups of the classes. This is now planned for next term. One teacher, working with the floor robot, has been able to continue the activity with the whole class, largely because this activity demanded less in terms of supervision, and now feels much more confident of its use with children. In the other classes, there is a determination to carry on with the work as soon as the timetable permits. There is a commitment to buy more Control Technology equipment and copies of Logo for each of the classroom computers. The staff now feels confident in the use of Control Technology, recognises its links to the whole curriculum, and are ready to take on the use of Control Technology as a school wide activity.

Ready availability of resources is one issue that has come out of the work. Without materials being readily available, it is difficult to manage D&T activities. Glue guns and glue sticks had to be found from classes, tools had to be acquired, wheels had to be found and the children had to bring in some materials from home. The author had to supply flashing light bulbs for the lighthouses, motors for the cars and 6 volt bulbs for the traffic lights. There was no budget in the school for IT for this year, so the school was working with a borrowed buffer box and software, hoping to buy their own equipment in the following year. Timing was not totally successful. Since it was Christmas term, there was timetable disruption in the last three weeks, greatly restricting time available for development by the class teachers. In order to prevent this in the future, a less ambitious plan, perhaps working with only two or three classes at a time might be better; however, the teachers felt that it was necessary for a critical mass to be involved in order for the initiatives to be developed.

One issue, noted by three of the teachers and the author, was one of a gender difference. It was noted that the girls seemed to have a different approach and attitude to the activities than the boys. They had less self confidence, seemed to listen to advice more carefully and were more persistent. In contrast, the boys seemed to have much more confidence and were better at managing the tools, but were less careful in following their designs and were more liable to produce ideas that would not work. The orthodox way of designing, making, evaluating, and improving seemed short-circuited. This is an area where more research is required. It might be that different teaching strategies could be employed to overcome these difficulties.

With regard to the model of assisted self development, this model was clearly successful. Its success depends on the motivation of the teachers concerned, and a feeling of a sense of ownership of the activity. IT is one area of the curriculum where teachers can be quickly alienated and de-skilled. "It is important for colleagues to be supported in using Information Technology to improve the quality of their teaching, rather than simply adding it on top of an already over crowded course" (Davis, 1992). Traditionally, British schools have had access to advisory teachers who would work in schools to develop aspects of the curriculum, usually employed by LEA's. However, the devolution of financial control to school has marginalised such roles, and many LEA's have reduced or closed down their advisory sections. As yet, private consultants have not filled that vacuum left by the removal of LEA advisory services.

Conclusion

This project demanded a large input of time from the author, although there was no cost involved to the school, except for teaching materials. Such a project can probably only take place successfully where there is an "animateur" who has time to give, in this case the time was made by the need to research. One must be aware of the problem of the "Hero-Innovator" who will "Assault the organisational fortress and institute changes in himself and others at a stroke" (Open University, 1985). In this case, the author was well known to the staff of the school and was participating at their invitation. The project became a successful partnership activity between the school and the university. It would not have been possible for the school to buy in a consultant for that period of time. However, the university lecturer at a school of education, with a contractual requirement to research and publish, is in an excellent position to undertake such activities. They give to the school in terms of their time and expertise; the school gives them the context for the research.

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Facts Versus Fads: A Teacher-Centered Program for Evaluating Classroom Technologies

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Seymour Papert made far-reaching predications for Logo when it was first introduced as a commercial product for school use around 1980. The claims for Logo's impact on cognitive development and learning effectiveness influenced school district buyers to invest in Logo as a central component of the elementary school technology toolbox. Over the years, the overall experience with Logo in the classroom has been mixed, and although Logo-related products still profess many advocates, Logo didn't live up to the proclamations of educational transformation made at its introduction.

Today, the developers of proliferating classroom technologies also declare expansive cognitive, social, and learning advantages for their wares. Because independent research almost never deals with the specifics of "which" of these new products to choose within a genre of expanding possibilities and provides few answers to the seemingly simple questions of when, where, why, and how to use the new technologies in the classroom, decision makers still rely mostly on the claims of the manufacturers or distributors when choosing to purchase one product over another. Not surprisingly, not all the products perform as promised. In this regard, the chronicle of the early Logo experience exposes the need for a more teacher-influenced approach to choosing technology products for use in the classroom.

Early Logo Research Exemplifies the Problem

The initial questions regarding the use of Logo focused on the impact of the technology on learning and cognitive processes: 1) How will the use of this technology affect the learning process? 2) How does the use of the technology affect cognitive processing in students who use it? 3) Does education with the new technology require different levels of cognitive processing from other educational experiences?

When Logo was introduced, Papert made very specific claims in answer to these questions that implied he knew the answers. Specifically, his assertions, derived from his relationship and studies with Piaget, were based on his constructivist view of learning and a few early Logo studies (most with older children) at MIT (Papert, Watt, diSessa, & Weir, 1979; Reinhold, 1986).

Logo was introduced to the larger educational community in 1980 with strong and specific theoretically-based pronouncements of its ability to enhance the independent construction of knowledge, improve higher-level thinking, and expand the generalizable skills of young children. The research on Logo to that point provided very little practical evidence to support the breadth of such claims. Even so, in Mindstorms, Papert (1980) eloquently described how Logo could develop a child's intellectual structures and how the computer could be used to expand the human mind. Teachers and administrators believed him.

Almost immediately after Logo was released to the schools, controversy ensued over the efficacy of Logo as a learning environment. Since that time, almost no specific computer-based product has received as much attention, research, and commentary as Logo.

Early Acceptance of Logo

Because of Papert's stature and the broad and growing acceptance of constructivist principles over the last fifteen years, the adoption of Logo far exceeded the research-derived foundation for its use. Soon after Logo's general release, concern evolved for the apparent absence of a well-defined empirical framework regarding the implications of Logo usage. Many researchers became concerned with the largely unsubstantiated claims concerning the benefits of Logo and computer programming on young children's cognition. This resulted in critical analysis of the design and the application of the technology to achieve specific classroom objectives. The few representative studies discussed below frame the issues of contention during the first few years of Logo's general implementation in classrooms.

Cognitive Development and Logo

Clements and Gullo (1984), for example, researched the benefits of Logo programming compared to drill and practice forms of computer-aid instruction (CAI). Their study of eighteen 6 year-old children randomly divided into a Logo and a CAI group were assessed using a pretest/posttest research design over a 12 week period. Posttesting revealed that the programming group scored significantly higher on a measure of reflectivity and on two measures of divergent thinking, whereas the CAI group showed no significant pre- to posttest differences. The programming group outperformed the CIA group on measures of metacognitive ability and ability to describe directions, but no differences were found on measures of cognitive development.

The study extended the work of others in demonstrating that programming with Logo could increase some aspects of problem-solving ability and perhaps affect cognitive style, but the early Logo research offered little evidence to support claims of general cognitive development.

Contact Time and Logo

The question of contact time with Logo also held early research interest. How much time was really required to master Logo and benefit from its use? Gourman and Bourne (1983) reported that third-grade children who used Logo for one hour a week performed significantly better on a test of rule learning than did children with half the programming experience per week. Today, the question of optimum contact requirements remains salient and unresolved in the employment of Logo and other technology innovations.

Student Preferences

Other research revolved around the variable impact of Logo on children from different backgrounds and with differing learning preferences. Papert (1980) assumed that all children would function well in Logo environments. However, research by Vaidya (1985), revealed three distinct categories of Logo learners: 1) those who are sophisticated Logo learners; 2) those who function well in Logo environments with support and direction from the Logo teachers; and 3) those who do not function well in the Logo environment.

The research conclusions were based on a very small sample (n=14) studied over a period of eight months, but at face value this type of analysis seems necessary to answer the question of different learning preferences and cognitive implications and the role of teacher intervention regarding Logo.

The Role of Teachers and Adult Mediators

The role of teacher or adult mediator also was questioned by Logo researchers. A number of studies concluded that mastery of programming concepts is not a guaranteed outcome of prolonged exposure to Logo and required carefully designed teacher intervention (Carmichael, Burnett, Higginson, Moore, & Pollard, 1986). Other studies found that young children without "appropriate" adult mediation may not discover the "powerful ideas" that Papert associated with using Logo (i.e., Kull, 1985; Clements, 1985).

Implications of the Early Logo Research

In total, the body of early Logo research was extensive, but not conclusive in any area. The research offered conflicting formal results in response to almost every salient question about the use of Logo in the classroom. The research efforts also lacked the consistent operational definitions, populations, and/or longitudinal design to definitively answer substantive questions about the impact of the Logo experience. Many arguments surrounding the disparate experiences with Logo focused on the method of research as opposed to teachers and children in classrooms. The conflicting research claims mirrored the informal case studies (admittedly legitimate qualitative research) and teacher reports of failures and successes with Logo. It seems that for every strong advocate there was an equally vocal skeptic.

Logo was abandoned by some teachers in favor of new or more traditional experiences, In other classrooms, Logo continued to be enthusiastically employed. Even today, the question of Logo's impact on learning remains controversial. As many results could be used to refute as to substantiate the claims made for the importance of the program in supporting specific educational benefits.

How Does This Relate to Today's Technologies?

In spite of the ongoing controversy, the results of using Logo technology are perfectly clear, if you know how to read the research. It doesn't matter if you live in the qualititative camp, the controlled camp, or somewhere in between. It all comes down to these facts: Logo did not revolutionize elementary education, but it did get computers in front of kids. Trained teachers and access to computers are prerequisite to employing any technology with success. With the training and access issues put aside, teachers who continue to employ Logo with positive results can tell you why they use Logo. They like the tool, the kids like to use the tool, and they believe the tool offers advantages over other activities they could be doing in the classroom. Teachers who dislike using Logo can tell you why as well: They prefer doing other things or using other products that help the kids learn similar computer skills.

Today, Logo is just one of many tools to use to program, explore alternatives, and debug operations. Some people prefer to teach these skills with Logo-related tools; some with Visual Basic; some with Hyperstudio or Digital Chisel; some with felt boards, crayons, blocks, and paper.

The Real Justification for Using Technology in the Classroom

The real reasons to use (or not use) Logo in the classroom may have had nothing to do with the original questions researchers asked about the technology. Yes, the research questions regarding efficacy may be important to guide in the design of appropriate technology-enhanced educational experiences—but teachers face a more immediate, practical dilemma.

Teachers want to know what kids think and what other teachers have done with the technology. Teachers, just as they did in 1980 when confronted with Logo, continue to ask very basic questions: Will the use of the technology enhance the learning experience from the students' point of view? Will my students prefer using the technology as opposed to another tool to learn the same concepts? How can I choose the best technology among seemingly similar products? What does the research have to say that can help me in choosing and implementing the technology effectively? Is using this tool the best use of my time and the district's resources?

Research has not traditionally addressed these types of questions. Instead, for 25 years, researchers have focused on questions of the efficacy of computer-based treatments compared to non-computer ones. The research results regarding the efficacy of technology usage are so ambiguous and politically driven, as they were in the early days of Logo, as to confuse rather than support educators in their search for the best technology investments. Even so, the research has been consistent. The research almost never shows the computer and related media as detrimental to results gathered through traditional learning measures (i.e., achievement tests). Instead, computer technology is measured as neutral or perhaps a bit more positive in its impact on traditional assessments of learning (Roblyer, 1996). After realizing that the scores can't definitively justify the use of technology in the classroom, then what?

Kaestle (1993) identified the root of the issue: "...the most common complaint leveled against [researchers] is the lack of connection between their research and teachers' practice" (p.23). Those who control the budgets want justification for their decisions. Teachers want techniques and methods that work once the technology arrives. Given these priorities, the questions of efficacy and improvement in learning are not always relevant when making product selections.

Is It Relevant?

Perhaps the most important justification for using a technology in the classroom is the relevance of technology. Technology is a major component of the real future where today's children will live. To prosper in that future, today's children must use and be proficient in using all types of technology. They must be able to move quickly from one form of technology to another, receptive to new and ever expanding capabilities. Even if computers and other technologies don't teach better—when selected and employed by trained teachers (and trained is the operative word in this context) the technologies can support an adaptive learning environment that is relevant to the world that children will live in for the rest of their lives.

In a relevant world, the right questions to ask regarding technology products in the classroom would include these questions first, and the questions of efficacy later: 1. Do we use the relevant technologies in the classroom that parallel the technologies being used in business, commerce, and academic research? 2. Are the technologies being integrated into the classroom experience in natural ways that encourage students to choose among tools that make the experience personal and relevant? 3. Do our students have the same access and opportunities to use the range of technologies available to other students in other schools? 4. Are we using the technologies we already have to maximum advantage? 5. Do our teachers embrace computer and information technologies and understand the priorities in making students technologically literate so they can prosper in the 21st century?

Since students will need to use technology in order to prosper in their adult lives, the employment of technology in the schools is necessary for reasons of social equity, societal relevance, and global competitiveness. In this context, trained teachers should not only use technology, but be able to filter out the self-serving claims from valid educational results and use their own experience with technologies to assess the best products for their classrooms.

Empowering Teachers to Choose for Themselves

The practical, relevant decision to use a specific technology product must be based on the experience of using a particular product in the classroom with specific teachers in specific, describable social contexts. For teachers to be empowered to make such informed choices about the technologies they use and the ways they will use them, five things must happen:

1. Teachers must embrace computers as one of the standard tools of their trade. People can't make informed decisions about technology if they don't use it. Teachers must employ computers in their own work and embrace them—just as computers are being employed in every other discipline in the modern world. This means that the educators who train teachers in colleges and universities must also model and demand the use of technology in courses at all levels. An often optional one-unit course in computer literacy can no longer suffice as adequate training for teachers who must prepare children for a future filled with technology.
2. Every teacher and student in America must have on-demand access to a standard desktop computer for research, writing, computing, Internet access, and

printing. The access to computers should be frequent, easy, and noncompetitive. Technology (as embodied in microcomputers for personal use) can no longer be considered an option in the classroom any more than desktop computers are an option in modern business. Imagine the CEO of a major corporation who restricts computer usage to a lab on alternate Tuesdays. Now, imagine nine high school students sharing a single three-year-old microcomputer once a week or 30 third graders trying to get on the Internet from one computer in the classroom. That's where our students are today (Baker, 1996). That's what needs to change.

Students without on-demand access may quickly become deprived of skill and motivation to use technologies. Access to online technologies, for example, was shown to influence college students' willingness to try online communication and their understanding of the increasing importance of online technologies in the workplace (Baker, 1996). Such contact-influenced attitudes could affect students' career choices as well as their practical skills.

To provide the requisite universal access to computers, the funding mechanisms for placing technology in schools needs to be reassessed. New acquisition programs, involving collaborative arrangements with vendors, leasing programs, and community contributions are needed. Capitalizing the purchase of computers over five or more years leads to obsolete technology and wasted budget dollars.

3. Research reports on new technologies must be independent and timely. The report-to-journal process is too slow for making product decisions. Research results must also appear in easy-to-digest formats that suggest practical implications to teachers who must design lesson plans and establish objectives for their daily activities. Most teachers don't read the referred journals in education and don't have time to interpret how complex studies may relate to practice. Perhaps one of the major educational technology associations should act as a clearinghouse for the dissemination and practical interpretation of (pre-published) research results. The World Wide Web and teacher-focused conferences would be logical venues for disseminating the compilations.

   In this vein, the fledgling movement to publish the action-oriented observations (whether qualitative or quantitative) of trained teacher-researchers should be encouraged and funded. Teachers should be rewarded to talk about what they like and dislike about specific products and practices. Teachers need to share their experiences as legitimate research with the rest of the educational community.

4. Technology-savvy teachers must be involved in the decisions to buy and use technology—and in the design of new technologies as well. Product developers must provide more teachers with advance copies of technologies to try before those who hold the purse strings choose and dictate the technologies available to a specific school. When teachers aren't involved and committed to a new technology product, even if the technology may have good applications, the products often end up on dusty storage shelves next to the mimeograph machine and the Apple IIs.
5. The experience of teachers and students should count as much in the reputation of a technology as the research claims of the developers. When felt boards were introduced to display stories and messages, no one questioned the justification of the tool. Teachers knew the felt boards helped the students remain engaged. The colors and shapes appealed to the children. How did the teachers know this? They observed their students moving the shapes and telling stories with passion—not always with more passion than they would have told the stories without the felt board, but in general the teachers "saw" the tool as useful, fun, and adaptive.

Teachers who found felt boards useful believed in them and had ideas for using them. The individual training, preferences, and experiences of teachers had a lot to do with making the felt boards useful. Teachers also shared their ideas about using felt boards in the lunch room and in meetings. No elementary school teacher with a felt board was without a box of forms, shapes, and project ideas.

Computers, the Internet and the World Wide Web are a lot like felt boards in many ways—in the right hands the opportunities are limitless. In the hands of those with lesser imagination or inadequate training, they are only shapes on a desk or pictures on a screen. The trained hands, imagination, and shared experiences of the teachers make a difference.

Moving Toward Informed, Teacher-Centered Decisions

With the five requirements of teacher skill, computer access, readily available research, teacher-centered decisions, and experientially-motivated practice in place, technology-enhanced educational practice will be able to move away from faddish expenditures based on largely overstated claims to fact-based choices made by informed educators with specific classroom requirements.

Recent introductions of interactive, multimedia programs and other technologies, exhibit patterns of employment by classroom teachers (or school districts) similar to the adoption of Logo in the early 1980s: The conjecture of theorists overshadows research-justified claims, widespread implementation precedes understanding of the impact of the technology, and opinion overshadows demonstrable results about the long-term benefits (or drawbacks) for the classroom, children, and/or teachers. But in practice, none of the general claims for the media really matter. The things that matter are the employment of relevant technology in real-world applications and the use of programs and tools that motivate kids to employ those technologies, as they'll be required to in the "real" world. In these terms, using Logo mattered, so it was worth employing even if it didn't deliver on its other claims.

Teachers must be empowered to draw their own conclusions regarding the best of the products to use in their classrooms. Yet, in no way should this conclusion suggest a moratorium on research regarding media, technology and learning by those in other educational and research roles. Controlled research and independent observations are still imperative to understanding the relationships between the capabilities of a technology and possibilities in practice. The questions of efficacy are legitimate—they just aren't practical when specific products are at question. If someone proves that a media definitively increases learning potential and efficacy in all settings—that's a different discussion. Whether you favor Clark's (1994) claim that media will never influence learning or Kozma's (1994) view that it does, the underlying justification for using technology in the classroom would remain the same: Students need access and experience with relevant technologies because technologies are instrumental to their success in the future.

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Software Quality Assurance: Planning for Teachers and Classrooms

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Software Quality Assurance (SQA) looks beyond the basic functionality of pieces of software to consider the myriad details that affect software's efficacy in classroom and teaching practice. Traditional factors such as cost, ease of use, and functional accuracy expand quickly to include a variety of technological and pedagogical factors. The most functional, least expensive software isn't always the best choice. The best choice is the software that can be integrated into the teaching environment to meet the goals for which it was originally desired (Richie, 1994). The role of SQA is to assure that processes are in place to do this. Software quality is a complex discipline. It entails multiple interdependent activities with the goal of improving and assuring the efficacy of software use.

SQA is a professional discipline that concentrates on the processes necessary to design, build, install, and use quality software for effectively meeting the requirements of the purchasers and users of that software. SQA is concerned with the *process* of acquiring and evaluating software.

Software Quality Control (SQC) is an applied discipline that involves comparing software products and services against predetermined standards in order to determine the likely effectiveness of the software based upon its compliance to a group of measurable factors that have been embedded in those standards. SQC is concerned with the *product* acquired through the *assured* process.

Quality Management Infrastructure

In evaluating software, SQC works to assure that software meets organizational standards. Compliance to standards only assures software efficacy if those standards are the right ones. SQA works continuously to assure that the standards to which software is held are the correct and most effective standards. This requires an understanding of a quality management infrastructure involving mission, policy, standard, and procedure that, when properly implemented, allows for reliable and effective quality control.

Software Mission Statement

The quality levels associated with individual pieces of software are largely a function of how well the software delivers against the mission established for that software. Establishing a mission statement for software requires asking why one would use software in education. Such planning is easiest in the context of a school or district that is already working to define its organizational mission. Those districts conducting such broad strategic planning will find it easier and more comfortable to discuss the narrower perspective of educational software.

Mission statement creation for educational software should be conducted in layers. Just as the mission statement for a school will be a superset of any particular mission adopted by a program or academic department, each school or district should create a single overriding mission statement for educational software across the entire organization. The cross-organizational scope of such a mission statement will require it to remain broad.

Each software activity within the school can then begin by adopting a specific mission statement for each area of software. Differences in mission will appear for different pieces of software, but each must remain consistent with the overriding software mission statement already adopted. Examples of such broad mission statements for education software might include:

1. We use educational software to augment and extend the capabilities of each teacher.
2. We use educational software to increase the efficiency of each classroom.
3. We use educational software to extend the content resources available to each student.
4. We use educational software to personalize each student's learning environment.

Many would choose to adopt an *all-of-these* attitude for the role of educational software in a school or classroom. Such a generalizing approach only delays the qualifications and prioritization that must then be developed specifically each time a particular software purchase is considered or debated. A final mission statement should not only be a hybrid of the above examples, but it should also accurately reflect the relative priorities that stakeholders assign to each distinct perspective. Only then can such a mission statement be used to effectively guide policy.

Software Policy Statements

In the educational setting, SQA works to identify the quality factors necessary to assure the effectiveness of software in the school and classroom. Policy statements are then created that embody the organization's values related to each quality factor (Lebow, 1995). The factors considered must move beyond simple technical concerns over software utility, although a prerequisite to the success of any software is that it be able to operate in its intended environment (Hezel, 1990). Or having established and agreed to a set of software mission statements, stakeholders turn toward identifying the traits or factors that quality software should exhibit if it is to be expected to fulfill its mission (Lathrop & Goodson, 1983). As with the mission statement this discussion happens at multiple levels of detail; general traits that educational software is expected to exhibit, and specific traits that should be exhibited by software in particular classroom situations (Raizen, Sellwood, Todd, & Vickers, 1995).

An effective SQA process will identify and prioritize those factors that are considered essential to the success of software in particular school or classroom settings (Sewell, 1990). Teachers in classroom settings will practice SQC using only the core prioritized factors as criteria. Adding such factors to teachers' classroom toolkits enhances their confidence in discussing and participating in complex software discussions which affect their classrooms.

Once planners have decided which factors to include in the software quality discussion, policy statements are written for each one. Policy statements define the organization's values with respect to quality factors without getting into the specifics of their implementation or assessment. By writing a policy statement for each quality factor, stakeholders can be sure that a common meaning is associated with each factor by everyone, thus eliminating problems later when differences in expectations surface around the semantics of the definitions and meanings associated with the mission and policy.

Some example policy statements for software factors might include:

1. Students should never be able to access, update, or destroy information or data of other students with whom they are not engaged in collaborative projects or activities.
2. Software should be able to run on the broadest possible range of hardware and communications capabilities available at the school, including those likely to be adopted in the near future.
3. Software interfaces should tailor the timing and content of any presentation of material, based either on student self-identification of themselves as being at certain achievement levels, or on software assessment of the level of a student's interaction against predefined achievement levels.

Software Standards & Guidelines

Standards and guidelines are written in order to clarify how policy directives will be met in the actual classroom.

Examples of standards and guidelines might include:

1. Students will save files only to diskette or to their own personal network directory.
2. Students will not copy software files to external devices such as diskette or magnetic tape.
3. Software documentation must include references to non-software support resources.
4. Software vendors must clearly communicate age and developmental levels of expected users.
5. User passwords are a preferred way of assuring students identify themselves correctly to the software that they use.
6. All software should be compatible with Microsoft Windows 95 or Windows NT.
7. Software that can be installed as a network version should be so installed.

Software Procedures

Few software packages will meet all desired standards or possess all desired traits. It is not possible for stand alone software to meet all classroom needs. Such expectations are only met by how we choose to use that software day-to-day (Niederhauser & Stoddart, 1994).

Procedures are statements of how shortcomings in software can be mitigated by the ways we train, operate, and manage the software in each classroom. By describing how to use the software, we define the broader *system* that includes the software, the user of the software, and the infrastructure that is in place to support the software and user. It is this broader *system* against which quality compliance is measured by quality control.

Procedures explain how standards compliance is to be assured in any context where the software itself doesn't guarantee compliance through its implementation. Few standards can be effectively enforced without some procedural support.

Examples of procedures that enhance software capabilities might include:

1. Awareness training on security and authorization needs of the school.
2. Independently developed documentation when vendor documentation isn't adequate.
3. Reflective journals by all students after using educational software.

Software Quality Factors

The development of effective standards and procedures helps assure that a sound process is in place for obtaining software compliance to the direction of the organization. Policy statements describe that direction and cumulatively support the organization achieving its mission for educational software (Winn, 1988). Since many teachers and schools struggle in knowing where to start as they set educational software policy, the following list of twenty technical and pedagogical factors might prove helpful.

Technical Factors

Technological factors to be considered are those that determine whether or not a piece of software can be practically used in the classroom at all. These include reliability, ease of operation, controllability, flexibility, portability, and any other considerations that might actually prevent the software from being successfully implemented. Each teacher, school, or district will need to identify the significant few that are important to them (Pelton, 1993).

1. Correctness. Extent to which software and its use satisfy stated requirements. All requirements must be shown to be clear, complete, unambiguous, measurable, and testable. All design features must be shown to conform to the requirements. A high level of correctness assures that all functions do what they're supposed to do.

2. Access Control and Authorization. Extent to which the use of software processing requires permission in order to be carried out. All relevant authorization rules must be defined as requirements and the design of the software must include a method for implementing those rules. Reconstruction requirements must be defined and an audit trail designed to meet those requirements must be designed and implemented.

3. Integrity and Reliability. Extent to which software activity must be accurate. File integrity requirements must be defined and mapped to the controls that are designed. Integrity assures that all system functions are secure from unauthorized access. Assures that a high degree of confidence can be assigned to all functions when they are used or needed.

4. Continuity of Processing. Extent to which processing must be able to continue. The impact of any possible failures must be defined during requirements and appropriate contingency plans developed during analysis and design.

5. Service Levels. Extent to which service schedules can be met by the software. Regardless of its ease of use, the software must support appropriate service levels. Software that takes a long time to set up for each student is too limiting in the classroom.

6. Ease of Operation and Use. Effort required to learn, operate, and use the software. With the variety of software available today, one need not settle for software that isn't easy for students to use and operate.

7. Portability. Extent to which software can operate in multiple environments. It is important to consider the long-term when discussing the flexibility and portability of software. The extent to which the software can operate on various new or emerging hardware platforms in a classroom is important. With technology changing as fast as it is, one must guard against software that becomes obsolete quickly because it doesn't port, or transfer, across revising platforms.

8. Performance Efficiency. Assures that all functions make the best use of available resources and the system is able to perform within its specified limits. High system efficiency implies both high software efficiency and high software usability. Software usability directly affects operator effectiveness and efficiency; and the system operator is a key factor in the measure of overall system efficiency.

9. Flexibility. Assures that all functions can be changed when needed. High system flexibility implies modular system components and generality of component functions. The need for flexible software also emphasizes verification of changes. Flexibility also requires high integrity in instances where modification of functions or data could possibly compromise security.

10. Expandability. Assures that the capability and performance of all functions can be expanded or upgraded. High system expandability implies generality and modularity of components and functions, and implies spare system capacity. The emphasis is on high system flexibility to incorporate enhancements and new functions, and high verifiability to test changes. For limited-capacity environments, efficiency would also be emphasized.

Pedagogical Factors

Pedagogical factors are those that determine whether or not the software will achieve its educational purpose once implemented. These include alignment with learning theories, cognitive schema and mental models, motivation, theories of instruction, and any other educational concerns that might affect the usefulness of the software in the teaching process (Collins, 1993). Again, each teacher, school, or district must determine the core significant set of factors that are important to assuring the success of software in their own circumstances (Tennyson, 1993; Townsend & Townsend, 1993).

1. Meaningful Learning. The information offered or required by the software should be potentially meaningful to students. It should offer students meaningful activities involving information and not just rote activities designed to maximize the capabilities of the software. Students should be required to make inferences while using the software, potentially creating groups of concepts, or differentiating discreteness within a range of information.

2. Personalization of Instruction. The software should offer some level of personalization in the way it interacts with each student. The software should be tailored such that students can pace themselves through the software, not just in speed, but in depth and breadth of materials available. The software should offer students constant and immediate feedback on their performance.

3. Behavioral Aspects. The software should go beyond facts and figures and specify behaviors and actions that are expected of students. The criteria for successful completion should be displayed by the software, and students should be offered a wide range of opportunities to model appropriate behavior.

4. Long-term Memory Emphasis. The instruction offered by the software should present or encourage multiple representations of the materials to be learned. Students should be offered a maximum of retrieval opportunities and heuristics, and they should be challenged to use or develop strategies for using these retrieval paths. The software should help to minimize counteracting distractions through an immediate and involved user interface.

5. Organization of Instruction. The software should offer information in such a way as to emphasize distinctive features of areas of study, and should provide opportunities for students to compare and contrast various materials and presentations. Heavy emphasis should be placed on representational elaboration and alternative representations, both initiated by the student and initiated by the software.

6. Metacognition. The software should promote each student's awareness of thinking and the self-regulatory behavior that accompanies such awareness. Software presentation should include memory strategy cues that are age appropriate to the student user. A balance of general and domain-specific presentation strategies should be used as part of any feedback to students. Users should be encouraged to use active skills and strategies in their interaction with the software.

7. Availability of Organizers. Presentation of information by the software should facilitate linkages to student current knowledge and prior experience by highlighting related or analogous information. Possible anchoring ideas for students should be triggered by continuous discrimination of new and repeated information in the domain context that can then be noted by student users. Software should work to stabilize and clarify anchoring ideas in order to facilitate their use in later sessions, particularly for software that is used periodically for short periods of time.

8. Support of Schemas. Information presented by software should support student knowledge by stimulating schemas they may already hold by either triggering existing schemas in order to create expectations of content that might be forthcoming, or by promoting alternate schema development by presenting information contrary to student expectations. Information should be presented in a form, and at a pace, such that schema discordance does not preclude a successful use of the software.

9. Diversity of Knowledge. Software should present information in ways that are age appropriate. Preferably, software interfaces should be available that help model physical or empirical knowledge using perceptual qualities of information being presented while also offering generalized information to encourage students to develop more intuitive logical-mathematical knowledge. Feedback within the software interface should emphasize one or the other of these presentation approaches based upon actual results achieved by the student user.

10. Stages of Development. Software presentation of information to student users should be capable of adjusting to the developmental stages of the students expected to use the software. Particularly important for software intended to be used across multiple grades, information presented should be tailored to the expected cognitive strengths of student users, while allowing further development through continued interaction with the software.

Conclusion

Quality is neither assured by having a mission statement for educational software, nor by having a list of policies in place. Rather, a thoughtful *process* of defining a mission statement and set of policy statements increases organizational confidence in both the mission and the policies. Likewise, clear standards that help define what is meant by the policy statements, as well as supporting procedures to assure that compliance to the standards is reasonable, help to assure that the day-to-day educational software activities in the classroom will support the mission for which that software is intended.

Many teachers will find themselves applying this SQA model in reverse. Rather than attempting to identify and purchase a quality piece of education software, they will find themselves confronted by an existing piece of software that they've been given or have inherited. Their desire will be to make the best of what they have got. In those circumstances, this SQA model can be used to diagnose the discomfort. Teachers should think through an abbreviated version of this planning process in order to determine if their problems with the software are incorrect procedures, inappropriate standards, misaligned policy, or the wrong mission. Problems with standards and procedures are easier to fix. If the software supports the wrong mission, it might best be abandoned.

SQA works to make quality compliance more likely. Nothing can guarantee that educational software in use will meet the needs of all. But effective quality planning, at the classroom level, in the school, and across the district, helps assure that a best effort is put into making educational software effective whenever and whenever it is used.

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Patterns of Leadership in Virtual Professional Communities

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Since the 1970s Computer Mediated Communication (CMC) have been used sporadically in education (Harasim, 1989; Rice 1992). Concepts like remote learning, copyrights control, lurking, MUDing (Multi User Dungeon), and other CMC terminology have appeared in the literature. While Rice (1992) says that "there is little theoretical or empirical research in this area" he, with others, published a few hundred papers about CMC. Such pre-1995 research dealt mostly with text-based systems that were used by computer users. The "text-ness" and the "computer-ness" of CMC have changed dramatically with the emergence of the Internet. As of 1996, even novice users can use CMC with relatively easy-to-use Graphical User Interfaces (GUIs). Three factors have led to the demise of "text-ness" and "computer-ness" of CMC.

Factor 1 - The deployment of the Point to Point Protocol (PPP) (PPP FAQ, 1996) which enable personal computers, often at the homes of users, to be linked as equal members to the net. This equality means that my home PC is equal to an IBM main frame when it comes to the Internet. Sure, the IBM may deal with more mail, and serves more files, but my own "little" computer can send and receive mail, send and receive files (e.g., FTP), and even be accessed from anywhere (e.g., Telnet).

Factor 2 - The development of the World Wide Web (WWW) which allows the publication of multimedia content. With any commonly available text editor one could write documents that would look almost the same by various browsers all over the world. With a little more effort one could add pictures, create links, and even deal with sounds and loading of files. The web became an easy way to publish content and a universal way to read content (with the dissemination of free or almost free browsers).

Factor 3 - A new improved cost/speed ratio of modems. In early 1996 the cost of 14.4 modems dropped below the $100 line. Currently (December, 1996) the cost of 28.8 baud modems became so marginal that many PC makers are embedding the modem board as part of the basic computer.

The combination of these three factors created the initial boom of the Internet, a boom that has changed the field of CMC. Let me therefore humbly argue that the value of pre-1995 research mostly stemmed from suggesting concepts and issues. Yet now we must take a fresh look at the relations between these concepts and the real world. CMC terms like, remote learning, copyrights control, lurking takes a different meaning when 75 million Internet users are involved.

The Lamda Community Project

The new networking technologies or the "Internet" as they are globally known, create a unique opportunity for building virtual professional communities. The uniqueness of the Internet stems from its social component. It is the first time we have a global many-to-many technology that facilitates media of all sorts (not just audio as in the telephone).

The Lamda community project was created to "use the Internet to support science and technology education" as part of the Israeli national program to "advance science and technology education in Israel. ("Tomorrow 98" or in its Hebrew name "MAHAR 98"). The funding was channeled through the Science and Technology Education Center which is located in the Tel Aviv University School of Education.

The research questions of the project revolve around the nature of professional virtual communities. More specifically we are looking at user-network interaction, site design, authoring of content on the net, the building of subcommunities, and project based learning. The issue of leadership, as this paper will show, emerged as one of the critical issues during the last year of operation.

During the first year, 1994, we conducted a general overview of network technologies, and their potential educational use both in Israel and in the world. This initial examination revealed what we then called "a messy situation." It appeared that beyond the usual challenges of "large scale changes in K-12 education" (Sivan, 1995) educational research and practice lacked a clear understanding regarding the role of CMC in such a change.

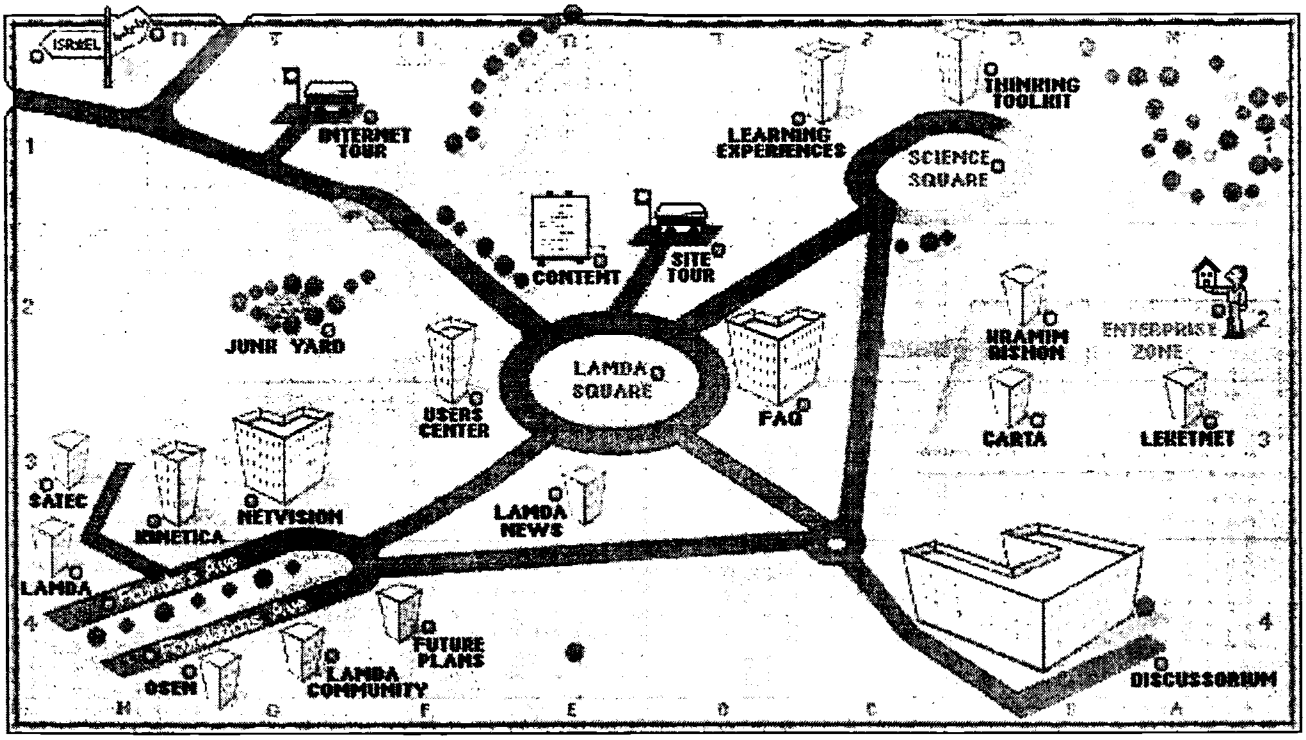

Figure 1. The Lamda Community Site. (www.lamda.org.il)

In the second year, 1995, the first 50 members of the community joined-in and the first web site was created. The initial design of initiating members and site building was constructed (See Figure 1.).

Once we developed the basic graphical language of houses, roads, tours, etc. we had to develop few iconic means to represent various aspects of the community. The city metaphor gives us a wealth of such means (i.e., special zones, the Junk Yard). Table 1. includes the main centers in the site. (For a complete description of the various centers see Lamda English Site Tour, 1995).

Table 1.
Main centers in the Lamda community site.

N.*, L+	Area or Center Name	Description
1, H1	Israel-WWW Road Sign	Leading to National & International Sites.
2, G1	Internet Tour	An explanatory description of the Internet.
3, E2	Content	A list of all informational pages & services in the site.
4, D2	Site Tour	A general description of all main centers in Lamda community Site. Accessible to non-members.
5, C1	Science Square	In this area, dedicated centers for Science-Education activities will be built. The brown area represents areas under construction.
6, C1	Learning Experiences	A collection of scientific learning experiences.
7, D1	Thinking Toolkit	A collection of pedagogic tools for teachers, to be used in class or at home.
8, B4	Discussorium	A center for holding discussion forums on a variety of subjects. Similar in concept to the Internet News.
9, D3	FAQ (Frequently Asked Questions)	Contains answers for users' questions.
10, A2	Enterprise Zone	A center containing member originated activities (successful activities will move out to somewhere in the site. Failed activities will find their way to the Junk Yard G2).
11, E3	Lamda News	A center containing news about the Lamda site, the Internet etc. Updated weekly.
12, F3	Users Center	A center containing a directory and home pages of all community members.
13, H4 G3	Founders and Foundation	An informational area containing description of the main founders and foundations of the community.

*Note: *N = Number; +L = Location can be found using the grid in the map (Figure 1.)*

449

1996 became the year of initial deployment. On the one hand steady growth in membership and on the other hand a steady build-up of the Lamda community Site. Today (December 1996) we have about 200 members and 9000 pages in our site. Among other things the Lamda site includes a dual-mail-web discussion center; a weekly news; an automatic front page; an automatic translation of MS-word files to web mini-sites (for project based learning); general feedback mechanism; and, of course, various content centers in the area of science and technology education.

Lamda Community as a Test Case for Virtual Professional Communities

The Lamda community was designed as a "self-evolving system." As such system, we try to foster an iterative interactive process among three factors: the members, the material on the Lamda community site, and the technological systems supporting the community.

This iterative interactive process is similar to the process of establishing a new city whereby there is interaction among the residents of the city, the physical structure (streets, zones etc.) and the various systems in charge of constructing the city (road contractors etc.) Unlike cities, which basically have a regular structure, there is no standard or known structure for virtual communities.

Our initial research on virtual communities (which was based mostly on typical Internet communities) identified four major dimensions of the relations between the community and its members (see Tables 2 and 3). In all four we have decided to veer from the typical Internet mode and to select a somewhat different approach (to be later called a "market-driven" approach.

The origin of our market driven approach can be traced to the classical dimensions of a community (Hazan, 1988; Shapira & Shavit 1995.). (See Table 4.)

Table 2.
What the Community demands from members

Dimensions:	What typical Internet communities demand from members:	What the Lamda community demands from members:
Who can join?	Members can freely join in. The "freeness" of the net means free access to information (i.e., web sites) and free participation (mailing lists and news groups).	The community is closed to nonmembers. To become a member one needs to submit a resume and be interviewed over the phone.
Does it cost money?	Free not only in terms of access but also in terms of costs. Most services on the net (till 1995) were free of charge.	Members are asked to sign a payment statement using a credit card or a direct bank withdrawal. While we have not yet charged members they are all aware of future "monetary" costs of membership.

Table 3.
What the community gives members

Dimensions:	What typical Internet communities give members:	What the Lamda community gives members:
Who helps new members?	Members are expected to install their software themselves. They are supposed to deal with both the hardware level and the software level.	Once accepted, members gets personal 1-on-1 training. A community trainer will go to their home, install the software and will spend another 2-3 hours showing the new members how to use e-mail, the web, and the community.
Benefits to members(money, respect, credit, etc.)?	Members are usually not paid for their time or efforts.	Members who initiate projects got paid.

Table 4.
Dimensions of communities and their ramification with the Lamda community

How we find them in the Lamda community:	Dimensions
Metaphor of a map as a physical place. The notion of members vs. guests. The feeling of a "club."	Borders
A logo of the person who is able to lift a house. Posters of the map, sweatshirts, and other gimmicks. Definition of language (i.e., a new word "Discussorium")	Symbols
Give power to those who need and can use it. Create a parallel support system. Encourage actions.	Power
Support for a long time. Stability. Creating a joint culture.	Time

If we follow these dimensions we can see that the simplest way to achieve a sustainable community is to base it on a market driven approach. We do not claim that professional virtual communities should always behave in this market driven way. We simply selected an approach that would match the look and feel of a professional community. This selection seems problematic to typical veteran Internet users, especially to those from the academia who were used to the freeness of the net. In the name of "free access to all" we are often perceived as elitists. While this was not the original goal, this very approach proved to be a selling point. Apparently, in the eyes of non-Internet users this approach seems natural. This market driven approach have special meaning when it comes to leadership within the community because we actually pay our leaders!

Leadership in the Context of the Lamda Project

In January 1996 we presented an initial vision for the community. In this vision (which was presented as a "starting point to be updated as the community develops," we defined the community as a meeting grounds for members. In the opening memo to new members we listed these examples:

- A teacher in Dimona (south of Israel) discusses the question of how can family members help in science teaching with a teacher from Ramat Hasharon (part of the Tel Aviv metropolitan);
- A group of students in Ma'agan Michael exchange information with students in Japan on the effect of salt on the quality of Sushi and Carp;
- Teachers who are interested in creating a teaching program on the subject of Alchemy from a historiosophic point of view consult one another;
- Teacher confer with regional science supervisor on improving the salaries of science teachers;
- A group of teachers in the South send their feedback regarding a new simulation program to the Logal company located in the North;
- Natural science teachers contact the Mabat project regarding their new booklet "The Average River and Its Future";
- The Rehes publishing house consults the users of the book "What is the matter of people - new age biology" on teaching methodologies used in this book;
- Teachers discuss the concept of pay-per-success

At that time we also coined the term "community entrepreneurs." These entrepreneurs would join forces with us (the team) and other members to develop the community and establish it. Again, in the opening message to new members, we demonstrated the meaning of "community entrepreneurs" by suggesting that entrepreneurs can:

- Lead discussion groups (e.g. on the advantages and disadvantages of "science for the gifted" programs);
- Initiate training courses for teaching staff at schools (e.g. a basic course on network uses);

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hr: #reqs  [Each + represents 40 requests, or part thereof.]
--  ----
 0:   607: ++++++++++++++++
 1:   433: +++++++++++
 2:   174: +++++
 3:   193: +++++
 4:    74: ++
 5:    89: +++
 6:   160: ++++
 7:   183: +++++
 8:   548: ++++++++++++++
 9:   631: ++++++++++++++++
10:  1042: +++++++++++++++++++++++++++
11:  1686: +++++++++++++++++++++++++++++++++++++++++++
12:  1415: ++++++++++++++++++++++++++++++++++++
13:  1313: +++++++++++++++++++++++++++++++++
14:  1387: +++++++++++++++++++++++++++++++++++
15:  1671: ++++++++++++++++++++++++++++++++++++++++++
16:  1626: +++++++++++++++++++++++++++++++++++++++++
17:  1168: ++++++++++++++++++++++++++++++
18:  1085: ++++++++++++++++++++++++++++
19:   827: +++++++++++++++++++++
20:   496: +++++++++++++
21:   819: +++++++++++++++++++++
22:   898: +++++++++++++++++++++++
23:   705: ++++++++++++++++++
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Figure 2 - Hourly Summary of use in June 1996.

- Initiate network-based teaching materials (e.g. types of flora throughout the country);
- Publish monthly news letters (e.g. on the subject of the science of matter);
- Manage a reaction team (that will provide scientific background for news events);
- Initiate educational programs (e.g. surrounding the Israel Chemical Company Ltd.);
- Translate material on the sciences and science teaching from English to Hebrew.

At the time we did not use the term leaders. Partly by ignorance, partly by design, we felt the term entrepreneurs matched better the needs of the community. As we will later report the issue of leadership became a major factor in the development of the community. While we have no conclusive results we are convinced that we need a better understanding of leadership within virtual professional community

Research Methods

Three types of data feed the research: use data; on-line reflection; and focus groups. They are described next:

Use Data

The web allows real-time capturing of member's behavior. Since all members must log on to the site we are able to know who used which service. For example (see

Figure 2.) we can see that there is a decline in use at around 8:00 pm (possibly due to family time). The numeric data allows us to analyze patterns of use (e.g., novice vs. expert use of the site; the appeal of various services, etc.). Further cross analysis (e.g., kind of member vs. kind of service) allows us to fine tune and adjust the services.

The charts above in Figure 3 lists the total numbers of hits per month (upper-left); the total number of hits per day (upper-right) and the distribution of total hits per the hours of the day (bottom).

On-line Reflection

Beyond the quantitative data that we get from the system there is also the automatic capturing of discussions. The main fora for discussion is called the "Discussorium." The Discussorium combines both the capturing of the data (into web pages) and the links to members via e-mail. The qualitative data is stored for future reference and study. A typical discussion page (See Figure 4) includes a list of messages. Let's follow line number 12 (marked with the arrow on the right). The line includes an icon for attached files (a Netscape .htm file in this case), the subject, the author, and the date and time of the original message (A click on the subject will lead to the message itself. A click on the author name will open a reply mail window).

Focus Groups

Few times a year we have open house meetings where we meet with members to explore the state of the community. Because valuable data and ideas are generated at these times, the meetings are logged and transcribed for further study.

Results: Patterns of Leadership in Virtual Professional Communities

The continuous stream of data coupled with the need to answer daily needs led to many insights of potential interest to builders of professional virtual communities. Of those insights, we believe that our understandings regarding the patterns of leadership in virtual professional communities are critical to the long term sustainability of such communities.

The original vision of the community was presented in January 1996. Since then it was not developed or reformulated. The theory was left aside and daily actions began. By December 1996, we had about 200 members and over 9000 pages.

Types of Projects Initiated by the Leaders

Leadership within the community manifests itself in many ways. During the year we captured these leadership acts under the title of projects. We have divided these projects into four groups which as listed in Table 5.

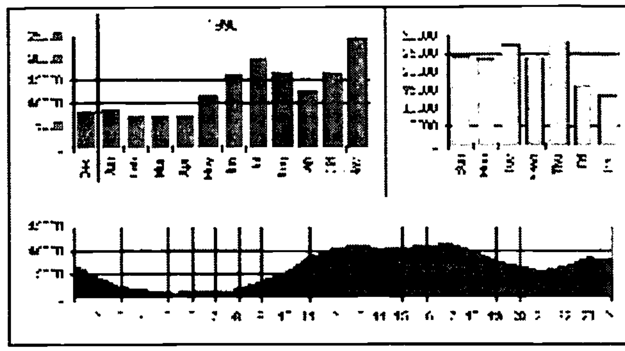

Figure 3. Money, weekly, and hourly distribution of total hits for 11 months.

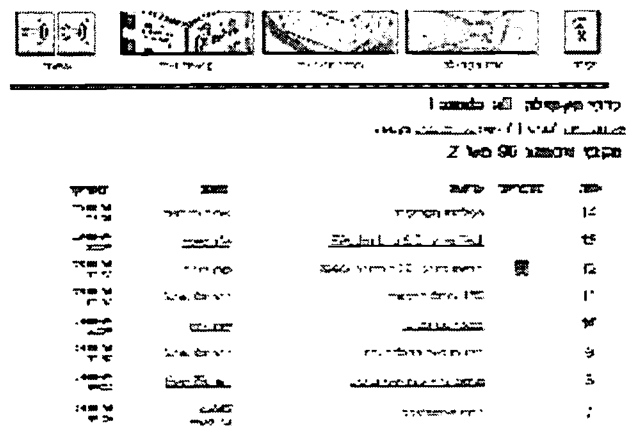

Figure 4. A typical discussion page.

Table 5.
Types of projects within the Lamda community

Type of projects Samples: (# of projects in 1996)	Definition:
Proposed projects. (8)	A proposed project. Most were submitted School wide web; a monthly newsletter; more data bases; in a university course I teach called "intro. to the electronic communication in education."
Start-up projects (10)	Some kind of an activity; may take any shape A data base of science sites, a mailing list about or form. alternative assessment; a column in the weekly news; a human search service, etc.
Paid projects (4)	Longer term commitment is needed; or larger. Evaluating the community; a "cool" site center, a investment of time and energy. Payment can presentation about the community in a conference. be a one time fee or a month payment (in the case of a service).
Mini-projects (8)	Small turnkey project. Does not demand long Translation of a paper to Hebrew; a document that talks term commitment. about searching the net; a summary of a talk, etc.

Preliminary Observations about Leadership in Virtual Communities

Here are some preliminary observations concerning those leaders:

- Leaders can learn new things quickly. They are not afraid to ask and demand resources from the team.
- Leaders appear in various ways. They contribute to mailing lists; they organize various new centers; and they bring-in new members.
- Leaders can be divided roughly into two groups: those who want to advance themselves and those who want to advance the community. In the Lamda community these types blend. Furthermore, we have found ourselves pushing for the self-advancing type.
- The idea of professional teachers who advance themselves does not come naturally to teachers. We succeed more with new (and young) teachers than with the veteran (and old) ones.
- At times, leaders in our community lack basic skills of organization and management.
- Longer term leaders are hard to find, shorter term leaders come more easily.
- Leadership takes time; and since teachers chronically lack time they are often prevented from becoming leaders.
- Leaderships of content is relatively easy (collecting data and presenting it); leadership of processes is more difficult.
- Virtual communities allow some people to becomes leaders, and prevent others from becoming one. The virtual world changes the needed entry qualities of leaders.
- Leadership in a virtual community calls for a different mix of leadership qualities.

Discussion

We must admit that currently we lack in our ability to fully analyze the issues of leadership within virtual communities 1) because the current leadership theory has not yet developed the concepts when it comes to the virtual world; and 2) because the current state of our Lamda community is not yet representative. Let me elaborate on this two claims here.

Leadership science deals with political (including wartime) leadership, idea-based leadership, and corporate leadership. While much can be borrowed from the this research we lack basic experience in virtual leaders. Leadership patterns, at least in the past, took years to develop, and we simply did not have enough years in the virtual world. The virtual world has not yet matured to the level where patterns of leadership have emerged (for a sample of CMC leadership see Perkins & Newman, 1996).

Beyond this general problem we also have a more local problem. Despite our genuine efforts we were unable to simulate real world virtual communities. Due to technical difficulties of installing new members, those with previous experience were able to fully participate in the community. For example, one of our first leaders was Mrs. Z a very prolific teacher who started up two mini-projects. To our surprise, when her system stopped working she did not push us to re-install her. While she may have dropped even if all the technology performed flawlessly, we will never know if she fulfilled her full potential as a leader in the virtual world.

Of the 40 proposed and implemented projects, four reached the level of paid projects. Apparently it takes longer for a project to justify a "paid project" status (paid status was given to projects that had real value for the community). We may see a surge of "paid projects" early in 1997 when some current mini-projects mature.

Another problem that revealed itself was the basic lack of project management skills. Apparently many members wanted to initiate projects that did not materialize due to lack of experience in managing projects. On the other hand, when we supplied the structure or when the person came with management skills the project took off more easily.

Although these two problems (the lack of leadership theory in virtual communities, and the immature state of our own community) prevents us from suggesting general lessons we can examine the seeds of leadership within virtual communities. In that sense the Lamda community presents a unique opportunity. We will therefore pay special attention in forthcoming year to examining these emerging patterns of leadership.

In conclusion, from the four classical dimensions of communities presented earlier (See Hazan, 1988; Shapira and Shavit 1995), the concept of "power" seems to be tightly linked with leadership. Alvin Toffler (1990) begins his book Powershift, by observing that "despite the bad odor that clings to the very notion of power . . . power itself is neither good nor bad." Since it is "an inescapable aspect of every human relationship," he determines that to "a greater degree than most imagine, we are the products of power" (p.3). Interestingly, he defines power as "purposeful power over people," and concludes that, "in its most naked form, power involves the use of violence, wealth, and knowledge . . . to make people perform in a given way" (p. 14) (argument made by Penner, 1996).

I find the juxtaposition of power and knowledge to be especially relevant when it comes to leadership within virtual communities where skills like communication, vision sharing, and story telling all take a new form.

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The Global Community and Cultural Diversity

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As political and ideological barriers all over the world have lessened, and in many cases disappeared, opportunities for collaborative research among scientists, researchers, and educators have grown, necessitating technological advancements to support these cooperative efforts. Although some of the technologies have long been available, only recently have the political climate and associated costs made certain classes of technology realizable for many members of the global community. The most applicable of these technologies fall under the category of computer-mediated communication (CMC).

Applications of CMC recognized by the majority of the global community include electronic mail (e-mail) and the currently evolving computer conferencing systems. All of these CMC capabilities provide opportunities for expansion of educational audiences. Teachers can share their experiences with new student groups and facilitate interaction between heterogeneous student populations. As in the physical classroom, the teacher in the virtual classroom should monitor and control student interactions to ensure a balance in each individual's dual needs for freedom of expression and protection during their educational experiences (Nance & Strohmaier, 1994). Before the individual types of CMC and the effect that each has on the virtual classroom can be presented, particularly with respect to the impact on cross-cultural communication in an educational setting, clear definitions of culture and community must be delineated.

Culture

According to Webster's Dictionary (Guralnik, 1986, p. 345) culture refers to "the ideas, customs, skills, arts, etc. of a given people in a given period." This general definition is presented after five other definitions that do not pertain to human beings. Although this definition is outdated, a vagueness persists in defining the concept of culture. There are many different perspectives on the term "culture." One way of viewing the concept of culture is as everything human made (e.g., Herskovits, 1955). Geertz (1973) discussed culture as a system of shared meanings, contributing a metaphor for culture quite appropriate for CMC:

> The problem of cultural analysis is as much a matter of determining independencies as interconnections, gulfs as well as bridges. The appropriate image, if one must have images, of cultural organization, is neither the spider web nor the pile of sand. It is rather more the octopus, whose tentacles are in large part separately integrated, neurally quite poorly connected with one another and with what in the octopus passes for a brain and yet who nonetheless manages to get around and to preserve himself [or herself], for a while anyway, as a viable, if somewhat ungainly entity. (Geertz, 1966, pp, -67)

Gudykunst (1991, p. 44) defines culture in a basic way that is easily applicable to CMC: culture refers "to the system of knowledge that is shared by a large group of people. The 'borders' between cultures usually, but not always, coincide with political boundaries between countries." The foundation of Gudykunst's definition comes from Keesing's (1974) long, but understandable definition:

> Culture, conceived as a system of competence shared in its broad design and deeper principles, and varying between individuals in its specificities, is then not all of what an individual knows and thinks and feels about his [or her] world. It is his [or her] theory of what his [or her] fellows know, believe, and mean, his [or her] theory of the code being followed, the game being played, in the society into which he [or she] was born....It is this theory to which a native actor refers in interpreting the unfamiliar or the ambiguous, in interacting with strangers, and in other settings peripheral to the familiarity of mundane everyday life space; and with which he [or she] creates the stage on which the games of life are played. (p. 89)

In essence the actor's — or interactant's — cultural foundation is interwoven in his or her perception. Perception "refers to how an individual views input based on past experience and knowledge. This perception allows the individual to incorporate stimuli, both common and new, to allow for an appropriate response" (Nance & Strohmaier, 1995, p. 609). To what extent is this process conscious to the interactant? Keesing (1974) elaborates:

> But note that the actor's 'theory' of his [or her] culture, like his [or her] theory of his [or her] language may be in large measure unconscious.

> Actors follow rules of which they are not consciously aware, and assume a world to be 'out there' that they have in fact created with culturally shaped and shaded patterns of mind. We can recognize that not every individual shares precisely the same theory of the cultural code, that not every individual knows all the sectors of the culture ...even though no one native actor knows all the culture, and each has a variant of the code. Culture in this view is ordered not simply as a collection of symbols fitted together by the analyst but as a system of knowledge, shaped and constrained by the way the human brain acquires, organizes, and processes information and creates 'internal models of reality.' (p. 89)

With the basic conceptualization of culture in hand, how does this affect the global community? "The flow of humans across national and cultural boundaries is more active than ever before... Among them...business men and women... researchers... [and] students.... In this worldwide context of cross-cultural [interaction], the concept 'adaptation' takes on a special social and academic significance" (Kim & Gudykunst, 1988, p. 7). Cross-cultural adaptation refers to becoming compatible, assimilated, or adjusted to a new cultural environment. It becomes ever obvious that cross-cultural adaptation is no longer a luxury, but rather a necessity for a successful participant in the global virtual community.

Community

Community does not imply that the parts should all be the same, but rather that the different parts have a common goal or purpose. Nance (1996, p. 431) states that in the global community, "as with any other community, the majority of community members desire safety and security." When dealing with a heterogeneous population it is important to acknowledge individual differences as well as the common ground or goal of the group itself. By addressing these, and other salient needs of the interactants, the value of diversity is maintained while continuing to focus on the common goal rather than hidden agendas, thereby increasing the effectiveness of the output. "Important issues need to be addressed in order to balance each individual's dual needs for freedom of expression and protection in the cyberspace" (Nance & Strohmaier, 1994, p.115).

As teachers and mentors, we shape the future by our choices of what to present to those in our sphere of influence, as well as our attitudes when we present those materials. Our presentations of our personal perspectives influence the evolving perceptions of those we encounter, both students and peers. Increasing our understanding of cultural diversity and applying these concepts to our own interactions can result in improved comprehension and tolerance — ultimately enabling and contributing to the unity in community. "Unity implies the oneness of that which is made up of diverse elements or individuals" (Guralnik, 1986, p. 1553). Unity in a community is impossible without effective communication.

Communication

Communication can be viewed as existing on a continuum based on the comprehension by the receiver of the message being sent. Computer-mediated communication is no different. By viewing the Internet as the communication facilitator, the communication effort can be assigned a location on the continuum based on two separate input criteria. The location could be evaluated based on the comprehension, by the receiver, of the message being sent. Alternatively, the location could be assigned based on the degree to which the communication facilitator contributes to effective communication. There are a number of unique communication technologies available, each of which would be assigned its own place on the continuum.

One characteristic of an Internet communication technology, which provides a means of measuring the effectiveness of communication, is whether the device facilitates synchronous communication, asynchronous communication, or both. Synchronous communication requires that both parties are available for communication at the same time. This is not to imply that synchronous communication can only involve two parties, but examples are simplified if synchronous communication is investigated as communication between two parties. This definition can be expanded when the number of participants is investigated, as it relates to the continuum.

Synchronous communication is ideal in some situations and extremely detrimental in others. Consider the generally synchronous tool which most commonly facilitates synchronous communication over distance in the current world: the telephone. When considering this example of synchronous communication, most individuals can readily identify the associated advantages and disadvantages, as most individuals have experienced both at some point in their lifetimes. Advantages associated with a telephone include immediacy of dialog, pitch, vocal tonality, verbal rate, and pausing among others. Disadvantages are quite varied, and include: omission of visual nonverbal cues, required accommodations for time zone differences; ensuring both parties be simultaneously ready for synchronous communication; dealing with no warning that synchronous communication is needed — often resulting in trial and error (phone tag); as well as the technological occurrences of echoes and odd lag time based on technological discrepancies.

Expanding on the basic examples of the telephone, one can add asynchronous components by introducing the concept of an answering machine, answering service, or voice mail system. These technologies allows synchronicity when both parties are available and have an asynchronous component which, if it doesn't allow complete delivery of the message, expresses the intent for synchronous interaction, thereby facilitating future interaction. Pure asynchronous communication is best exemplified by current electronic mail (e-mail) systems. Communicating in this way allows individuals to respond to each other as time permits. It does not allow the immediacy of dialog, nor the visual nonverbal cues, but does facilitate communication as respondents wish to respond, without regard to time zones and partner availability.

The Virtual Classroom

How does synchronicity affect the virtual classroom? The effect is in direct correlation to the location on the continuum of the communication facilitator. If the virtual classroom is an asynchronous environment, and is facilitated by pure e-mail in a one-to-one context, then the instructor and student rarely extend the virtual classroom to include others beyond the two of them. If the virtual classroom is extended by using e-mail in a one-to-many context then the instructor is generally the "one" and the students are the "many." This context has the same issues for the virtual classroom as the one-to-one situation, due to the lack of awareness and input of the students regarding their student peers. If the example is extended further – each individual "broadcasts" all messages – then there truly is a virtual classroom, but in a limited sense. Since many cultural differences are less evidenced by our written words than by our method of delivery and associated actions, the traditional asynchronous e-mail model minimally facilitates the opportunity to learn about other cultures. The obvious exception are courses in which culture is a topic.

Synchronous environments, such as current computer conferencing systems, can have either audio or audiovisual capabilities in a one-to-one, one-to-many, or many-to-many context. In the audio-only context, the students have the advantage of the audio cues. The cues in this category include all aspects of vocal communication such as tone, pitch, rate, pausing, and silence. However the visual cues are absent from the interaction. In the audiovisual context where the visual is in real-time condensed mode, there are also the advantages of the audio cues for the interactants. The visual mode gives the interactants certain visual cues, however these cues require some training to accurately decode. As the visual mode is compressed, one will see periodic snapshots of visual interaction.

Even when the video is compressed, the audio is generally not compressed. The nature of the human ability to decode the two sets of cues will intuitively allow the interpretation of the two inputs together although the timing will not correspond exactly. This situation will prove difficult for the teacher or student in trying to decide which set of cues to work from when determining turn-taking behavior. The final scenario involves both audio and visual cues in real-time. This is the ideal situation as both audio and visual nonverbal cues are available for interpretation by the interactants. Unfortunately, the technologies which support this final and ideal situation are extremely expensive at this time. Thus most virtual classrooms require the adjustment to the virtual environment created by the technology being used as well as to cross-cultural variables.

Conclusion

The Information Age and the associated global community provide many exciting opportunities for people everywhere. Collaborations are possible between individuals who will never meet. Conditions which had previously restricted the individual's sphere of influence no longer exist. Successful interaction between the many subcultures in the global community can be accomplished through increased awareness. Perhaps the global classroom can be facilitated through the development of a "general protocol for cross-cultural interaction which provides a reasonably homogeneous environment for interaction between heterogeneous cultures" as proposed by Nance and Strohmaier (1994, p. 118). Or perhaps, we, as teachers and mentors, can facilitate improved communication by educating the global community with regard to cultural diversity.

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INSTRUCTIONAL DESIGN

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As technology is increasingly being integrated into various curriculums, the need for strong instructional design is increasing as well. Currently, there are many computer programs and World Wide Web sites that provide information, but is this information presented in an instructionally sound manner? The authors in this section address these types of instructional design issues.

To begin this section, Heath discusses the tradtional approach to instructional design and its incompatability with the concept of flexible learning that is required for distance education and online learning. The dynamic and unpredictable nature of learning is recognized in non-linear development models.

According to Ahern, Burleson, and Martindale, there are more consumers of information on the internet than there are producers. To create good instructional software for the internet, the producers need to incorporate useful instructional design practices. Next, Salis and Masili describe hypermedia in an internet environment for distance education applications. They are developing a markup language and a browser that will aid in explicityly showing navigation strategies.

Gillan and Fuller use the web as a means for children to work with businesses. Together, they explore the development of web pages. This project integrates technology into the Social Studies classroom while emphasizing learning through group activities in school, community, and buisness partnerships. Houghton focuses on communities as well. He discusses CROP, Communities Resolving Our Problems, a web site that purpose is to teach people across communities by integrating desktop and online resources. Three main modules are discussed, each of which represent a differnt type of educational model.

Sadok, Kelner, Marques, and Lima explore authoring paradigms. They discuss video and audio media as a means of communicating information, going beyond the mind on to further human dimentions such as feelings and emotions. Boger-Mehall and Mehall present the strengths of using technology, mainly multimedia and hypermedia, to teach surgical intuition and problem solving.

Adams and Jansen present a paperless classroom implementation that uses technology to support appropriate models of learning in various instructional situations. How technology enhances learning is emphasized. Finally, Shimizu and Yamashita explore the application of fuzzy reasoning to the educational evaluation of calligraphy.

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INSTRUCTIONAL DESIGN MODELS FOR EMERGING TECHNOLOGIES

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Over the past two decades educational course designers have used a cognitive or a *systems* approach for designing and developing courses. But course developers are now finding that the traditional systems approach to instructional design is not compatible with the concept of flexible learning required for distance education and online learning. Consequently, the systems approach is being challenged by constructivist theories and models which recognize that social context, roles and relationships are central to learning (Jones, Kirkup, & Kirkwood, 1993). Non-linear development models also recognize that learning is dynamic and unpredictable and that learners can and do make their own decisions about learning tasks (Thorpe, 1995).

As a whole, instructional design models have evolved through three phases over the past three decades and some experts agree that the field is now experiencing a fourth generation of change (Tennyson, 1995). First generation models were based on behaviorist concepts like those which guided the development of instruction through teaching machines. Rapid growth in educational technology, together with the introduction of systems theory, led to second generation ISD models which saw the addition of phases for analysis, needs assessment, and formative evaluation. The third generation experienced was characterized by a proliferation of mature models (Anglin, 1995) and provided more and varied interpretations of ISD. Second and third generation ISD models are basically refinements of first generation ISD models and approach learning from a positivist point of view. However, fourth generation ISD rejects the behaviorist point of view and embraces contemporary interpretivist and constructivist approaches of how people learn and what it means to learn (Anglin, 1995).

Systematic Design Models

The systems paradigm, which emphasizes hierarchical and linear processes, grew out of the early computer programming efforts and the influence of early Artificial Intelligence theorists (Mandler, 1985; Massaro, 1986). Newell and Simon (1972) and others asserted that human thinking and processing could be understood as analogous to computer processing. That is, a human operates as an information-processing system with a goal, a problem, a task, a task environment, and a processing system with input/output buffers. This behavioral-empirical point of view with its explicit representations of knowledge and language, corresponding formal structures and logical rules strongly influenced ideas about human learning, problem-solving, instruction, and instructional design.

The systems concept was one foundation for systematic instructional design models — the most well-known model being the Instructional Systems Design (ISD) model of Dick and Carey (1990). Using the ISD model, the procedure for designing, developing, and validating instruction progresses through predetermined steps in a systematic fashion. The goal is to begin with well-defined needs, goals, and learning objectives so that the "correct" knowledge can be transferred to learners effectively and efficiently (Dick, 1995). Experts play a critical role in ISD and the roles of end-users are minimized. A major activity for the instructional designer is to correctly classify learners, skills, hierarchies, and tasks with the underlying assumption that design can take place out of the context of the learning environment and with limited input from learners

The use of instructional objectives is the essence of systematic design models. Instructional objectives define behaviorally what is to be taught, how it is to be taught, and the criteria for determining whether instruction has been achieved. Without a doubt, when Mager's (1962) method of writing and using instructional objectives is combined with Tyler's (1949) concept of objectives-based instruction, and with Bloom's (1956) Taxonomy of Learning; a sophisticated objective-analysis format for development is created (Popham, 1993). Even novice designers have been known to embark on creating an instructional package by simply following all of the steps and rules of this approach. The ISD model is an example of this combination.

The systematic design model was introduced into educational settings with the intention of improving "traditional" instruction in several ways. For example: active learning, not passive learning, should take place. Performance objectives, not teacher objectives, should determine the content of instruction. Measurable outcomes, which meet performance objectives, should improve instruction and guide future instructional design. Among the earliest authors who bridged the gap between psychological research and educational practice were Glaser (1962) who coined the term *instructional system*, Mager (1962) who created a system for writing instructional objectives, and Gagne (1965) who elaborated on the analysis of instructional objectives and related classes of objectives.

However, in its attempt to offer a solution to instructional design problems, the systems approach generated a set of its own problems and accompanying critics. Ironically, models based on information processing theory and systems theory are now called "traditional" design models. Jonassen (1991) criticizes systematic models as a "top-down" behaviorist and subject-matter-expert approach to education. Instead, he champions constructivist instructional approaches (Jonassen, 1994). Wedman and Tessmer (1993) comment that systematic models are too linear and time-consuming to be practical in the "real world" and Rowland (1992) states that systematic models do not reflect the ways that instructional design experts really work when designing learning materials.

From the learner's point of view, the weakness of the systems approach for instructional design becomes apparent: learning may not always be linear. It may require the learner to spontaneously adopt a different approach for learning the task at hand. Some critics complain that linear instruction is often boring and lacking creativity although proponents try to refute that charge (Dick, 1995).

From the designer's point of view, instructional design cannot always be based on careful and logical decomposition of the knowledge and skills to be learned (Carroll, 1992). "One size fits all" does not work successfully for instructional purposes. Development does not occur in a linear fashion; some steps require several visits and some may follow a different order or be completely eliminated. Too many instructional objectives with too much detail can be counterproductive, especially if they are created early in the development process (Willis, 1995).

Reigeluth (1996) recommends taking a more global view because our larger "super systems" have changed radically and no longer support the underlying assumptions of systems thinking and linear process models. Private, public, and non-profit sectors of our society are being transformed from the industrial age to an information age. This means that industrial-age concepts such as standardization, top-down organization, centralized control, conformity, and compliance are being replaced with customization, teams, diversity, initiative, and personal autonomy with accountability.

Constructivist Design Models

New concepts and approaches to cognitive processes are emerging today from a new paradigm - called Constructivism - where learning is regarded as a constructive process and the learner is building an internal representation of knowledge (Perkins, 1992). Constructivism has its roots in twentieth century psychology and philosophy and the developmental perspectives of Piaget (1954), Bruner (1966), and Vygotsky (1978). Knowledge and understanding are not acquired passively but rather in an active manner through personal experience or experiential activities. As Perkins (1992) explains: "The key concept of Constructivism is that a human is 'active' - not just responding to stimuli, as in the behaviorist rubric, but engaging, grappling, and seeking to make sense of things" (p. 49). The application of a constructivist agenda recognizes that most, if not all, knowledge domains are complex and ill-structured in a number of ways and mastery requires a significant degree of practical experience. Knowledge and skill are intimately bound up with each other, and knowing and knowing how are seen as significantly interdependent (Spiro, 1992).

Consequently, Reigeluth (1996) thinks that the underlying instructional theories for instructional design must change. Approaches to instruction must support construction of learning through problem-based learning, project-based learning, team-based learning, simulations, and use of technology resources. Learning must shift from passive to active learning and from de-contextualized tasks to authentic learning tasks. Design activities of analysis, synthesis, evaluation, and change can no longer occur in a linear fashion. Instead, these activities must occur in a series of decisions which take place in an iterative series of cycles.

Hannafin (1992) expresses concern regarding the ability of traditional ISD (Instructional Systems Design) models to accommodate design of learning which takes place with the support of emerging technologies. "Emerging technologies" can be explained as those that go beyond single-use applications of video, audio and computers to include more sophisticated combinations and complex applications of artificial intelligence, expert systems, hypermedia, Internet and WWW access, and advanced computer and telecommunications. Emerging technologies provide a rich set of resources that progressively broaden, rather than narrow, learning themes and therefore require an alternative design model.

Alternative Design Models

An effective Computer Mediated Communication (CMC) course design calls for a collaborative and group-oriented approach. Course topics best suited for the CMC medium are those that invite discussion, emerging objectives, opinion-sharing, reflection, and debate (Berge &

Collins, 1995b). Use of new technologies, CMC activities and online classrooms necessitate an alternative, nonlinear instructional design model. Berge and Collins (1995c) recommend a "facilitation" model which is derived from a humanistic framework and posits that adult students are best capable of defining their own learning needs, objectives, strategies, resources, and means of evaluation.

The facilitation model of course development encourages adults to be more self-directing throughout the instructional process; capitalizes on their experiences, strengths, and interests; and enables them to apply whatever knowledge and skills while they learn to their own problem solving or developmental tasks. Successful course design offers objectives, resources, strategies, timelines, products, and assessments that are flexibly negotiated between faculty and students. (Berge & Collins, 1995c, p. 61)

The R2D2 model (Willis, 1995) is another non-linear instructional design model which can be used successfully for the development of CMC courses and activities. The R2D2 model promotes recursive, non-linear, organic and developmental planning, and reflection and collaboration among experts and participants. Like the "facilitation" model, objectives emerge from design and development in the R2D2 model with an emphasis on learning in meaningful contexts. Formative evaluation with subjective data is considered of prime importance. One of the key attributes of a non-linear model such as the R2D2 model is that different pieces of development can occur simultaneously. Design and development activities are accomplished as a cross-functional team effort with the different project members contributing to emerging decisions, solutions, and alternatives. Although activities of a non-linear model cannot be captured on a flow chart, it is incorrect to assume that there is a lack of form and structure guiding the process. Willis captures the essence of these activities through the three focal points of the R2D2 design model — *Define, Design/Develop, and Disseminate.* The overarching principles are *Recursion and Reflection* which take place through out the development process.

Gayeski (1995) also recognizes that instructional design should be an iterative process, not a linear one. Projects are never really done. Design becomes a collaborative process with input from a variety of constituencies, including prospective learners. Instead of a single instructional designer who works with a subject-matter expert, project teams carry out development projects. These project teams can work over greater distances of time and space with enhanced electronic communication tools. This approach corrects one of the major weaknesses of a traditional linear ID model, in which various phases are often accomplished independently from each other. In this context, individual developers will know how changes by other groups affect their contribution to the total project.

Emerging technologies will continue to challenge instructors to create meaningful learning activities. As a result, alternative design models will take on a more important role.

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AUTHORING LESSONS FOR THE INTERNET: FACTORS IN DESIGN

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The World Wide Web's (WWW) ability to deliver entertainment, provide information, and conduct commerce holds a particular fascination for the public. Everyone from individuals to corporations and major newspapers to universities have a homepage that provides information, entertainment or a product for sale to anyone who is "surfing" the Internet.

The World Wide Web is more than a simple curiosity but represents a fundamental shift in the way the world interacts. Historically separate industries of television, cable, telephone and computers are merging rapidly into single web industries.

Education is not immune from this rapid technological shift. The Internet represents a tremendous opportunity to redefine our notions of computer-based instruction, distance education and even teaching itself. The established fields of courseware and multimedia design are time consuming, mechanistic processes. The Web, however, has the promise of providing highly targeted individualized instruction for all students with a fraction of the development time and cost. The possibilities are endless but the transformation of the Internet into a truly capable delivery vehicle for education is not without problems.

The Problem

A major problem is that traffic on the Internet represents more consumers than producers of information. Teachers using the Internet for instruction must use whatever is currently available from a myriad of information providers. This can be frustrating because there appears to be little awareness of good instructional design or methodology displayed on the World Wide Web. The active design of home pages is more for information and not for educational or instructional purposes.

Consequently, for this study we assumed that good instructional software could be developed for the Internet by incorporating useful instructional design practices in conjunction with typical courseware authoring development techniques using readily available tools (Grabowski & Droms, 1994). Because Hypertext Markup Language (HTML) is the current Lingua Franca of the Internet we were also interested in how well HTML would behave as an authoring language and whether it could be used to deliver instructionally sound Internet applications. The results of this investigation indicate three major design factors that designers and teachers should consider when using HTML and the Internet as an instructional design and delivery vehicle: connectivity, architecture, management.

Authoring

Given the complexity of programming a computer, authoring programs are designed to allow non-programmers such as teachers the opportunity to create instructional software using a simple palette of instructions and commands. In the late seventies to early eighties, developers could choose from either an authoring language or an authoring system. Later, as operating systems became more graphic, scripting environments were invented to deal with the advanced complexity.

Authoring Languages and Systems

Authoring languages are based entirely on a formal programming languages such as Pascal or C. By reducing the number of available instructions and restricting the development of code to accepted instructional patterns simplified the language and the development of courseware. For example, PILOT (Programmed Inquiry, Learning or Teaching) was designed to create computer-based tutorials based on the concept of the frame (Conlon, 1984). Using a simple set of commands, an author could easily build a sequence of content screens while managing how the user would interact with the lesson. Authoring languages, although designed for a narrow application, were still enough of a programming language to allow the developer a great deal of freedom in the actual implementation of the courseware.

In contrast, authoring systems relied on highly structured instructional strategies. A content expert using an authoring system would simply answer a series of questions presented on the screen in order to build an instructional application (Miheim, 1994, p. v). The reduced time to build an application at times outweighed the restrictions in design.

Scripting Environments

In the late 1980's microcomputers such as the Apple Macintosh developed the graphic user interface (GUI) which allowed for non-linear, event driven software. Developers had to create applications in an environment that made it very difficult to program. Consequently scripting environments were developed that bridged the gap between higher level and authoring languages. Further these environments allowed the developer the opportunity to choose the level of complexity. Scripting environments fit nicely between an authoring language and a formal high-level programming language.

HyperCard was the first attempt to allow non-programmers to develop Macintosh-like applications that would conform to the GUI interface. HyperCard allowed the developer to choose between 5 levels of complexity ranging from simple browsing to full scripting capabilities. For example a developer using HyperCard could create a card reminiscent of PILOT to construct content frames. At the other extreme, HyperCard also provides the developer with a complete scripting language called HyperTalk.

HyperText Markup Language

Hypertext Markup language is not an authoring language nor is it a scripting environment, instead it is simply tokenized text. HTML provides a standardized way of transmitting information over the Internet by incorporating embedded commands or tokens in text files that can be recognized by applications called browsers. When a browser such as Netscape or Mosaic logs on to the Internet it downloads a simple text file. If the text file is encrypted with tokens that the browser recognizes, then the file will be displayed on the screen according to the design of the developer. Even though it resembles an authoring language using the frame concept, there is no underlying programming language controlling the interaction. Instead the developer must rely on the inherent capabilities of the user's browser. Nonetheless, HTML allows for the easy development of cross-platform applications currently not possible with traditional authoring applications.

Instructional Design

The goal of any instruction is to overcome a deficiency in skill or knowledge. A careful understanding of the instructional goal provides the designer with clear guidelines in terms of content organization, as well as determining the content sequence and pacing. Without a clear understanding of the goal state, instruction becomes muddled and unproductive. Consequently, we developed our lessons using sound instructional design practices.

The Study

Participants

The participants were fourteen advanced graduate students in a Summer Special Topics course in Instructional Technology. These fourteen students included: nine doctoral and one masters student in Instructional Technology, one masters student in Interdisciplinary Studies and 3 masters' students in Museum Science. In addition, three students who were taking the course over a distance from the primary location

Materials

For each lesson, the audience, task and outcome were identified. Furthermore, the content organization was determined and finally the implementation plan was decided.

Each individual lesson corresponded to traditional instructional design methodology. Issues of scope, sequence, and pacing guided our lesson design. Consequently, it was recommended that each lesson implement the following plan:

- Open with a splash screen (orienting technique)
- Use a typical frame design that adhered to appropriate sequence and pacing
- Implement guided practice
- Provide for simple evaluation

Standard HTML was chosen as the authoring environment. Furthermore, we did not use an HTML editor to produce the lessons because there is no industry standard HTML editor available to classroom teachers.

Procedure. The course was delivered using various Internet protocols such as e-mail, ftp, telnet, and http over a period of four weeks. The first two weeks included basic instruction in HTML along with a refresher course in instructional design. Each member of the class had two weeks to develop an individual lesson that corresponded to the delivery plan. The final week was spent in uploading and evaluating each individual lesson.

Results

In general, we found that HTML can be used to quickly create lessons that correspond to simple computer-aided instruction (CAI) (Hannafin & Peck, 1988). Consider Figure 1 in which the author used a mix of graphics and text to both capture the students' attention while also providing an orientation to the content of the lesson. Notice the use of a HTML link to simulate a button that links the next screen in the sequence.

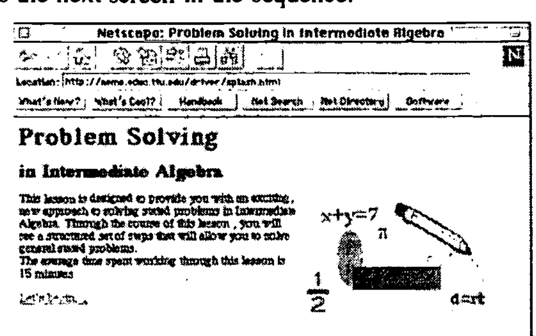

Figure 1. Splash Screen.

We wanted to know if we could develop lessons in appropriate chunks, which would in HyperCard be represented as a single card. The underlying HTML code for Figure 1 was a single text file (see Figure 2) that the Netscape used to display the splash screen information.

The goal was to be able to easily modify the individual screens and provide for a convenient way to reorder the sequence and pace if the instruction warranted it.

```
<<HTML>
<HEAD>
<TITLE>Problem Solving in Intermediate
Algebra</TITLE>
</HEAD>
<H1>Problem Solving</H1>
<H2>in Intermediate Algebra</H2>
<IMG SRC="splash.gif" ALT="Problem Solving
logo" HEIGHT=125 WIDTH=200 ALIGN=RIGHT>
<P>This lesson is designed to provide you
with an exciting, new approach to solving
stated problems in Intermediate Algebra.
Through the course of this lesson, you will
see a structured set of steps that will
allow you to solve general stated
problems.<BR>
The average time spent working through this
lesson is 15 minutes.</P>
<P><A HREF="main.html">Let's begin...</A>
</P>
</BODY>
</HTML>
```

Figure 2. HTML source code.

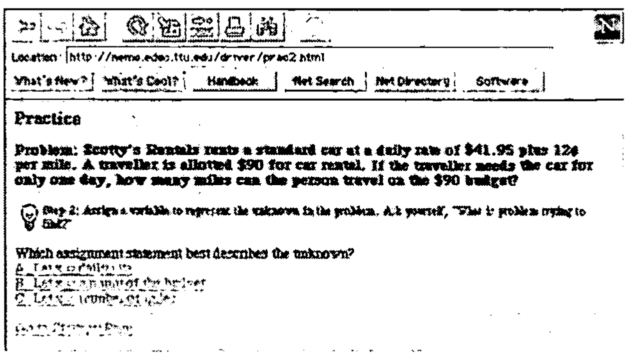

Figure 3. HTML source text.

Instead of a single application file that includes text and graphics such as in HyperCard, HTML requires separate files for both text and graphics. For this investigation it was decided that, like individual cards in a HyperCard stack, each content screen would be constructed in a series of individual text files that would then be linked together. These links would act as buttons and would be normally indicated both by a different color than the main text as well as underlined (Figure 3). When the user clicked on the link, it would change color to indicated that this link was visited. This displays some of the limitations of HTML as an authoring language because the author must manage each link without the help of the application.

Design Implications

In developing Web-based instruction, we identified three major factors that educators must consider when using for the Internet for instruction: connectivity, architecture, and management.

Connectivity is a major problem for network-based instruction. Traditional authoring was designed for specific delivery platforms. In the Internet, the actual machine that the software will be delivered on is unknown, which can cause different display problems for the instructional designer. One result of this study noted is which platform the HTML is developed on and whether it does make a difference. However, a more pressing problem is the lack of easy and affordable access to the Internet. Slow connect times, incompatible browsers, or a lack of suitable hardware can cause problems for students and reduce the impact of the network-based courseware.

Network architecture is also a problem. Authoring systems typically developed and delivered the instruction using the same platform. Networks change this development cycle into a client/server relationship. This essentially removes one of the core features of authoring which permitted a content expert to control how a lesson would be delivered as well as how individual users interact with the software.

The Internet is a server-based system, which means that the content of a lesson resides on a remote computer from the one that is actually delivering the lesson. Due to the variety of different platforms and browsers it is difficult to provide true student interaction. One way to overcome this limitation is to provide a server-based solution through a language called Common Gateway Interface (CGI). In the future, this may be resolved with applications that support Java; however, simple but effective interaction can be built into the design as this study has demonstrated.

Management issues are also a very important consideration. Issues such as what type of server (Macintosh, Unix, PC) are crucial for longterm development and management. The type of server can make trivial issues such as file names a huge problem and require a large time commitment.

Other issues such as who provides the Domain Name Service will require teachers and educators to come to grips with the nature of other issues such as firewalls, file names, etc.

The managing of specific development issues can also be very time consuming. Even though HTML and the Internet work well in cross platform situations, questions such as which version of HTML to use, which graphic format or the conversion of files from one format to another requires careful attention.

Conclusion

The Internet has a lot of potential to deliver quality, effective instruction but in reality is in its infancy. Over the next few years many of these issues will become moot with the development of new tools and technology. Currently, there is a tremendous interest in Java a programming language developed by Sun Microsystems to create applications for delivery over the Internet. Other technologies and even authoring environments will surely follow. Nonetheless, the results of this study simply underscore the fact that sound instructional design will always mean better instructional applications regardless of the tools used to produce instruction or the medium used to deliver instruction.

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The User Control on Verbal/Non-verbal Knowledge Visualization

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In the past few years we have been experimenting with using hypermedia in a World Wide Web environment for distance learning applications. The courseware was essentially composed of 3D representations and textual nodes interconnected at several strategic points. Most of the students reported positively on the organization of the inherent nodes of the 3D model and appreciated the utilization of referential and bi-directional links. Despite the positive results of this first experimentation, we have identified, through the analysis of students' comments and tracking issues, a common lack of intentional activation of conceptual nodes. In this paper we discuss this problem and propose solutions at the level of the visualization of a didactic component's network, in order to provide a potential guidance for students. Our solutions are based on visualizing, before selection, the nature of the reachable components and the semantic model, showing more explicitly navigation strategies. We are currently developing a markup language (AOML) and a browser (Bùxis) to support these concepts. Besides various information-filtering features, the language supports differentiating the access to the same data set from different paths. The browser provides navigation and information retrieval features and manages contents visualization and fruition, through several site views, compass functions and tracking functions. Our system offers a basis for carrying out studies and comparisons on the way students utilize pedagogical resources, as well as for evaluating the recall of knowledge processing.

Iperler is an integrated system for telelearning developed at CRS4. It combines a World Wide Web browser, a 3D viewer and a synchronous collaborative tool (Salis, Scateni, Leone & Vandamme, 1995; Salis & Scateni, 1995; Salis, Leone & Benevento, 1996). Iperler presents hyperlinks from both the 3D viewer and the hypertext browser.

Experimentation with an Iperler prototype has been carried out with a small group of students from the School of Medicine at the University of Cagliari. The analysis of quantitative and qualitative data related to the bi-directional access to visual and verbal representations highlights some interesting points to be considered for future development (Salis, Scateni, Leone, & Vandamme, 1995). For the present purpose, we refer to the qualitative analysis. The following points are worth noting:

1. Most of the students who have used Iperler reported positively on the way inherent nodes of the 3D model are structured, so that it seems to enhance the progressive research of details.
2. For the same reasons, most students appreciate the use of referential nodes that link visual and textual attributes using a direct method for reaching a specific modality of knowledge presentation.
3. One of the main complaints reported by the students has been their lack of confidence that they have covered all the information.

This result makes clear that since students are worried about the so called *didactic contract* that exists between the tutor and themselves, they do not utilize the most important property of a hyperdocument; in fact, the interactive hypernodes permit does not seem to lead students to a personal construction of a conceptual network. This problem is crucial from the constructivist learning theoretical point of view, which is granted from a significant number of cognitive psychologists. The linking mechanism is viewed as the most significant transformation of conventional learning material, but it could have no effective impact if it does not assure learners a helpful cognitive strategy.

Problem

Students are not accustomed to the non-linear approach which hypertext provides. Indeed, it is the first obstacle of student performance with hypermedia navigational tools. Not surprisingly, it has been found that knowledge of the subject matter relates to an ability to navigate in a non-linear way through the information space (Ohlsson, 1992). The hypermedia integration in the teaching practice has suffered from lack of guidance and structure in the instructional sequence.

It is true that hypertext technology has emerged to help the recognition of the idea of non-linear-thought capabilities as a great advantage for the construction of conceptual relationships. It is also recognized that knowledge construction does not necessarily derive from a linear process or from an ordered addition of an idea's parcels. A problem arises as soon as we base the construction of hypermedia for learning on the fusion of these two assumptions: by stating (implicitly) that, as the construction of knowledge is not linear and as the main feature of hypertext technology is the non-linear access, an interactive conceptual network becomes a pedagogical solution. Duchatel (1992) reports: "Hypertext based systems do not teach, but, instead, provide the student with an excellent opportunity to learn on their own accord, as they possess minimal structural knowledge of content." Moreover, studies processed by Messing (1990), have shown that students tend to adopt a linear pattern of hypertext review similar to that taken with a book. We suppose that by applying this strategy, students think they may increase opportunities to better fulfill the *didactic contract* and do not consider other strategies which might get them lost in an implicit knowledge structure.

We consider that a novice user does not have any reason to spend time in understanding how and why isolated concepts have been connected in a certain way. The interest in such a question might be mentioned by an expert in the knowledge domain, but Is not to be expected from a novice before reaching a *consolidation stage* of knowledge processing. Learners go through the nodes doubting that selective activation of nodes is useful. One reason is probably due to the lack of clear advice about each nodes' composition. A second reason is given by the fact that when learners reach a node they do not have the possibility to evaluate what another selection would show them.

The observation of how most hypernodes are reachable emphasizes that learners should assume a conceptual network of knowledge similar to that acquired by an expert in order to perform the navigation through information. We think that the cognitive overhead often discussed in the literature may issue from this problem, rather than from an inappropriate interface. If the interface presents unclear navigational tools, learners would have to face the problem of disorientation, which is a different one. Disorientation cannot be directly associated with the construction of meaning, since increasing the time spent following alternative paths could resolve the problem of covering content.

According to these considerations, we propose the study and development of a flexible mechanism for the free selection of interconnected nodes that avoids the loss of the conceptual map defined by the document's author caused by conventional hypermedia navigation techniques.

Cognitive Approach System for Navigation Control

A *Cognitive Approach System* (CAS) for the control of navigation should provide the following capabilities:

1. display of the concept mapping from which the user may activate a conceptual node;
2. continuous presentation of the current node and of at least two sublevels;
3. tracking functionality, showing if a node has already been visited or has never been seen;
4. distinguishing subcomponents of a node which belong to the visual or to the verbal representational systems, in order to let users select the preferred knowledge representation form when more than one is available.

When selecting a specific medium for presentation, users should be informed about all referential links available in other formats presenting the contents of the same conceptual node.

Most of the web hypermedia systems include a navigational tool for the structure of the documents rather than for the knowledge nodes. Users may eventually be guided in using the system (commands, help, index, menu, etc.). The guidance through the structure does not solve the exploration problem for learning goals achievement.

A solution to this problem resides in the construction of a didactic tool which may support the navigation over and through the knowledge corpus. User orientation will be supported by a control panel on the screen where the concept map of topics is continuously presented. In this approach, parts of the concept map are tracked according to the location of the nodes users move in. The tracking mechanism produces a systematic update of the control panel window. Thus, the control panel may be seen as an advanced organizer for learning strategies and as a path monitor as well, in that it helps users to anticipate the nature of the content they are going to explore.

Referential Framework

Barker (1993) has individuated the three most common types of navigational tools normally implemented into hypermedia systems:

1. the *trial-and-error* mechanism simply involves *jumping* from one node to another. In this case, the user does not base his decision on a semantic link's nature at all.

2. a second type of navigational tool is based on semantic web links priorities, as decided by the designer. Usually, the designer arranges web links in a thematic manner, which could help users avoiding getting lost. Exploration may be limited with this approach.
3. finally, a *concept map* tool can be used to indicate the type of material available and also the nature of links between nodes.

The concept map function is seriously limited when implemented within World Wide Web hypermedia. The limitation is essentially caused by the lack of a tracking system over the knowledge corpus, and by the impossibility to keep users informed about the status of their exploration. Furthermore, once users decide to reach a modality-specific presentation (visual or verbal), they follow subsequent links which could also be explored through another medium. Other strategies that allow the exploration of the components of a node are parallel semantic web connections that the designer thinks users should access on their own at any time along the hypermedia consultation.

The notion of parallel exploration could expand the role of the utilization of multimedia on the Web; if we want to profit of multimedia advantages a differentiated approach with respect to learning style, multimedia components must be selected by learners themselves. As symbolic systems for knowledge presentation, visual and verbal environments call for a different perception activity the users should be able to carry out according to their preferences. Because of the way we process information, these systems can be used independently or simultaneously.

Among a number of relevant studies of conceptual representation, the dual coding theory proposed by Paivio (1990) has retained our attention. The author stresses the important relation that exists between the visual and the verbal system of mental representation. It seems that this relation exists along all the phases of the learning process. This process starts with the reception of the external input which solicits the visual system or the verbal system according to the nature of the input. As one proceeds through the coding/recoding phases, Paivio hypothesizes that the activity may happen from one of these systems independently from the source of the input. This should be due to the important influence of prior human experience which matured with a given topic. The same independence is detected at the final step, when the output or the response is generated. Rieber discusses this double coding mechanism in terms of memory effects: ". . . information encoded in both verbal and visual forms with strong and flexible links between the codes should enhance retention, retrieval and transfer" (Rieber, 1994). Such cognitive assumptions let us think of the existence of an interrelation between systems during information processing.

We start from with the cognitive assumption that human cognition may deal simultaneously with verbal and imagery codes during the knowledge coding or recoding phases. This assumption helps us define a framework that could offer a useful interface for the dual coding approach. Believing that the interconnection between modality-specific knowledge presentations should work with more correspondence to the manner human cognition works, we are developing a CAS interface facility in order to empower users with a greater control on how they orient their learning approach.

CAS Implementation Components

We have already developed a first version of a CAS interface facility, implemented using several existing software components, such as HTML and VRML browsers, image viewers, and sound players. The system's core, however, is constituted by our own data organization and navigation layers.

Data-Organization Layer

The special requirements of CAS for data organization has demanded the creation of a new markup language, i.e. a new SGML document type (Sperberg-McQueen & Burnard, Eds., 1994), that we named *Approach Oriented Markup Language* (AOML). The language allows the definition of approaches through which to access an information base, thus making it possible to access the same data set from different paths. Elements also contain a keyword hierarchy to allow standard or affinity queries, as well as attributes that provide static or dynamic filtering for discriminating contents following user's needs.

The differentiation in the dual coding theory's systems are implemented by AOML at the node level. In an AOML document each node is a finite conceptual element and contains all representations needed for digestion. Subcomponents cannot be addressed separately, but are just classified by their belonging to verbal or visual system. User can, through this property, choose to use contents of one of the two systems or both.

Points of View

To fulfill aforementioned needs we have coded a *Points of View* (POV) system, that supports, besides various information-filtering features, distinctions between the two cognitive systems. For example, after setting a POV concerning verbal data, the user navigates in that system, until he decides to examine a parallel path or to activate both verbal and nonverbal representations, or until the author proposes a POV's change. In any case, through the visualization techniques that we will detail later, users always know what kind of media will be used to represent nodes, which contents are already examined and what else could still be used. It is also possible to filter all the node hierarchy in order to extract (and then visualize) only visual or verbal contents.

Information-Access Layer

The information-access layer is constituted by the *Bùxis* navigator, implemented in the Java language, mainly to relieve users from software maintenance and to give independence from a particular HTML or VRML browser.

For the time being, the tool allows navigation and retrieval of information, delegating contents visualization and fruition to other existing software, controlled using a master/slave paradigm, in a manner which is transparent to the user. Future revisions could be integrated in a single software object, in order to reach maximum interface homogeneity and simplistic installation.

Site Views

Bùxis offers several site views, different by detail level and features, that can be used simultaneously, providing thus a range of advanced navigation and orientation features.

Level one, the highest-level, is the *Bird's Eye View*. It provides an overview of the site's graph, zooming if necessary to see more in detail some portions (i.e. arguments) of the graph, without getting into dual coding elements.

The *Neighbor View*, instead, involves both immediate static and dynamic (i.e. based on keywords or affinity search) arcs of the current node, in order to provide the simplest representation of all available local links between conceptual nodes, without overloading users with complex arcs among physically distant nodes; furthermore, at this level nodes show if they comprise verbal, non verbal or both types of elements, as well as what kind of elements have already been visited.

Such map views cooperate with the *Focus Node View*, that gives maximum control on the current node (Card, 1996). This high-detail view shows different icons and comments for every element in the node, highlights if it belongs to the verbal or to the non verbal level, and gives all of its tracking information.

Orientation Aids

Bùxis allows navigation through its views and follows the user when changing node using another browser (or viewer), providing a feedback and a *Compass* function that helps orientation.

A *Graphical History Map* gives another navigation landmark (Gershon, 1996). It allows the user to jump back of one or more visited nodes or sub-elements that are graphically represented by their icons.

Tracking Functions

A *Track Function* indicates if a node has been visited, the time of the last visit, and what kind (and what number) of subcomponents have not yet been activated.

A complementary feature is the *Path Receipt* which is displayed on the different views, or in a textual representation, the space-time route that users follow during exploration in order to fulfill tutor and user's knowledge control needs.

Conclusions

AOML is already refined and stable; the navigator is currently in a prototypical state. We have released the first working version last June and we are, at this moment, developing the advanced visual features. In order to implement CAS in the Iperler structure, we will proceed to the validation of a first version of the tool in the framework of a definite verification study. Given the nature of our approach, we will verify and validate the system by using a *control group*. Thus, the validation phase will allow us to assess the effect of CAS application through the recall method as well as through the analysis of data drawn from open questionnaires.

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Web Marketing as Free Enterprise Education

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Public school students often develop World Wide Web design skills that seem remarkable to older, technically less-sophisticated people. The traditional values of age and seasoned experience seem at times to contradict the apparently youth-controlled worlds of the Internet, Web page design, and the alternative systems of advertising and marketing that the Web allows. Though the truth of such an inverse relationship between age and success is far from proven, small business people, especially those working in business that do not have a pronounced technology component, can feel quickly lost in a world where every national competitor shows a URL at the bottom of each television or magazine ad.

Schools alert for business partners and campus adopters can find a source for rich cooperation in this anomaly. Middle school and secondary school students, as the youngest of young Internet designers, engage with small business partners in an expertise-sharing activity that imparts to the students a new appreciation for the demands of free enterprise and provides a local outlet, as well as an enhanced appreciation, for student projects. Students help businesses designing Web-based pages for marketing and community service. In exchange, businesses, Internet Service Providers and Chambers of Commerce provide free-enterprise and occupational exploration opportunities for students and their teachers.

The primary tool for this program is the HTML-based Web page. Each teacher or teaching team tailors relevant information to extend specific curriculum goals in ways that support other class activities. Working with relevant demographics, business/marketing surveys, governmental information, maps, pictures, and other records that have a unique relevance to the school's supporting community, further enhances required research skill.

The exploration vehicle for this innovative teaching partnership is a Northwestern State University Educational Technology Program project called MainStreet on the Web. This two-year grant, recently funded by LEQSF, addresses the following curriculum goals:

1. The project develops a model for technology integration within social studies/free enterprise curricula.
2. The project applies computer literacy skills and introduces programming design and multimedia application.
3. The project imparts relevance to state and local studies of the broader curriculum through the search for facts, marketing studies, demographics, maps, local industries, and natural resources.
4. The project incorporates the creation of schemata through designing and researching a variety of kinds of information through HTML documents and systems.
5. The project emphasizes cooperative learning through group activities involving school, community, and business partnerships.

The World Wide Web provides a system for linking each classroom with the greatest imaginable system of resources. While the global scope of those resources permits classrooms to transcend the geographical and cultural limits of their communities, MainStreet on the Web has as its primary objective a more modest ambition. Students are linked, not with infinite resources, but with the system of cultural and business activities that occur just outside the school house door. MainStreet on the Web encourages students to see familiar and local enterprises in the same context as the worldwide resources of the Web. There, they have the chance to engage in constructive investigation of local resources, both in terms generated by their own understanding and in relation to other, possibly more sophisticated, Web-based information and marketing pages. They help their local businesses develop an initial presence on the Web and, at the same time, learn from those businesses what they hold dear, have to offer, and most want to describe in their marketing presentations.

Two central players in this program, apart from schools and their adopters, are the local Chamber of Commerce and local Internet Service Providers (ISPs). The Chamber provides a standardized set of links identifying general, governmental, cultural, and commercial resources common to many of the concerned businesses. Chamber members can provide valuable assistance in making school-with-business connections, as well as providing a framework for Web-based marketing for both the City and many of its public agencies. The development teams can encourage ISPs to provide connections for Web developers as well as special rate for new business partners. This partnership increases interest and Web utilization which repays the ISP.

There are additional benefits in this program beyond experience for students and a set of preliminary marketing tools for business persons. Business participants learn to appreciate and work with school technology personnel, both young people and professionals. Students gain valuable insight into the relationship of their current skills and their applicability to the workplace, in addition to understanding the nature of computing within a broad spectrum of the entrepreneurial system, especially within businesses not commonly thought of as technological industries.

Free enterprise classes and Web Development Teams from local schools are not, of course, going to provide Web marketing documents of professional or enduring quality. The purpose of this program is not to underwrite business marketing campaigns but rather to introduce small businesses to the Web, to introduce students to the world of business, and to introduce schools and businesses alike to each other — their skilled and committed fellow citizens of different generations and, often, surprisingly common purposes.

A prototype of this program can be found at the URL http://www.tec.nsula.edu/mainstreet.htm along with project materials which outline the development, management, and instructional considerations necessary to insure an educationally sound collaboration among participants. The files include curriculum enrichment ideas for computer literacy, free enterprise, economics, social studies, and retail marketing.

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CROP: Communities Resolving Our Problems - Community Design for 21st Century Learning

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In brief, CROP is a feature-rich and instructionally focused web site currently in operation on the Internet. The basic idea of the CROP site is to teach each other across communities, and through integrating desktop and online resources, to more effectively teach ourselves. In design, the CROP web pages consist of three main modules (SUP, LEAP, and THINK), each of which represents a different kind of educational model. These three main modules will be discussed in greater detail.

CROP promotes constructivist principles, engagement through situated learning, authentic problems, distributed professional development and learning, higher order thinking, problem solving skill development, just-in-time training, collaboration and team building, and technology integration for classrooms and communities. An easy-to-search database format provides data for on-going course improvement and long term qualitative research into the nature of questioning. CROP is also a process of value to any content area at almost any age, but adds special value to reading, writing, and social studies activities. Beyond the classroom, CROP integrates larger communities along the lines of specific problems. It also constructs social capital and provides a new kind of social history; a public record of a community's on-going work towards solutions to problems. Along the way, CROP provides a bridge from classrooms in technology transition to a twenty-first century learning community.

A Module: SUP - Problem Survey and Threaded Interaction

This module emphasizes social interaction. It promotes communication through a running survey of problems as well as contributions to those problems. As educators we know the value of authentic problems. Authentic problems engage us in specific situations, giving concrete application to our teaching. It is not that these are so hard for teachers to create, but creating them every day for every lesson is certainly a major challenge. It is a bit ironic that public schools that need real problems for their instruction are surrounded by communities awash with real-world problems, with Still Unsolved Problems (SUP). Until the Age of the Internet, we have lacked a constant means of communication between those actively engaged in the classroom and those in the home, business, government and other systems that surround our educational community. We can increase this rate of interaction through the use of the Internet which gives us a historic opportunity to do so. This opportunity has important implications for our culture in general and education in particular.

At its most basic level, this module is a database linked by form pages. These form pages allow the user to add records to the database and to search the database. When displayed, the full database records simultaneously provide a form that attaches contributions for the discussion to the thread of thought on a particular topic.

For now, preservice and inservice teachers in various courses and workshop participants are encouraged to use these form pages to enter problems; any problem on any subject. In time, as we train our local community members to use the Net (slang usage for Internet), they will also be encouraged to share in community problems. As the number of users increases, a critical mass can be achieved where every question will be likely to have an interested contributor. Further, the questions are of interest in their own right. What percentage of the questions match different parts of Bloom's taxonomy? How does this change within a particular community or classroom that is participating? The questions become both a running poll of community needs and a running history of a communities problems, whether the community is a classroom or stretches to communities beyond the school building.

That databases provide excellent reporting functions raises interesting political and sociological implications. During the next debate on school financing, a school district might be able to report that several thousand community based questions were actually answered by classroom students. Interaction builds social capital as well as educational capital. Schools might also be reporting increased student interest in community development and community service. Knowing the problem goes a long way towards generating the interest to solve it.

To be successful, the database must have a wide range of problems for a very wide range of children and adults. When this database grows large enough, those looking for problems to solve, will find extensive lists of problems on any topic. They will find real people with actual problems that could use problem-solving help. In theory, with a database of sufficient size, any teacher nearing the end of any unit could search for still unanswered problems relevant to their instructional activity.

Currently, though, the database is not rich with problems. This process of filling the database works most effectively as a team of people interested in the same area share with each other their problems and contributions: a team of employees, a classroom full of students, a region of student teachers, a group of administrators, etc. Others who are not part of our team can begin to make contributions as well, Because we are sharing our problems in a public forum. As teams and groups begin to cross-talk, many new directions are possible.

A further limitation on the growth of CROP is the state of technology diffusion. Your classroom and work situation may be in transition from no or limited technology access to something greater. You need a way to participate now without computer technology and then migrate to more sophisticated uses as your resources grow. The SUP process can be carried out with cards, tagboard and the school building library. This process will parallel important aspects of a computer-rich environment.

A Module: LEAP - A Taxonomy of Tools

LEAP stands for Look, Evoke, Assess and Perform (or Publish). Each represents a different stage of the problem solving cycle. This module is a structured toolbox in which the structure is a process for solving problems. It provides scaffolding to assist the problem-solver towards integrating a wide array of technologies and applications at different stages of the problem-solving process. Increasingly, it teaches users how to use its tools. Links to these resources are made directly from the World Wide Web (Web) pages. This module tackles another long standing issue for our field of education, providing a conceptual model for integrating technology and curriculum (Taylor, 1980).

Because a wide range of computer tools is suggested by links to these tools at each LEAP stage, LEAP widens the view of the computer-mediated tools that should be in use. In so doing, the model also builds on the wide range of cross-curricular thinking processes involving discovery learning and critical, reflective and evaluative thinking. It further complements prior work across many content areas (Germann, 1991; Peters, 1987; Clarke, 1990; Gipe & Richards, 1992). Consequently, the model has application for the learners/students, preservice and inservice teachers and administrators; this group will hereafter be called the thinkers.

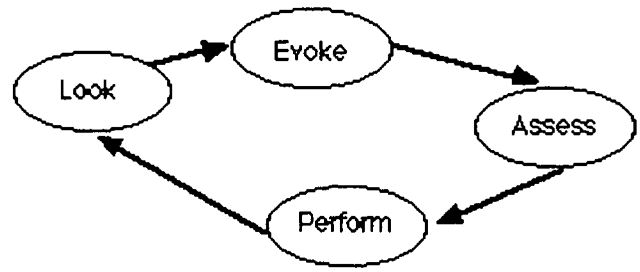

Figure 1. Simplified LEAP model.

An Overview of the Simple Model

In this model, the learner looks for and collects data, constantly cycling through decisions based on relevance and interest. The quantity of data streaming through our computer networks has been likened to a firehose operating at capacity, but a firehose surrounded by the needy who are holding out small and specialized cups. To throttle this deluge and move just the needed information to the problem at hand makes management a critical skill for the learner at this stage of the thinking cycle. Further, the tremendous range of "information highway" options through our computer networks (e.g., the Internet) along with the numerous high capacity local workstation tools (e.g., the full Compton's Encyclopedia with multimedia on CD-ROM) make for both complex and sometimes costly decisions (costly in terms of time and access charges).

These thinkers use the found information of the previous stage to evoke a response. That is, the composer must create with sufficient skills to stimulate a response from others. Without a response, the effectiveness of the communication cannot be known. The greater the communication skill, the greater the ability to put the new found information of the Look phase in a context readily understood by the creator or by the listener(s). To date, primarily just one computer tool, the word processor, has been heavily promoted for composing thought. However, not only is the text manipulated by the word processor (just one of many means of computer mediated expression like paint, digital video editing, and music, but it is no stronger than other equally available tools for efficiently and playfully mapping and guiding developing thought through the use of outliners, draw programs or spreadsheets.

The learner must next pause to assess progress. Assessment runs from low level spelling and grammar checking to reflective discussions among members of online work groups of projects underway. This stage requires emphasis on value judgment. Evaluation skills must cover the wide range of potential means of expression noted in the previous stage, from word processor programs to spreadsheet programs to multimedia. This assessment is formative in nature. That is, the goal of assessment at this stage is to have an impact on a creation still in development.

Last in this cycle, the thinkers perform or publish their creations. Publishing implies far more than submission for a grade in a classroom. It calls for the targeting of an audience most similar to the focus of the author or creator. Publishing is sharing among peers, among those with genuine interest in a topic. Further, I use the term synonymously with perform. I intend for this stage to appeal equally to those whose means of sharing does not necessarily involve the simple frame of a page or a video screen, such as a choreographer, a conductor or a gymnast. The emerging information highway gives thinkers an instantaneous neighborhood and global reach for their effort. Yet, publishing is not really last in the cycle. Publishing often serves as the incentive to begin the cycle again, a recycling stimulated by feedback on the performance or publication. Inherent to the publishing stage is a more summative assessment of achievement.

A Deeper View of the Model

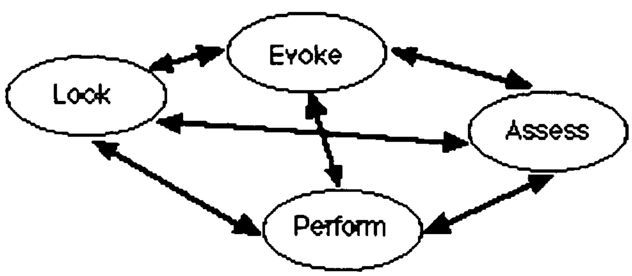

Figure 2. Complex LEAP model.

The concept of a cycle facilitates description within the linear nature of an essay on paper and aids initial instruction for students. However, it disguises the nonlinear nature of the process in the real-world. The model should support non-sequential interaction between any two or more stages of the model. In a more realistic model above, the arrows go both ways and to all stages, not just the next stage.

An Overview of the Complex Model

The implication for the more experienced thinker is simple. There is no correct place to start. There is no mandated next stage. The time spent at any one stage varies with the experience of the thinker and the needs of the project at hand. Yet it is my hunch that when the project is finished and the communication has been "published", thinkers will find that the better the balance among the time spent at each stage, the higher the quality of their work.

LEAP is an extension of the work of those developing thinking process skills in many curriculum areas (Kelvin & Leonard, 1992; Pelletier, 1992; Manzo, et al, 1992; O'Loughlin, 1992; Pruett, 1993; Reschke, 1991). LEAP and the larger CROP model can easily scale to communities of many different sizes, taking advantage of the global reach of today's computer networks (Hunter, 1992; Anderson, 1993).

Not!

A balanced discussion of new technologies must also consider actions not performed by the computers of today or of the foreseeable future. Humans, not computers, choose problems and purposes. That is, somehow a selection must be made among all the vast things at which one might view at the look stage. Our selections are based on human intentions, on problems and purposes as thinkers see them. Only when these decisions are made can computers amplify human intelligence. At each LEAP stage the most substantive actions of that stage are not taken by computer technologies, but by the value laden actions of human beings. Consequently, these actions taken at the local computer highlight aspects of thought that are unique to humankind. I pass for now a more extended discussion of the question of whether technologies can ever can fulfill them or whether it should. It is my bias that the computer cannot perform these value laden roles, but if it could, it should not; however, connecting our value systems with these wide reaching computer capabilities is essential in allowing the technology to provide the greatest possible magnification for the role of human intelligence, for the ethical direction of technology, and for the even more critical role of intelligent teaching. The importance of this issue requires educators to consider carefully the degree to which our system of education emphasizes instruction in ethics. Without a significant ethical base, increasing human power to think (through the enhanced ability to deal with information) merely empowers a two-edged sword to cut in both random and negative directions.

LEAP provides an educational framework for integrating new technologies with the critical and creative processes of finding, inventing and sharing solutions to real world problems. In the nonlinear environment in which we live, our inventiveness and our ethics, not just our forecasting skills, may yet keep the human race alive.

A Module: THINK - A Reference Room

Where the SUP module is a polling booth and chat room and the LEAP module is a workbench, the THINK branch is a specialized reference room. THINK serves as a growing reference room of resources and links to study higher order thinking skills, to explore issues in the practice of problem solving and to follow links to other thinking agendas including ethical, creative and critical thinking. As Bloom's taxonomy and the thinking skills agenda is reasonably well known, it is perhaps more useful to consider why the Bloom initiative has been so difficult to achieve.

Bloom laments that years after the publication of the taxonomy of thinking, it is still not well used and worse, that the quality of thinking activity is little different in American classrooms than it was forty years ago. So, where do we go from here? I believe that Bloom and others have not gone far enough, but by this I do not mean go further in analytical divisions of thinking. Neither Bloom's work (Bloom, 1956; Jonassen, Hannun, & Tessman, 1989) nor Marzano's revision (1988) of it used by some states (e.g., North Carolina's educational system) connects sufficiently with real-world problem solving. Bloom's taxonomy is not a strategy but an analytical listing of the elements. For example, when your tire goes flat or when you need to advise your state legislator on an issue Bloom's taxonomy does not readily come to mind, even though when finished we can analyze our process and see that at different times we used the different levels of thinking skills. One might say that Bloom's thinking stopped short of his stages of application, synthesis and evaluation. Bloom has given us a set of tools, some bricks and boards, but not given us the design for how this becomes a house. CROP is so designed to provide the house whose blueprints reference the higher order thinking skill agenda that was given such momentum by Bloom and others.

Conclusion

Today, then, not only do we need instructional designs to apply Bloom's taxonomy in a meaningful way, but we need models that incorporate power tools into our models of thinking. The previously discussed LEAP model represents steps in this direction. LEAP provides scaffolding to assist the problem solver with integrating a wide array of technologies and applications at different stages of the problem solving process. SUP provides engagement with authentic problems to solve and contributions to make. In turn, the Internet provides the vehicle to deliver these new forms for extending and transforming the practice of learning and teaching. Our instructional designs are no longer bound by our physical architectures. Those interested in experimenting with the expansion of this form of learning into the twenty-first century are encouraged to contact the author.

CROP's Web Address: http://www.ceap.wcu/Houghton/learnerhomeEasy2.html

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Thinking About the Author: A New Authoring Paradigm

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The wide-spread use of multimedia tools often involves people from different walks of life including education specialists, designers, publishers, marketing personnel, sales personnel, and film producers. The integration of various media has proven to be a powerful means to facilitate communications and persuade users. It is the dynamics of video media and audio media that makes information absorbing go beyond the mind, carrying new human dimensions such as emotions and feelings. As most multimedia users are not computer literates, we look at how easy it is for them to produce multimedia presentations under current multimedia authoring tools by analyzing the stages, components and complexity of the authoring process itself.

Authoring

Authoring refers to the process of creating anything in any area of human knowledge, generally through the help of specialized tools. We use the name *multimedia authoring* when referring to the process of creating multimedia presentations using computer hardware running authoring software which deals with texts, images, audio, etc.

Authoring Paradigms - A Quick Review

Authoring should be a systematic and a well structured process. There are very few techniques specifically designed for the authoring of hypermedia documents. Currently there is no completely "point-and-click" authoring system; some knowledge of algorithm design, heuristic thinking and a basic understanding of how programs work is required (Siglar, 1995).

A number of authoring paradigms can be distinguished depending on the authoring technique used. Usually a combination of one or more of the following paradigms is found: time and flow based iconic representation such as Authorware; card based such as Apple's HyperCard; frame paradigm; script-based systems such Hypertalk used in Apple's HyperCard and Toolbook from Asymetrix; structure editing systems as described in the paper Rossan, Hardman, & Butlerman, 1993); object direct timing relations paradigm used in (Ryichu & Kaneko, 1990; Fujikawa, 1991); the cast score scripting paradigm; collection based as in HM-Card (Maurer, Andrews, & Scherbakov, 1994). Whereas time- and flow-based authoring is intuitive and best suited for rapid development, it does not capitalize on the inherent modularity of the presentation.

The use of index-card structure makes the card scripting paradigm less attractive because of its low performance and long learning curve. Therefore, the script paradigm offers a strong interactivity with the environment and better flexibility.

Some of the paradigms are biased towards specific applications. A case in point is the cast score paradigm which has better handling of interactive presentations and animations where synchronization is of prime importance.

Structured systems, (see Rossan, Hardman, & Butlerman, 1993), define where and *when objects* are presented on the screen or on audio channels. Structure-based authoring is far from being intuitive and requires a greater learning curve than the time- and flow-based one, for example.

The Authoring Model

The Active Context-Based Authoring Model (ACAM) is a distributed multimedia generic authoring model. It defines four main modules for presentation, authoring, hypermedia and distribution support. The full model is described by Kelner, Djamel, Sadok, and Ricardo (1996).The authoring module is the object of study in this paper. It is divided into two main parts: auth*oring in the large* and *authoring in the small.*

Authoring in the Large and Authoring in the Small

A major drawback identified in existing authoring systems is that they deal with the authoring of multimedia information and ignore the conceptual phase of a *project design*.

This work considers *project authoring* as an important part that is essential to the authoring process. Many authoring applications require a *macro* vision enabling them to provide a big picture of the subject being presented. At the project level, a graph with application links can be used to show the way these components are related to each other. This mechanism was first used in the HDM model (Garzotto, Paolini, & Schwabe, 1991; Garzotto, Paolini, & Schwabe, 1993; Lucena, Rossi, Schwabe, & Cowan, 1995).

Authoring in the small refers to the process of instantiating the types/classes/concepts/structures defined during the previous stage.

ACAM's Authoring Methodology

A methodology for this development work, with stages representing the natural and intuitive course of an authoring process, was established. Starting with a generic model, successive refinements are applied until it results in the author's target application.

The methodology consists of the four stages:

- Conceptual Modeling - an open authoring stage allows the modeling of real world situations. It defines relations among topics/subjects/themes;
- Navigational Modeling - defines the navigational aspects through the promotion/election of parts of the topics/subjects/themes to the status of nodes;
- Presentation Modeling - the presentation interface and user interaction aspects are defined; and
- Instantiation - multimedia data is created and associated with the elements of the presentation according to the pre-established author's model as defined in the previous stages.

ACAM's Authoring Paradigm

The discussion has shown that different paradigms have different strengths and that there is no single one that outperforms all the others for all considered applications.

The Proposed Paradigm

In order to support the above requirements, the ACAM user interface adopts a balanced combination of the following paradigms: time line and flow icon based paradigm to allow direct manipulation of multimedia objects an links; in order to facilitate the understanding of complex applications, ACAM adopts the idea of context, supported by the collection paradigm, and found in systems such as in HM-CARD. Contexts modularize presentations into manageable hierarchical objects and avoid overwhelming the author with information; run-time execution information can also be stored in the objects themselves, independently of the time line as adopted in the direct timing relation paradigm; support for structure editing and automatic derivation of synchronization information; a script language is used to provide better interworking with other applications.

An Analysis of the Authoring Process

To implement the four ACAM's modeling parts, namely, conceptual, navigational, presentation and instantiation, the proposed paradigm defines six stages that an author may execute sequentially or in a cyclic way. These are:

- *application parametrization*: defines parameters controlling the application. Examples of these maybe the levels of users, the application purpose, users' age, presentation language, etc.
- *definition of blocks, sub-blocks and relations: here the application* is structured in information blocks and sub-blocks (see Figure 1). The way these are inter-linked is also defined here; therefore, the system may derive from here the navigational model. The way a block is going to interact with another one, through the use of a selection button or after a given time has elapsed, is defined later together with the information that makes up a block. A user may select a block and define its graphics, context and synchronization information separately from other blocks, therefore guarantying their reuse and extendibility.

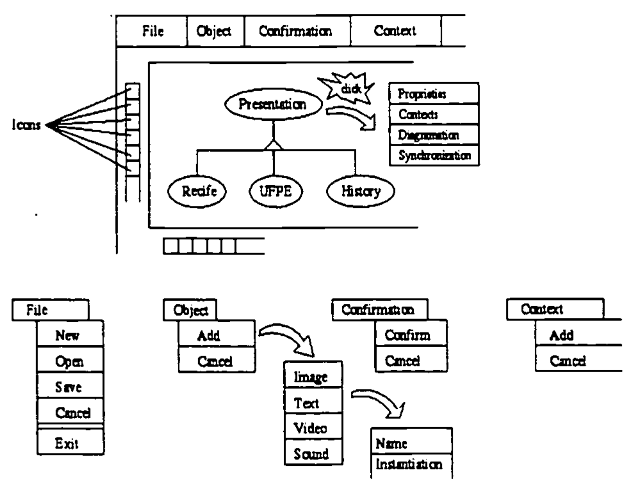

Figure 1. Project Authoring.

- *definition of media objects*: involves the creation of multimedia objects using the menu option "Object" (see Figure 1). Objects will be subsequently associated to their respective blocks (see Figure 2). Created objects are then added to the system's object library. Library objects may be real ones (such as sound, text, image, or video files) or significant names that will be instantiated later on.

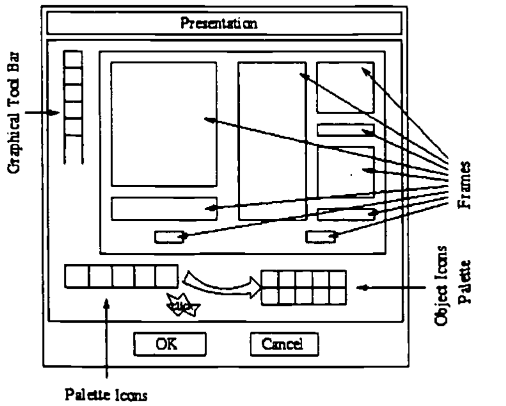

Figure 2. Creating Presentation Frames and Objects.

- *defining the graphics information for a block:* when clicking on the node, the author can select the option "Diagramation" and a window containing graphical tools is provided. These graphical tools, except the sound icon, are used to define the frame location and size (see Figure 2);
- *assigning objects to blocks*: the objects of each block will be retrieved from the "Object Icon Palette" and dragged to the frame which the object must be associated. The window where this task is carried out simply covers the previous information ensuring that the structural scheme remains visible during the whole process (see Figure 2);
- *definition of the flow and object synchronization of a block:* using this option the author may define temporal relationships among the objects of a block, through the use of a time-scale flow line, in order for these relations to be as visible as possible (see Figure 3);

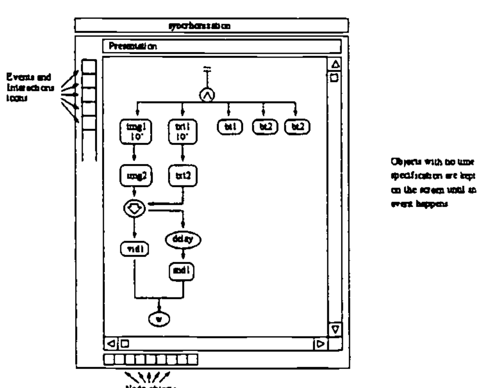

Figure 3. Object Synchronization.

Conclusions

In this paper we have presented an authoring paradigm that, unlike existing ones, focuses on the author as well as the final authoring application or product. We have shown, through a comparison of some of the existing paradigms, that there is no overall best paradigm but that a suitable combination of these may produce better results. Core to this paradigm are the initial stages identified, namely the parametrization and project design phases. The proposed paradigm combines the use of icons, the time line and structured authoring.

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Surgical Problem Solving and Intuition in Today's Medical Education Curriculum

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The pace of medicine in today's society has quickened. With the explosion of medical information, medical education has struggled to keep pace. In addition, the changing health care environment means faculty have less time for bedside teaching and demonstrating physical diagnosis. Overall, this has left medical students alone trying to bridge the gap between learning core medical knowledge and using that knowledge to care for patients. In addition, advancements in medical technologies such as CT and MRI imaging have taken much of the mystery out of making diagnoses. Many times these machines will make the diagnosis for you (Whitman & Lawrence, 1991). However, "[r]adiologic or ultrasonic examinations, CT, and the vast array of laboratory tests available to all of us today will not compensate for a poor or incomplete history and physical examination" (Silen, 1991, p. 7). Over-reliance on technological aid has led to decrease in the quality of problem solving skills among younger physicians. The ever widening gap between learning and using information indicates that the need to teach problem solving is greater than ever.

Traditionally, the hypothetico-deductive method is taught to medical students. This is the diagnostic process of focusing on one or more evolving diagnostic hypotheses. The hypothesis can fall into several forms: a state, a clinical disorder, a syndrome, or a specific disease entity. Usually, the doctor will begin this process simply from the patient's age, sex, race, and presenting complaints. Additional hypotheses emerge as new findings are discovered (Abernathy & Hamm, 1995). This model obviously works well because it is what most doctors use. However, this approach is ill-suited to some fields, notably surgery. In trauma, emergencies, and operative situations, there is rarely time to reflect and formulate formal hypotheses. Therefore, experienced surgeons have develped problem solving skills and intuition to cope with these situations.

Whitman and Lawrence (1991) discuss five reasons problem solving should be taught. First, patients do not present with a disease, they present with symptoms. Physicians must apply factual knowledge by moving from symptoms and physical findings to a diagnosis. Problem solving enables the student to transition from data gathering to data interpretation. Second, due to today's hectic medical teaching pace, there is a decrease in contact between students and teachers. This places the burden of learning to interpret information on the student. Third, students who use problem solving and systematic approaches to diagnosis save time and money by using fewer tests and arriving at a correct diagnosis more rapidly. Fourth, there are some medical diagnoses that only can be made through problem solving. For example, there are no tests that will tell a doctor that a patient has acute appendicitis. One must weight the factors for and against and arrive at a conclusion. Finally, in operating rooms and emergency situations, surgeons must continue to rely on their problem solving abilities because information is changing rapidly and many times a decision must be made before all the facts are gathered. "Problem solving when taken to its highest level becomes superb judgement" (Whitman & Lawrence, 1991, p. 97) or intuition. Surgeons must develop problem solving skills which will later evolve into intuition.

The material that is taught to medical students, especially in surgery, is increasingly complex and ill-structured. Typical instructional methods which teach isolated medical facts, will fail to accomplish important educational objectives in part because of the oversimplification of the material presented. This oversimplification results in the inability to transfer knowledge across to new and varied domains (Boger-Mehall, 1996). Since one cannot learn every fact for every situation, the new surgeon must be taught problem solving skills that will allow him or her to think with flexibility and apply their knowledge across many situations.

The most common method of teaching problem solving is through the use of patient scenarios or "scripts."

Recently, *The New England Journal of Medicine* started featuring "Clinical Problem Solving" which uses thinking aloud scenarios to highlight the thought processes involved in making medical decisions. This "script" or "hypothetical patient" approach to teaching medical thinking gaining popularity.

The mind of a master surgeon has been compared to that of a master chess player. It is thought that both have a kind of "intuition" that allow them to determine the next move. According to Abernathy and Hamm (1995) "'Intuition' often means that part of thinking which cannot be explained...[I]n general, intuition refers to remarkable mental performances that move rapidly yet unaccountably to correct conclusions" (p. 23). On a practical level, intuition is the ability to recognize the whole from the sum of its parts.

> A 28-year-old man with a stab wound to the left chest in the midaxillary line, 6th intercostal space. His vital signs are pulse 120, blood pressure 120/80...A left chest tube produces 400 cc of blood. Diagnostic peritoneal lavage (DPL) shows 3,000 red cells per cc... While you are preparing the patient for laparotomy, another 1,000 cc of blood comes out of the chest tube. You take him to the operating room, and first you explore the chest, finding an actively bleeding deep laceration of the left lower lung...Oversewing doesn't work. It is still bleeding. (Abernathy & Hamm, 1994, p. 39).

Situations in real life are not black and white as they are presented in many texts. In the scenario above, it is the "intuitive" application of knowledge to the given situation that enables the surgeon to help the patient. For any problem there is not a universally right or wrong approach, rather each problem is patient specific. Often there are several coexisting problems, and in some cases, time doesn't permit the gathering of all the facts before a decision must be made. Thus, the development of problem solving skills and intution best enables surgeons to apply their knowledge to an array of problems in changing and varied situations.

The goal of curriculums that teach surgical problem solving and intuition is for the students to gain the characteristics that master surgeons possess. These surgeons are clear thinkers that are not distracted by false leads. They can link their present situations to past experiences quickly and accurately. They know what questions to ask and how to prioritize their actions. Three ingredients necessary to create a master surgeon are: (1) surgical practice, (2) intellectual curiosity, and (3) an ability to look back on cases objectively (Abernathy & Hamm, 1995). Teaching surgical problem solving and the use of scripts promote the aquisition of these necessary ingredients.

Unlike problem solving, intuition cannot be directly taught. The instructor must provide opportunities for the student to acquire this skill. The script approach allows students to examine the thought processes of master surgeons "as they consider problems and make decisions about them" (Abernathy & Hamm, 1995, p. 11). Abernathy and Hamm (1995) discuss the potential benefits of using scripts to teach surgical intuition. As a student reads a script, it provides a framework on which to hang additional textbook information. While an actual patient is always the best teacher, the use of scirpts allows the student to experience a wider variety of patient situations than one could ever encounter in real life. This provides the students with "experience" upon which they can draw for future patient encounters. Scripts also allow exploration of the risks and benefits of different decisions and how they impact the patient's outcome with impunity for poor decisions. They may also be used by cognitive scientists to better understand how expertise is acquired (p. 11).

Utilizing the script approach to teach medical students will give them the opportunity to think flexibly and intuitively. According to cognitive flexibility theory, the way students are taught has a significant influence on the type of cognitive structures they create. The manner in which students store and structure knowledge acquired determines to a great extent how flexible they will be when using that knowledge (Boger-Mehall, 1996). Cognitive flexibility "...includes the ability to represent knowledge from different conceptual and case perspectives and then, when the knowledge must also be used, the ability to construct from those different conceptual and case representations a knowledge ensemble tailored to the needs of the understanding or problem-solving situation at hand" (Spiro, Feltovich, Jacobson, Coulson, 1991, p. 24). Flexible instructional methods (i.e. problem based learning) help students learn the contours and complexity of the material they are studying, and it helps them work with that content from several different perspectives (Spiro, Feltovich, Jacobson, & Coulson, 1992). The flexibility of the students' knowledge structures allows them to apply their knowledge to novel and varied situations.

Although the content of the scenarios must be created by experts in the surgical field to create the best learning environment, the method of instruction is crucial to cognitive flexibility theory and the development of intuition. Scripts must provide multiple presentations of the same information, and there should be many concrete examples of the uses of a given concept(Dick, 1991). In addition, scripts should provide opportunities to utilize the same information for different purposes.

Through the development of problem solving and intuition, higher order thinking skills are acquired. These skills are nonalgorithmic and complex (ill-structured). The path which surgeons take is neither visible nor specified in advance. Higher order thinking skills lead to multiple solutions, each with benefits and costs. Many operative situations will require the application analysis of multiple criteria, sometimes conflicting with each other. A surgeon with higher order thinking skills can derive meaning and direction in situations where there is apparent disorder. Overall, this level of thinking requires effort. There is considerable work involved in making these kinds of judgements and elaborations (Abernathy & Hamm, 1995).

With advances in technology in today's society, traditional medical education can be enhanced to teach skills that aren't learned during lectures. Lecture is a teaching format that is ideal for well-structured domains such as anatomy and biochemistry. These do not require the flexibility that ill-structured domains like clinical medicine does. Traditional systems such as textbooks and lectures lack the flexibility needed. Each case in medicine is different requiring doctors to be cognitively flexible. With appropriate supporting material, the computer is a well suited tool to teach in a flexible method. It provides the variability needed to present ill-structured material and to help students explore more than one perspective on a topic or issue. Technology provides a nonlinear, multidimentional medium in which complex subject matter can be taught. The power of technology supports a flexible approach that uses multimedia and hypertext systems.

Advantages of computer instruction include for students to work independent of faculty thereby requiring less faculty time commitment. Students can also return to the program for additional studying if desired. The logistics of coordinating students and faculty into class meetings is alleviated, and there is no limit as to the number of students who can utilize the program. Self-contained programs can be exported to other schools via CD-ROM or World Wide Web. Some new technologies allow the student to utilize the program from home or otehr remote sites.

Using technology to teach surgical problem solving and intuition is gaining interest in several medical schools across the United States. Computer programs can be used to teach problem solving skills and to encourage the student to integrate and process information instead of memorizing.

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Information Technology and the Classroom of the Future

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Universities are usually successful in creating, gathering, and imparting knowledge. They are less successful in applying that knowledge to instruction. Academic researchers recognize the valuable addition of technology to communication, efficiency, and decision making, but whiteboard and paper remain the primary teaching materials in most classrooms. There have been efforts in the academic community to move from a paper-based classroom to a paperless classroom. Unfortunately, these efforts have usually been isolated and generally have not tailored technology to support various student learning styles. This paper presents a paperless classroom implementation that uses technology to support the model of learning appropriate to a particular learning situation. The focus is not on the technology but how the technology enhances learning.

Goal

The Department of Electrical Engineering and Computer Science of the United States Military Academy (USMA) is in the sixth year of an on-going project to use technology to enhance learning. The goal is to use information and educational technology to make the transition from a lecture-based, paper-centered learning environment to a discussion-based, paperless one. Lectures and texts are linear in nature, while learning has long been recognized as a non-linear sequence of events. By reforming and reorganizing the way learning material is presented, the paperless classroom enables students to be more efficient in their learning. Applying the paperless classroom concept facilities an active learning environment that uses distributed resources to contribute current information to the student.

The current learning environment is for the most part instructor driven using in-class resources. Students attend lectures where topics are developed and discussed and then depart the classroom to hopefully practice or review concepts through readings and homework. In the cases where there is audio or video employed to demonstrate a concept, there is usually little linkage between the mediums. The paperless classroom desires to change to multimedia and hypermedia, linking media and concepts to cater more effectively to students' learning styles and academic desires.

Background

Problem

Despite the proliferation of computer networks and information technology into the classroom, instructors and students still use paper as the primary means of assigning and submitting graded requirements.

Solution

With computer networks, such as local area networks (LAN) or the World Wide Web (WWW), instructors assign, assess, return, and discuss student projects without ever using a piece of paper. This not only sales the cost associated with paper products but also gives the students the ability to display a broader range of information in multiple media. This effort is primarily a pedagogical step towards identifying and implementing student-created multimedia in a current technical course.

Previous Work

There is a wealth of research on the positive effects of technology in the classroom (Leidner, 1995). Studies on the introduction of video clips into classroom instruction show that video clips are motivational for students. It has been shown that instructor consoles contribute to both perceived and actual information structures. Classrooms with both instructor workstations and videodisks improve student attitudes about the instructor and the course. Several institutions have reported positive results from the use of electronic mail (email). Overall, the body of literature convincingly illustrates that new technology positively influences student attitudes toward the quality of the instructor and course organization. Several institutions besides the USMA have attempted to institute paperless classroom concepts (Brown, 1994; Lane, 1995; Shneiderman, Alvi, Norman, & Borkowski, 1995); however, none of these efforts have been as broad or as enduring as the efforts at the USMA.

The evolution of a paperless classroom began over six years ago in CS383, Computer Systems. Previously, assignments were handed out in printed form. Lectures were delivered using overhead slides, and students read and annotated printed text books. In 1990, the Academy purchased large screen monitors for all computer classrooms, enabling instructors to deliver material through presentation graphics. At the same time, the Academy network was established, allowing students after-hours access to the instructors' slide show materials. Instructors embedded multiple media items into the slide shows to accentuate or expand on certain concepts. The course was well on its way to becoming an all-encompasing multimedia in the classroom, but was still tied to a text course resource.

When the Academy network reached the student rooms, the course began to make serious inroads in the pursuit of the paperless classroom. Students were emailed assignments and given access to shared directories on classroom servers, making it easier for students to ask specific questions or submit class assignments. Multi-user dimensions (MUD) were created and used for student interaction. Other interactive forums were list serves and electronic bulletin boards. They are all used with varying success.

In 1994, course media elements and slide shows were incorporated into a system of Web pages that allowed students a nonlinear access to the course material. A learning style assessment was added to help students approach the massive amount of material contained in the WWW course resource. A hypertext reading file gave students a new way of pursuing a topic through the reading assignments (Carver & Howard, 1995). For the last two years, efforts have been dedicated to expanding the media coverage throughout the lesson material. Throughout these technological innovations, the overriding focus was enhancing the learning environment for the students. Technology that distracted from or did not add to this focus was discarded.

Requirements Planning

Before beginning the odyssey of purchasing and implementing vast amounts of information technology, it is useful to articulate actual requirements. Based on experiences at USMA, the following questions can help ensure that all participants of the budget and planning process are clear on the intent and execution of the transition plan.

Where Are We Teaching?

In this step, instructors should focus on the physical locations of the student and the instructor. If the instruction is delivered in the classroom, one should focus on information presentation. If the student uses the course resource outside of class or in a distance learning situation, connectivity and supporting referential materials are important. If using the resource as an integrated tutorial or help system in the work place, structuring the information to answer specific questions is the dominant design theme.

What Are We Going To Teach?

Multimedia is not the goal. The information technology integration process must focus on using multimedia or hypermedia as the means to the end. The goal should always be making learning more efficient. By considering how applicable particular technology is to the target subject, an instructor can assess and articulate where and how technology will affect the lesson. Experience shows that at the beginning of the transformation lesson content will be the same as it was in the older style class. Later, instructors discover they can cover more material in less time due the power of the multimedia and hypermedia presentation.

Who Are We Going To Teach?

Just as text books are selected so that they are at a meaningful and realistic level for their students, technology used in a paperless classroom should not overwhelm the course material nor scare the students away. Before purchasing any technology, instructors should survey their courses to determine the degree of computer literacy and the overall level of comfort with technology. Experience shows that younger students seem to adapt easily to on-line systems, while older students have difficulty reading large amounts of text from a computer screen.

How Are We Teaching?

Technology should allow lecture based courses to migrate easily into discussion-based ones. The key is to create active learning environments. Instructors should consider how they have organized their courses and then find ways to implement new tools. For example, large lecture courses could benefit from having notes, slide shows, or recorded lectures placed on the campus network for student reference.

Learning Environment Tasks

Deliver Instructional Material

Perhaps because professors, instructors, and lecturers perform the task of delivering instructional material on an almost daily basis, this area has seen most of the advances in recent years. Starting with notes written on a chalk board, instructors have progressed to view-graphs and presentation graphics slide shows.

The next step is the use of multimedia to enhance the information content of the presentation. This can be done in several ways. The first is to use several separate media sources and have the instructor switch the presentation between them. For example, he might show a slide show, then switch to a video cassette by turning off the projector and turning on the VCR and TV. This solution has the elegance of simplicity but is hindered by the fact that not all faculty are comfortable with the technology involved in operating and maintaining all the different media devices. A more advanced technique would be to embed the multimedia objects into the slide show and have the instructor select them when they are appropriate to the presentation. The use of embedded graphics has been implemented using Hypertext Markup Language (HTML) and the WWW. Using web pages that link to multimedia files, the instructors use the web browser to select and play the various media files. So far, maintenance has not been an issue due to the wide variety of media formats available through most web browsers.

Another benefit to delivering instructional material electronically is that students can tailor the way they receive the information by their learning style (Carver, Howard, & Levelle, 1996). In CS383, students take a learning style assessment that adapts the lesson interface through the material based on their individual learning style. Used for three semesters now, this assessment tool is implemented using the Felder Learning Model. While this has been successful in a robust multimedia course such as CS383, further work is being carried on to validate the benefits of an adaptable interface to an on-line course reference.

The future of delivering instructional material lies in reaching students outside the traditional classroom environment. This is not only crucial to the student living in a remote area (Farinetti & Malnati, 1996) but is also important to schools with limited enrollment in some courses (McShane & Shaw, 1996) one way to accomplish this is to record video or audio tapes of classroom lectures and mail them directly to students or place them on a Web site or networked computer. While this does enable the instructor to deliver material, experience (Hubbard, 1996) as shown that students quickly become bored with the "talking heads"' and are frustrated by their inability to ask questions.

Delivering instructional material can also be achieved with video teleconferencing (VTC) systems. While the cost of these systems range from hundreds to thousands of dollars, their implementation is the same. One instructor sends video and audio signals to students at another location. The students can interact with the instructor by using the system on their end of the conversation. At this time, VTC has been used primarily for guest lecturers.

Interact with Students

Once the basic instructional material has been presented to the students, they will often respond with questions or comments that help them gain a better understanding of the material. Traditionally this has been done in lecture classrooms, through office hours, and laboratory sections. The common thread to all three methods is giving the student contact with an instructor as well as instigating conversation among the students as a class. In large courses or situations when the student cannot conveniently travel to the instructor's location, this is typically the first area of education to suffer.

One method for generating student interaction is to use electronic mail (email) to pose queries, answer questions, and pass along assignments and assistance. A more open forum can also be generated by a mailing list, such as a USENET news forum, list serv, or bulletin board system. In these applications, one student's question is passed to all users that are subscribed to the list, allowing many people to comment and keep up with a discussion. Another method that uses computer connectivity to foster interaction is the use of Multi-user Dimensions (MUDs) to enable students to interact with instructor. At both Georgia Institute of Technology and the USMA, faculty members hold virtual office hours by logging in to the MUD at specified times. Students can pose questions on certain topics in theme rooms, where the question is available to anyone entering the room (Dieberger, 1996).

One of the more innovative means of interacting between students is with a game. The CS383 course uses the action-adventure game DOOM to pose multiple choice review questions to the students (Carver & Gregory, 1996). The goal is to place the students in a familiar environment (a computer game) and then encourage studying through a competitive application (answer the question correctly or your game character dies.) This has been extremely successful and, with a free editor available through the WWW, been maintained to keep pace with the course.

Assign, Receive, and Evaluate Assignments

To increase comprehension of the material, most courses assign projects and papers that force students to demonstrate an understanding of certain concepts. Assignments are given out in CS383 through links on web pages, files on networked drives, and email to students. They search library resources using automated databases, browse the WWW using search engines, and request material from information services like ERIC and Lexis. These are all available to most instructors, but experience has shown that students must be encouraged to use them. Project requirements to include a multimedia component or hypertext link to outside sources are the first step in showing the student that information is available through sources other than the text book (Adams, 1996).

When the project is due in a paper-based classroom, students print out their paper or project and hand a folder to the instructor. This is not only inefficient and costly but it also denies anyone else the benefit of student research. One simple method of electronic student submission is to create a shared directory on a networked computer and require students to place their submissions there. The instructor can access them at anytime and the projects are available for later use. Care must be taken, however, to prevent the spread of computer viruses and electronic copying between students. Passwords, permissions, and logs have been useful but not totally effective.

The most elegant method for receiving and evaluating assignments is to have students create Web pages and submit their projects as HTML files. This has been done successfully at Brown University (Landow, 1996) and USMA. Not only does it allow student research to be available, it is also a vehicle toward expanding projects beyond linear text. Students are able to include graphic, video, and audio components in their projects that were not previously available. The drawback is that electronic submission requires projects to be graded online. Qualitative evidence in CS383 has shown that it is no more difficult than reading printed papers.

Assess Understanding and Assimilation

Finally, every course has an evaluation or assessment component. As with the other categories of classroom tasks today, this is mostly done through printed examinations and possibly scanned answer forms. This method has several widely recognized drawbacks:

1. Tests are costly to create in terms of instructor time. Usually, multiple editions of a test must be created to allow fairness between separate sections of a course.
2. Written examinations are costly in terms of time spent evaluating the student responses. Although electronic grading is useful, its restriction of multiple choice tests is too confining for most instructors.
3. Consistency of evaluations can vary because of the time pressures placed on graders. An answer that earned a B at dinner time might earn an F at 3:00 AM!

Automated Testing can alleviate these issues. Quizzes can be given through scripts and test programs (Carver, Ressler, & Biehler, 1995) or games (Carver & Gregory, 1996r The advantage to these methods is that a computer can create an almost endless number of different multiple choice and short answer tests with little effort and grade them all consistently. In the case of CS383, the Student Response System can give tests that adapt to the user's demonstrated level of knowledge (Carver & Ring, 1996)The drawback to these methods is one of student validation. Passwords and user names are not stringent enough to prevent students from getting other people to take tests for them. There is also the question of time constraints. Both of these issues are addressed by having the student take the exam in a computer lab at a specified time. In this way, a proctor can verify the student's identity and ensure that the test is completed in a set amount of time.

The Value Added

Whenever educators and technologists begin discussing ways to introduce technology into a classroom environment, the question of value added or return on time invested immediately surfaces. While it has been shown that students enjoy and are challenged by learning in a paperless classroom, CS383 has also shown that instructors can teach more efficiently. Preliminary or reference information typified by objectives on the lower end of Bloom's Taxonomy can be delivered outside class through electronic means. This frees the instructor's time to enable higher level concepts to be discussed and exercised during limited lecture or interaction time (Howard & Lane, 1996).

Another, perhaps more tangible, benefit is that studies have shown that students who learned via online multimedia retain the information as long as or longer than with only text (Howard & Carver, 1990. Information retrieval is also more efficient, if certain structural methodologies are applied when creating the electronic course material (Adams & Carver, 1996).

Challenges

Each step along the path to a paperless classroom has requirements for integration and maintenance issues that must be resolved in order for the technology to continue to be beneficial. At a minimum, instructors must have the knowledge to place material on networked computers or create multimedia resources for their courses. Following this, of course, is the requirement for students to be able to access the material from their dorm rooms, classrooms, or study areas. This investment into connectivity and network infrastructure is not trivial in the short run, but it shows substantial returns in the long term.

Initial decisions to implement a certain piece of equipment or technology must be made after consideration for both integration with current equipment and expansion in the future. Most institutions have adopted an open systems approach rather than tying themselves to a particular operating system or platform. Normally, their funding does not allow for replacement of equipment within the projected eighteen month obsolescence cycle.

Funding is the most contentious of all the issues raised in this paper. It is undeniably difficult to find funds to initially purchase equipment or software. Additionally, one must budget for proper staffing to ensure maintenance. There needs to be a sustained flow of funds. Another budget planning item is upgrading and eventually replacing equipment. Depending on the technology, this period varies between one and five years.

Conclusion

There are varieties of opportunities for using technology to implement the paperless classroom. Technology is the means to increasing learning efficiency. One can use technology to better display information, increase access to information, improve information sharing, and organize better class presentations. Technology is not a panacea for educational problems, but by combining technology with applicable learning models, the overall quality of education is enhanced. Students raised in an age of technology demand student-centered and led learning. Educators must discover and develop how to implement new technologies into the learning environments and focus efforts on facilitating learning–not implementing "multimedia toys."

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Educational Evaluation of Calligraphy: Applying Fuzzy Reasoning

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Recently, the computer-assisted instruction (CAI) system and multimedia system have been developed, but the fuzziness exists when we decide our educational evaluation; especially, in the case of sensitive evaluation such as calligraphy, art and so on. The authors would solve such a problem by applying fuzzy reasoning.

In this paper, we would not only discuss the analysis method, but also illustrate its practical effectiveness with the case study concerning calligraphy education in primary school.

Introduction

Although computer and the other educational technologies have been developed in the last ten years, the fuzziness concerning many educational evaluation decisions exist. Compared to the evaluation of Mathematics and English, the evaluation of calligraphy and art, what we call artistic subjects, are affected by the teacher's subjectivity. Especially in the educational evaluation of these artistic subjects, it is most difficult to evaluate students works objectively. When teachers evaluate them they are driven into a difficult situation, because they should mainly evaluate the sensitive aspect of the students works; however, the fuzziness of these sensitive aspects prompt teachers to shy away from objective evaluation.

In order to solve such problems, we have developed an evaluation method for calligraphy education through the application of fuzzy reasoning.

We would firstly explain our new analysis method and present its practical effectiveness for the students' works in calligraphy evaluation.

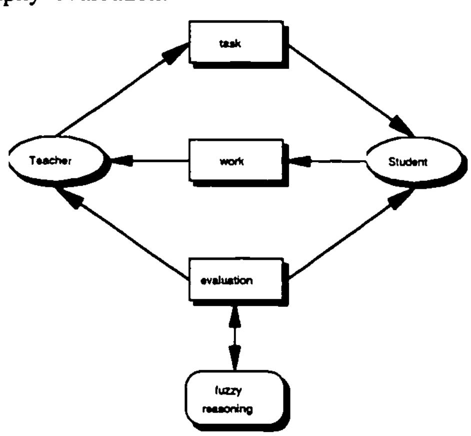

Figure 1. Evaulation of Artistic Subject.

Analysis Method

We propose the process of calligraphy evaluation applying fuzzy reasoning which is shown in Figure 1. Generally, the student's works in calligraphy education could be evaluated by two aspects; one aspect is technical, and another aspect is sensitive.

Next we explain the process of evaluation methods while applying fuzzy reasoning:

1. construction of evaluation tree;
2. preparation of evaluation standard and reasoning rules;
3. establishment of evaluation membership function;
4. analysis of works and execution of fuzzy reasoning; and,
5. evaluation of result by fuzzy reasoning.

Let the technical variable be x and the sensitive variable be y, then the evaluation function z of a work could be defined by the following:

$$z = Đ(x,y)$$

Moreover, the technical aspect could be evaluated by its sub-aspects such as the formatting, the balance, etc. And the sensitive aspect could be evaluated by its sub-aspects such as the vividness, the dynamics, etc.

Let the formatting variable be x_1 and the balance variable be x_2 and let the vividness variable be y_1 and the dynamics variable be y_2, then the evaluation functions for x(technique) and y(sensitivity) could be respectively defined by the following:

$$x = Đ_x(x_1, x_2)$$
$$y = Đ_y(y_1, y_2)$$

According to these analyses, we could construct an evaluation tree which is shown in Figure 2.

The value of each function $Đ_x$, $Đ_y$ could be measured by several ways, but we would evaluate them applying fuzzy reasoning proposed by Mamdani (1974).

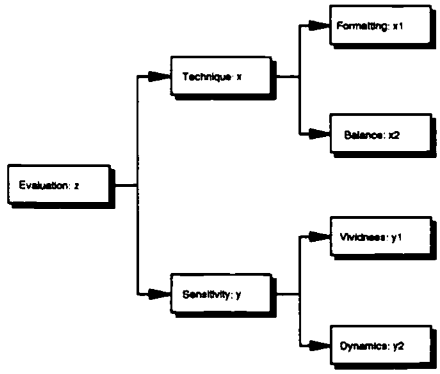

Figure 2. Evaulation Tree.

Let the evaluation value of x and y be by three levels, H (high), M (middle) and L (low), and the evaluation value of z be by five levels, A (excellent), B (very good), C (good), D (fair) and E (poor) then we have the nine reasoning rules which is shown in Figure 3.

	Technique x	Sensitivity y		
Rule 1:	H,	H	□	A
Rule 2:	H,	M	□	B
Rule 3:	H,	L	□	C
Rule 4:	M,	H	□	B
Rule 5:	M,	M	□	C
Rule 6:	M,	L	□	D
Rule 7:	L,	H	□	D
Rule 8:	L,	M	□	E
Rule 9:	L,	L	□	E

Figure 3. Reasoning Rule.

If we define the membership functions for the evaluation of x, y, and z, then we could evaluate each work of students calligraphy. We decide most suitable membership function which are based on expert teacher's knowledge. These membership functions are the most popular triangle type proposed by Mamudani (1974).

Case Study

We would present a case study of the calligraphy evaluation which has been experimented at fifth grade in primary school. The student's work is shown in Figure 4, which we would evaluate according to the fuzzy reasoning mentioned above. The calligraphy looks fairly well-formed and nicely balanced, so we could decide that x is H (fairly high) in aspect of the technical evaluation; on the other hand, it looks neither so vivid nor dynamical, so we could decide that y is M (middle) in aspect of the sensitive evaluation. Therefore, we could have the function z=Ð(H, M) and evaluate the calligraphy. When the fuzzy reasoning is executed, we get the final results. By the defuzzification, we have the gravity-centre z. We have z=Ð(H, M)ªB; then, this calligraphy could be evaluated B which implies fairly good.

Figure 4. Calligraphy.

In this way, we could evaluate the calligraphy works by applying the fuzzy reasoning. We are integrating the observant opinion of veteran teachers for this analysis and they say the same.

The analysis method is not only effective for such evaluation, but also useful for educational training of the novice teachers. If the novice teachers evaluate students works by this method, they could obtain similar evaluations as the expert teachers.

Conclusion

We have discussed a new evaluation method for calligraphy education by applying fuzzy reasoning and have illustrated its practical effectiveness with a case study in primary school. The evaluation method is useful for calligraphy education; and, moreover, it could be also used for educational training of the novice teacher.

Finally, the authors are grateful to Prof. L.Zadeh of University of California for this research.

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INTERNATIONAL

Section Editors:
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With the dissolution of the old USSR and the further fragmentation of countries across the globe it appears at times that we are all swirling out of control and growing farther apart. At times the world seems to be fragmenting with chunks growing further and further apart but, simultaneously, it feels as if the world has grown smaller, more friendly with bigger, broader, and brighter with friendships around the world. We've all been on a journey of discovery, ours, an incredible trip from Greenville, North Carolina eight years ago to 1997 in Orlando, Florida, USA. Part of what makes it such a fascinating trip, and a reassuring one, is this International section of the Annual. As you read the accounts of teacher educators from around the world notice the number of articles coauthored by educators in different countries and reflect on the continuum we are part of.

The path of technology infusion is very similar for each of us; perhaps it is a collection of paths that crisscross, weave in and out, present differing vistas and different difficulties, and, for some, even dangers, but still there are the same barriers, the same epiphanies, the same successes. Each year editing this section I am reminded of the beliefs, the ideas, and the concepts that bring us all together: the education of our future through the education of teachers who can use technology to break down barriers to learning and construct realities from dream castles spun on the Web, sided with shining CDs, and windowed with the Internet and CuSeeMe, giving views of the world we never dreamed of but views our children and grandchildren will live in. Let this section stand as symbol of the interconnectedness of humanity and of the path we are all on.

Sections Decisions

Every year it becomes more difficult to decide the placement of papers into discrete sections. More and more we encounter *proposals* that seem to fall into one category only to have the *papers* fit better in another. It would seem the simple thing to do to place the paper in the more appropriate stack, but in reality it is quite difficult so we tend to let papers stay with their original editors. There are 20 or 30 other papers we would have liked to appropriate for this section for they really provide us with additional international views; however, every paper in this section could be rightly be claimed by *other* section editors as well. Papers in this section cover telecommunications, preservice education, graduate education, distance learning, special needs — the list goes on.

We attempted a Venn diagram of our papers and section topics, but it began to resemble an explosion in a bicycle wheel factory so we gave up and were forced to get to the business of editing and arranging.

Several years ago readers of the Annual *traveled* via articles from the West to the East; it seems fitting that the trip be reversed this year. Start with the global overview provided by the Chisholm, Irwin, and Carey article. Their initial analysis of perceptions and attitudes towards computers across continents is the first stage of developing a crosscultural research tool to explore learning and computer use.

Asia

After that initial review we land in Malaysia. Keng-Soon Soo describes the positive results of using interactive video in ESL classes. Going north across the South China Sea we explore two projects in Taiwan, the Republic of China. The first, described by How-gao Hsu, Dar-chin Rau, Yen-dann Lin, and Shih-shion Liou, review the results of the Faculty Cultivation Code of 1994. They report on the three research methods used to gather data and formulate ways of improving the educational practice component, i.e. practicum or student teaching, of teacher education. The second paper, also from this group of authors, focuses on training art teachers in the integration of computer multimedia for use in primary schools' fine art and craft classes.

Almost due north from Taiwan rests the largest city in mainland China, Shanghai. Authors Weiguo Feng, Yi Lu, Yuren Wu, and Maochang Que, from two Shanghai universities, describe the rising need for more foreign language speakers and, thus, more teachers of foreign language. They explore existing technologies that are available to students and teachers, both in schools and at home. They also discuss the projects sponsored by the Audio-Visual Educational Committee, a subcommittee of the National Committee of Education, to increase the use of technology in teaching.

The second Shanghai article, by Chen Xin with American coauthors Julie Bao and JoAnn Lan, tells of an interesting method of IT dissemination — through a testing program delivered by the Shanghai Television University. The incredible numbers taught and tested would be a daunting task in any situation, but is a Hurculean task in this period of Shanghai's rapid growth.

Shanghai makes an excellent gateway into mainland China. The next authors, Zhang and Bao are at the Universities of Maryland and Shippensburg respectively, but their article reviews China 5000, a virtual learning center, on the WWW, with China related materials. This is a major resource for IT in Chinese studies.

Southern Europe and Western Russia

Leaving China and moving west we pick up signals from a distance learning system in Patras, Greece. Bouras, Lampsas and Spirakis describe Open and Distance Learning (ODL) as learning from telematics. The TRENDS project uses ODL techniques for the development of inservice and distance learning. Leaving Greece we cross the beautiful Ionian Sea to Italy, where three authors from the University of Calabria, Frega, Grego, and Volpentesta, work with Meeus of Le Réseau, Belgium, to develop telematic services for training those with reduced mobility. This project is part of an employment initiative of the European Union and involves many regions of Spain, Germany, Austria, Belgium, and Italy.

Retreating from Western Europe across the Black Sea we stop at Rostov-on-Don where Kramarov, Rozina, & Mezhevikin report on the initial steps they have taken to involve students, faculty, and inservice teachers in IT. They focus on using the Internet for research and professional development. While still in Russia we head north-north-west to Saint Petersburg where Zhegin of the Herzen State Pedagogical University, with Mims of State University of West Georgia (USA, not formerly part of the USSR), describe how political changes have led to new education paradigms. The new paradigms affect three aspects of the educational process: content, structure, and technology, with technology becoming a priority.

Northern Europe and the United Kingdom

Leaving Russia, again heading due west, we encounter Helsinki where the University of Helsinki has linked a large urban school with a small school in northwest Finnish Lapland to provide a virtual classroom where students in both locations participate and learn. This project is described from different perspectives in two separate articles, one by Jukka Husu, the other by Heikki Kynäslahti.

Turning south we enter Germany and arrive at the University of Bonn where Cremers, Lüssem, and Sünderkamp have developed a WWW-supported course on graph theory for teachers. The initial part of the course is modularized into learning units, with each unit having a number of components and ending in an automatically generated test which provides immediate feedback. In the second stage students work in small groups to develop greater understanding of the concepts. In the third phase all students work together to create a common hypertext document.

From Germany we cross the North Sea to Scotland arriving via a number of web sites identified by Walker, Curran, and Hattler (Chatham College, Pittsburg, USA) who prepare their students electronically for a junior interim abroad. Their use of technology enabled others who could not make the trip to share is some of the learning.

At the other end of this British Isle we hear from Brunner and his partner in New Jersey, US, about their Internet exploration. Exciting aspects of this paper are their use of video-conferencing and their review of the experiences in two voices. Also of interest are their issues to be addressed which begins with the social and moral aspects.

Africa

Before we hear further west we turn south and visit the continent of Africa. At almost the southmost point sits Port Elizabeth where Greyling and Calitz examine the new challenges for Information Technology departments. South Africa has a growing need for a computer literate workforce and meeting that need begins in the schools; however, students have great difficulties passing the IT courses. The authors examine the possible causes and look at proposed solutions. A key element seems to be the language difficulties such as when the instructor does not speak the first language of the student, or a language has no equivalent word for some technical part and/or no equivalent concept.

South America and Mexico

Once again headed west we leave Africa for the New World. Recife, Brazil is the easternmost point of South America. Jurema, Lima, and Filho with their collegue Dalmau in Oregon report on how the prepare educators to face the challenge of instructional technology. They point out that "the challenge facing educators today is not just to use computers at school, but to use computer education and informatics to mediate improved social and learning relations in schools." In addition they identify a number of foundational premises for developing a program based on the pedagogy of informatics that includes the very interdisciplinary nature of IT, the need for learners to be active participants, and the idea of a new cultural resource being created when students and teachers work cooperatively.

Our final paper takes north west from Brazil to Mexico City where Vallejo, Espinosa, Brito, and Tames discuss the development of a department to aid faculty who wish to create educational technology materials for their courses as well as to direct IT projects that enhance students learning. The department brought together an interdisciplinary group that has overcome a number of difficulties to develop a new virtual university.

A Guiding Memory

This year the annual is dedicated to the memory of Brent Robinson. For many reasons the size of this section and the Annual in general is due in part to his fine efforts as Vice President in charge of international affairs. He has been our conscience, reminding us Americans that the World does not see things through our eyes nor perceive things through our experiences. At times I think he viewed us somewhat like well-intentioned puppies who still needed house breaking; we are a young and brash nation. In any event Brent kept us humble, sometimes amused, sometimes irritated, always challenged to become better neighbors. I fervently hope that we may continue to grow in that wisdom and that in some way this section, dedicated to sharing papers from around the world, may add to that growth.

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Perceptions and Attitudes Toward Computers Across Continents

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Through American schools have more computers than schools in other countries and a much higher ratio of comput ers to students (Anderson, Beebe, Lundmark, Magnan, & Palmer, 1994), the presence of hardware does not guarantee equitable access to technology for all students (Arias, 1990; Dunkel, 1990). Lamentably, "the poorer, non-Anglo-American, limited English proficient students have least access to computer use in schools" (DeVillar & Faltis, 1991, p. 112). Even when schools with large low socio-economic and minority population have computers, frequently there is limited availability of varied technologies, a disproportionate use of drill-and-practice applications, and defective, inoperative, or outdated hardware. Moreover, these students are not likely to have computers at home. Consequently, to meet the diverse needs of our multicultural population, teachers must have both *computer* and *cultural* competency. Cultural competency hinges upon cross-cultural knowledge and understanding of preferences, attitudes, and perceptions of technology.

Similarly, university study-abroad programs, faculty exchange programs, and international business studies require an understanding of computer training preferences among various cultural and international groups. As we learn more about ourselves and our global neighbors, we become more effective partners in the technological world. Also, evidence shows cross-cultural differences in educational traditionsas well as social and cultural philosophy (Yoder, Shaw, Siyakwazi, & Ylin-renko,1993). These differences likely correspond to differences in teaching and learning preferences, so awareness of international differences in attitudes and perceptions toward computers may provide insight into the challenges of becoming a computer literate society.

Computers are a cultural artifact; as such, they reflect the cultural, perceptual, and cognitive perspective of their creators. The resulting computer culture is individualistic, analytical, and sequential (Chisholm, 1993). However, this computer culture may not be compatible with other cultural groups and their preferred ways of interacting, organizing, learning, working, and thinking. Moreover, the introduction of computers, especially into non-Western and Third World countries, will likely induce changes in interpersonal behavior, communication, and education (Darr & Goodman, 1993). The computer, as a tool, organizes knowledge, reshapes work and learning environments, and expands information access. In the same way, social, cultural, and political factors define how computers are perceived, used, dispersed, and experienced. Thus, the computer culture generates changes in the recipient native culture and, in turn, the native culture influences how computers are learned, used, and perceived.

Developing countries face a dichotomous dilemma of need and accessibility. There is a necessity for computer literacy to participate in the global exchange of information, trade, and the benefits of computer technology in education. On the other hand, the introduction of computer technology is viewed as a massive financial burden and a socio-cultural intrusion on traditional societies with fragile economies, high illiteracy, few skilled workers, high unemployment, malnutrition, and even starvation (Hawkridge, 1990). Though these countries have imported computers from more technologically developed nations, access to computers is still limited. Both logistical or problems of infrastructure (such as the lack of electricity and telephone lines in some areas) and resource problems (such as the small numbers of trained people to maintain the hardware) limit access. Further, humans tend to naturally resist change. Attitudes and perceptions of computers in these countries, therefore, may be ambiguous at best.

Research suggests that negative attitudes and unfavorable perceptions of computers adversely affect computer literacy (Chen, 1986; Dambrot, Watkins-Malek, Silling, Marshall, & Garver, 1985; Lillard, 1985; Loyd & Gressard, 1984; Marcoulides, 1988). While positive attitudes increase the likelihood of achievement, negative attitudes decrease the attainment of competence (Lloyd &

Gressard, 1984). Indeed, "personal attitudes about using computers in a learning environment can be critical to the success of a computer-based project" (Clement, 1981, p. 28). Thus affective factors play a crucial part in computer competency. Likewise, research indicates that gender, ethnicity, and previous computer experiences are related to computer anxiety and confidence in computer use (Brooks, 1990; Campbell, & Perry, 1988; Huang, Waxman, & Padron, 1995; Liao, 1996).

Paprzycki and Ubermanowicz (1996) suggest, however, that computer knowledge and computer attitudes may be unrelated. For example, a person with little knowledge of computers may have a positive attitude toward them. Loucks, Newlove, and Hall (1975) also distinguish between the computer users' feelings and thoughts about computers and the level of computer use. Indeed, they suggest these areas develop independently during the process of achieving computer competence.

There is some evidence that culture influences perceptions and attitudes toward computers. As Urevbu (1991) points out, in developing countries there is some resistance to Western lifestyles, standards, attitudes, and values. In these countries, technology transfer is both essential for economic survival and annihilative of the indigenous cultures and values. Since the importation and implementation of computers in non-Western and Third World countries are a relatively recent phenomena, these countries may question the appropriateness of technology and its compatibility with local, cultural, and economic conditions. Urevbu concludes that we need new paradigms for science and technology education stemming from a multicultural perspective. In short, the indigenous culture should shape technology, rather than passively be absorbed or demolished by it.

A study by Collis and Williams (1987) also noted the influence of culture on technology. In a survey of adolescents from Victoria, British Columbia, and Shanghai, People's Republic of China, they found Chinese students had significantly more positive attitudes toward computers than the British Columbia students. Collis and Williams believe this attitudinal difference results from differences in underlying values. Also, the Chinese have mandated two major strategic thrusts in education— the learning of English and the use of computers. Additionally, the Chinese generally perceive intelligence and academic success as desirable attributes; the British Columbia students tend to believe that academic success makes them less socially attractive to peers. Although females in both countries conceded that women have as much ability as men with respect to technology, males were skeptical of this gender equality. This perceptual difference may arise from gender expectations and stereotypes. For example, since machines are perceived as a male domain, computers may then be considered a male specialty. Thus inconsistencies in research on gender differences in computer anxiety (Wallace & Sinclair, 1995) may be due partially to cultural differences in gender expectations.

Cultural gender differences may also extend to learning preferences. Yelland, White, Gilbert, and Smith (1996), for example, observed that female Aboriginal and Torres Strait Islander male students tended to seek help from the mentor on an individual basis while female students tended to come for help in small groups. When working without a mentor, females generally remained in small groups and worked collaboratively. These gender differences may be attributed to differences in gender roles and socialization.

Culture influences how people prefer to learn. Research supports the relationship between culture and learning preferences (Anderson, 1988; Griggs & Dunn, 1989; Jacobs, 1990; Rhodes, 1990). These learning preferences, though not determinants for individual learning, are tendencies of a cultural group based on values, beliefs, norms, world view, and expectations. Cultural learning preferences suggest differences across various groups in their preferred ways of learning, interpreting, organizing, experiencing, and reasoning about the world (Chisholm, 1996). Thus, there are cultural roots to cognition. How people prefer to learn to use computers may be directly influenced by individual and cultural learning preferences.

Purpose and Research Questions

The primary purpose of this international and interdisciplinary study is to investigate and compare attitudes and perceptions towards computers and computer training among college freshmen in six countries. The authors seek to understand the computer attitudes and perceptions of college students in Australia, China, Ghana, Mexico, Puerto Rico, and the United States. The researchers will compare these attitudes and perceptions to determine if they differ from culture to culture or country to country. In addition, the researchers explore individual and cultural differences in preferred training among the international subjects. Lastly, the authors investigate computer access in the selected countries and its impact on the development of computer competency. Consequently, the authors seek answers to the following questions:

1. Do preferred ways of learning about computers differ significantly across cultures and countries?
2. Do attitudes towards computer technology differ significantly across cultures and countries?
3. Do attitudes towards computer technology differ significantly across ethnicity?
4. Do perceptions of usefulness of computer technology differ significantly across cultures?
5. Do perceptions of usefulness of computer technology differ significantly across ethnicity?
6. Is increased access to computers related to more positive attitudes toward computer technology?

Methodology

For the purposes of this study, the researchers define computer attitudes as a learned predisposition to respond in a consistently positive or negative manner towards computers. This definition is derived from Fishbein (1972). Attitudes consist of three components: cognitive, affective, and conative (Assael, 1987). The cognitive component consists of a person's beliefs, which can be informational and valuative about an object. The affective component represents the person's overall evaluation of computers. The conative aspect is a tendency to act toward the computer in a positive or negative manner. Computer perceptions are an awareness and discernment of computers based on personal opinion, knowledge, and experience. Perceptions are ways of finding out, both through sensing (fact finding) and also through intuition (finding meanings and relationships) (Briggs Myers, 1976). Computer access in this study refers to the extent to which computers, as well as varied applications, are available to an individual. The instrument used for data collection hence reflects these definitions.

Instrumentation

The authors developed a four-part questionnaire addressing computer training preferences, computer attitudes and perceptions, and computer access. The first section gathers demographic information such as age and college major. The second section asks fourteen questions about computer access and training. The third section, a four-point Likert with twenty-seven questions, investigates attitudes and perceptions toward computers. The final section, a four-point Likert scale with thirty-six questions, explores training preferences and perceptions of computer technology.

A graduate student from mainland China with six years of experience teaching English as a Second Language translated the questionnaire into Mandarin, and a native Spanish-speaking university professor in Bilingual Education translated the questionnaire into Spanish. Foreign language faculty then translated the items back into English. This process ensured the accuracy of the translations.

The pilot questionnaire is now being administered to American college students majoring in business and education at a metropolitan university in the Southwest. Results of this pilot will help refine the instrument and provide reliability and validity data.

Procedure

The researchers are sending copies of the questionnaire to collaborating faculty at urban universities in the targeted countries. Instructions included with the questionnaire contain specific instructions for achieving uniformity in its administration. A cover letter to the participants assures them of their anonymity. The collaborating faculty will administer the researcher-developed questionnaire to one hundred freshmen education and business students at each participating institution. The researchers will also obtain data at two community colleges. These community colleges are located in a large metropolitan city of the Southwest. One of the two colleges has a large minority student population; the second has a large majority population. Faculty will collect and return the completed questionnaires. In addition, the collaborating faculty and the researchers maintain continual communication via electronic mail. This rapid and direct form of communication facilitates articulation and provides expeditious responses to queries.

Summary

This paper describes a study in progress. It includes a review of the literature, purpose and research questions, methodology, instrumentation, and procedure. By the SITE conference presentation of this paper, a pilot study will have been conducted and corresponding data analyzed.

The researchers speculate that computer perceptions and attitudes among freshmen university students in developing countries are similar to those found in the United States during the late 1970's and early 1980's when personal computers were not widely used in this country. The researchers also believe that there may be more congruency between freshman students from a minority-rich community college and the samples from developing countries than between that same community college and the community college sample from a majority community. It may be that access to computers and previous experience with computers may be more important to attitudes and perceptions about computers than the state of development of the country in which the students reside.

The researchers are interested in the relationship between computer culture and native cultures. It may be possible to discover links between attitudes and/or perceptions and training effectiveness suggesting better training within specific cultures and across cultures. Knowledge of computer training preferences and other data generated from the research will assist in the development of international business programs, international exchange programs, and secondary education. The findings will also provided useful information on culturally compatible instructional approaches for developing computer skills among students of different cultural and national backgrounds.

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Cost-Effective ESL Instruction with Interactive Video: The MCALL Project

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Like other Asian universities, Universiti Malaysia Sarawak (UNIMAS) must grapple with the problem of improving students' level of English proficiency. Over 80% of undergraduates are required to take courses in English proficiency. Other Malaysian universities are leaning toward a 'no-exemption' proficiency English policy, meaning every student must take English proficiency courses. To compete in the global economy, Malaysians must be able to use the recognized international language, English, at a level of proficiency acceptable not just to themselves but also to the international community (Soo, 1995). This represents an enormous challenge in terms of human, monetary, and physical resources. It would be nearly impossible for conventional English proficiency programs to meet this challenge. Soo and Ngeow (1995) proposed a new multimedia computer-aided language learning (MCALL) program to cost-effectively overcome the bottlenecks ofconventional English proficiency programs. They demonstrated that froma cost-effectiveness perspective, such a program compared well with conventional teacher-taught classes (see a revised version of the cost-effectiveness comparison in Table 1).

The enormous savings made possible by the MCALL program makes it very attractive to institutions with the organizational flexibility and the technical expertise to implement it. However, the most important question remains: Are MCALL classes as effective as conventional classes?

The MCALL Program

The MCALL program was designed to provide a learning environment based on the following constructs:

1. Adopting an Internationally Recognized Benchmark of English Proficiency

No evaluation process is perfect, and standardized tests have been heavily criticized for many inadequacies. However, stakeholders such as administrators and employers want to know how well students are doing in their courses. Where the professed objective of a program is an *internationally* recognized level of proficiency, an internationally recognized evaluation tool, such as the Institutional TOEFL, is preferable. A widely used test simplifies comparing student achievement across institutions and even boundaries and is one of the simplest ways to demonstrate the effectiveness of any proficiency program.

2. Returning Control of the Learning Process to the Learners

Students expect teachers to teach them the English language as if they are empty 'sponges' waiting for teachers to fill with knowledge. Unfortunately, hard-working and well-meaning teachers have tried their best with little success to transmit lexical items, grammatical structures, and communication strategies into the blank minds sitting passively in front of them (Rogoff, 1994). In many instances, vocabulary and grammatical rules are internalized, but when it comes time to communicate, the language produced violates even the most basic rules of grammar and is often inappropriate to the context.

Recent learning theories suggest that learning is an active process of constructing meaning rather than acquiring knowledge. Following this line of thinking, instruction should be a process of supporting the process of construction and not merely transmitting knowledge (Duffy & Cunningham, 1995). This construction process requires learners to individually construct their own understanding by interacting in authentic situations. Because learners are central to this process, they must have ownership not only of the learning process but of the problem itself. Therefore, students should be given autonomy in setting up their personal learning objectives and take responsibility for their own learning (Mar-Molinero & Wright, 1993).

3. Redefining Teachers' Roles

In this new paradigm, teachers are no longer transmitters of knowledge but are coaches, mentors, and managers of the learning environment to aid their students in constructing knowledge. Scaffolding, or supporting, learners is a very demanding job. In addition to being subject experts, teachers must be experts in learning psychology as well.

Although learners have ownership of the problem, teachers ensure that the problem is authentic and sufficiently challenging and that learners do not go off the proverbial cliff in their attempts to solve the problem. In some ways, computers can help, but teachers must acquire a measure of technical expertise as well. In short, in this new learning environment we need a 'super' teacher acting primarily as a "resource provider and mentor, with students as apprentices who gradually advance themselves...to gain an increasing measure of skill and independence over time" (Pennington, 1996).

4. Utilizing Digital Multimedia Language Learning Courseware on a Massive Scale

Although conventional CALL research has a history of at least thirty years, effective application into education has been scant. This may be due to the limited capabilities of the early, heavily text-based CALL. In comparison, multimedia is a far more powerful medium than traditional CALL, but comparing the two should be done as cautiously as comparing the computers of today with those of a decade ago. In this paper, multimedia is defined as a hypertext format consisting of a combination of video and audio instructional materials on a common platform to create a data-rich, intellectually stimulating learning environment allowing constructive higher-order learning. Rather than the all-too-common rote drills that actually constrain learning to low-order learning, the multimedia mind-tool should promote the conceptual understanding stemming from successful construction of knowledge resulting from puzzling and reflecting on one's new experiences in the light of one's prior knowledge (Jonassen, 1996).

As multimedia technology has only recently matured and its application into language learning is far from advanced, its effects must be researched. The effectiveness of multimedia CALL compared to that of human teachers is in question because language is largely creative and skill-based. The computer itself, devoid of creativity and intelligence, cannot adequately 'teach' creative and intelligent learners the use of a creative skill (Jonassen, 1996). However, certain types of computer activities such as authentic simulations of language tasks are well suited for higher-order learning. To create a realistic learning environment, often there is no better tool than well-designed and well-managed multimedia courseware.

Method

To test the effectiveness of the learning environment, from July 5 to October 26, 1995, UNIMAS set up an MCALL Laboratory (Soo & Ngeow, 1995) to compare the effectiveness of MCALL classes with conventional teacher-taught classes. Learner achievement was used as the basis for comparison. Unfortunately, because of technical difficulties with the laboratory, the MCALL component of the experiment did not begin until August 9. In other words, the conventional classes had a five-week headstart over the MCALL students, who had no language lessons during this period.

Sample

The student population consisted of first-year undergraduates who were enrolled in their first semester of college. The students were from a heterogeneous population since, in Malaysia, enrollment in universities is controlled by a central body ensuring that each university has a representative mix of ethnic groups and SES. The students averaged 21 years in age and 11 years of English proficiency instruction in school.

Instrumentation

Upon entry into the UNIMAS experiment, all participating students took a placement test, the Institutional TOEFL. Students scoring 550 or more were exempted from taking any proficiency courses and, therefore, did not participate in the experiment. At the end of the experiment, the students sat for a parallel test. The Institutional TOEFL was chosen as both the pre- and post-test because of its high reliability and validity.

Assignment to Experimental and Control Groups

Participating students were first randomly assigned to ten English classes. Six of these were randomly chosen to serve as the experimental group. Students in these classes would learn English in the new learning environment outlined in the MCALL program. Besides using the computer, the experimental group could also use a workbook that came with the courseware. In the remaining four classes (the comparison group), students were taught in conventional teacher-taught classes. These classes used a grammar text and other supplementary teaching aids such as newspapers and audio tapes in their lessons.

Table 1.
Average cost per student for MCALL and teacher-taught classes

Number of students	MCALL - alone	MCALL - group*	Teacher-taught class
370 students for 1 year	RM755.00	RM251.67	RM227.03
370 students for 4 years	RM188.75	RM62.92	RM227.03
600 students for 1 year	RM465.58	RM155.19	RM224.00
600 students for 4 years	RM116.40	RM38.80	RM224.00

**Groups of 3 students to 1 computer lowers cost per student. Alternatively, with the same number of students, equipment requirements can be scaled down three times.*

Negotiation of Goals

Consultations were held between each MCALL student and the researchers to determine their achievment goals. These goals referred to their target scores at the end of the experiment. Considering the students' goals, the researcher offered suggestions as to the amount of learning time the individual student should spend in the MCALL laboratory so that the student could achieve his goals. Formal commitments stating the minimum amount of lab time were made between the researchers and each student.

Assignment of Student-Mentor

In the experimental group, five to eight students were assigned to a senior who served as their mentor. Mentors monitored the students' learning progress and attendance records as well as acted as the liaison between the MCALL teacher-manager and the students. The student-mentor also did basic housekeeping tasks to staff the MCALL laboratory. However, they did not provide any teaching to the students.

Extraneous Factors

The main objective of this research compared the effectiveness of the MCALL program to conventional teacher-taught classes. However, the outcome may be skewed by some extraneous factors.

Race. Few studies have examined the effects of race in relation to instructional methods. Scott (1995) found no relationship between race and posttest scores of students. Strohsahl (1994), however, found that non-white male students performed better than non-white female students and better than both white female and white male students on language achievement. In light of this, race was included as a factor analyzing results.

Gender. In introducing new instructional methods, especially those based on technology, the possibility of differential effects on the achievement of male and female students cannot be ignored. Clariana and Schultz (1993) found a significant interaction between gender and achievement in mathematics computer-based instruction (CBI) but not in language arts CBI. Roy (1993) found no difference between males and females learning with CBI at all grade levels. However, Strohsahl (1994) found that male students outscored female students in language achievement when CBI was used. In view of the mixed trend and to ensure educational equity, gender is also included in the analysis.

Analysis

Instructional Methods

Using a repeated measures design (SPF-p.q), the performance of the experimental and control groups was compared using instructional method as the independent variable and the pre- and post-test scores as dependent variables. The post-test scores were significantly different from the pre-test scores [$F(1,185) = 133.20$, $p=0.0001$]. The 39.17 point increase for MCALL students was significantly different from the 26.28 point increase achieved by the students in conventional classes at [$F(1,185) = 5.25$, $p=0.0231$]. Obviously, the MCALL program is significantly more effective than the teacher-taught classes (see Table 2).

To analyze if this significant difference could have been caused by race or gender, two models using a common repeated measures design (SPFpr.q) were used. Race and gender were the independent variables, and the dependent variables were once again the pre- and post-test scores.

Race

To test for the effect of instructional methods on race, a 4 X 2 X 2 factorial design with repeated measures was used on the pre- and post-test scores. The variables were a) race, b) instructional methods, and c) both test scores. Race did not interact significantly with either the pre- or post-test scores [$F(3,178) = 1.47$, $p=0.2235$]. The 3-way interaction between race, instructional methods, and the pre-test and post-test scores was also insignificant [$F(3,178) = 0.48$, $p=0.6975$], showing the significant difference found between the two instructional methods was not caused by race (see Table 3).

Gender

The effect of instructional methods on gender was analyzed using a 2 X 2 X 2 factorial design with repeated measures on both test scores. The variables were a) gender, b) instructional methods, and c) the pre- and post-test scores. Gender has no significant interaction with both test scores [$F(1,182) = 0.11$, $p=0.7415$]. The 3-way interaction between gender, instructional methods and the test scores was also insignificant [$F(1,182) = 1.40$, $p=0.2383$] (see Table 4).

Discussion

Race and gender did not affect achievement significantly. However, the difference in achievement caused by instructional methods poses a few fundamental questions to ESL teachers.

Altlhough teacher ineffectiveness is relative, the MCALL program appears far more effective than conventional teacher-taught classes in increasing the English proficiency of the students as measured by the TOEFL. If the MCALL Program had not existed, the conventional classes' performance would have been commendable. The 26-point average improvement over a 16-week period is a significant result that many institutions would be proud of. However, this improvement pales in light of the 39-point average increase achieved by the MCALL students in 11 weeks. Simply put, the MCALL program yielded a 50% improvement over teacher-taught classes in 31% less time at potentially 83% less cost.

The difference is likely to have been caused by a variety of factors. The MCALL's learner-centered environment is supremely conducive to language learning. Providing greater motivation, responsibility for learning was transferred to students. Students themselves set the learning goals at the start of the course (with the researcher) and decided when and what they needed to learn. In short, should they fail, they only had themselves—not the teacher's teaching—to blame. To learn, the students had only themselves and the multimedia computer to depend on.

The multimedia computer does not have the intelligence to teach anyone. This proved a boon. When teachers were present, they could always be relied upon to supply the correct answers in good time. Without teachers, students were forced to rely on their innate analytical skills to find solutions, which ultimately proved a more productive way to learn. What the computer lacked in intelligence, it made up for in storage capacity. It had an enormous database of authentic language use that students could use to model and scaffold their learning. In this particular instance, this scaffolding facility was all the students needed to pull themselves up by their bootstraps.

The students were given a task they believe in—earning an internationally recognized English proficiency certification. The task sufficiently challenged their abilities and improved their proficiency by a fixed quantum. Although the TOEFL is not a perfect test or even suitable for evaluating English proficiency in some circumstances, it is set up and graded externally, so students perceived a greater sense of 'fairness' or objectivity because there is no possibility of teachers influencing the outcome in any way. No longer could they depend on the final evaluation being set to reflect *their* norm because the TOEFL is set to reflect the norm of the world. One tends to be more motivated when competing against the world.

Teacher-taught students were required to be in class at fixed times even when they were tired or distracted. In the MCALL program, students could choose to learn only when they felt fresh and able to concentrate. Sometimes this freedom was abused, but the student-mentor system and the teacher's monitoring kept this in check. Should a particular student not comprehend a certain learning point, the teachers in class only had that many minutes to correct the problem because they had a responsibility to the other students too. In contrast, the computer could repeat the same point to one student for hours if need be, without holding up or boring other students.

Language is more skill than content and is learned more with practice than by abstract reasoning. No one has ever learned to speak by silently reading a passage. The computer proves to be a more tireless model to the students than any human teacher ever could. The limitation of this is that, not having any judgmental capability, the computer cannot decide the 'appropriateness' of the students' oral and written production, but in scaffolding students' acquisition of listening and reading skills, its strengths outweigh its weaknesses. Asian students are more risk-averse in situations where 'face' can be lost. A class is a potential face-losing situation because a student is at risk of being corrected by the teacher in front of the whole class. Taking part in a computer simulation removes this fear. When asked what they liked best about the MCALL program, the students' answer was frequently "No teacher!"

The creation of an effective learning environment would have been made much harder without appropriate software. It is often said the computer is merely a tool and what makes the difference is how it is used. However, how a computer is used depends partly on available software. Traditional software has been little more than rote drills promoting low-level rather than higher-level learning. In creating the MCALL program, a deliberate decision was made to use interactive video because it is more authentic. Rote drills were eschewed for interactive multimedia because the latter is infinitely more flexible, and the flexibility conferred by the software should not be underestimated because with flexibility comes freedom to create a more powerful learning environment. Until true artificial intelligence is achieved, the computer's abilities to teach are limited, but the appropriate application based on sound learning principles can create a learning environment where teachers and computers work seamlessly together, each covering the weaknesses of the other. Although such a learning environment enhances the capability and value of effective teachers, it can also replace ineffective teachers.

Ineffective teachers use ineffective teaching strategies often stemming from viewing language teaching as "information dissemination". This leads to a teacher-dominated learning process emphasizing rote learning and automaticity. Such an orientation is self-defeating because it nullifies creativity, the hallmark of humanity, and prioritizes automaticity, the hallmark of computers. In disseminating information, computers are bound to be more effective. We should re-examine what we mean by "knowledge" and "learning" and whether our learning theories, teaching strategies, and classroom practices truly support learning.

Teacher-training has been the main culprit of ineffective ESL programs. Reform in this area is urgently needed. Technology not withstanding, the MCALL program was created, maintained, and managed by experienced *human* teachers who harnessed the computer to enhance *their* effectiveness by effectively blending learning theory, practical teaching experience, and computer expertise. Without the right *human* teachers, learning environments such the MCALL program cannot be sustained, a tragic loss to future generation of language learners. Although computers cannot replace the "right kind" of teachers, the remaining question is whether enough teachers of the right kind exist.

Table 3.
Mean scores according to race and instructional methods

		MCALL		Conventional	
		Mean	SD	Mean	SD
Malay	Pre-test	447.11(*n*=35)	56.60	428.47 (*n*=30)	55.38
	Post-test	490.17 (*n*=35)	71.95	458.31 (*n*=29)	66.15
Chinese	Pre-test	461.04 (*n*=46)	54.47	419.17 (*n*=29)	45.64
	Post-test	492.54 (*n*=46)	65.28	440.93 (*n*=29)	55.49
Indian	Pre-test	396.50 (*n*= 2)	47.38	440.00 (*n*=1)	-
	Post-test	439.00 (*n*= 2)	104.65	510.00 (*n*=1)	-
Others	Pre-test	458.93 (*n*=28)	54.74	406.44 (*n*=16)	54.77
	Post-test	505.61 (*n*=28)	70.33	432.19(*n*=16)	69.98

Table 4.
Mean scores according to gender and instructional methods

		MCALL		Conventional	
		Mean	SD	Mean	SD
Male	Pre-test	449.74 (*n*=39)	56.43	420.32 (*n*=31)	45.73
	Post-test	494.54 (*n*=39)	70.63	445.03 (*n*=31)	58.47
Female	Pre-test	457.78 (*n*=72)	54.90	420.51 (*n*=45)	55.40
	Post-test	493.90 (*n*=72)	68.49	447.87 (*n*=44)	66.77

Limitations

The results need to be confirmed by replicating the program. A bigger sample size would have allowed more powerful tests in the analysis stage. Sample size is a particular concern with the teacher-taught group. The 77 students in this group came from four classes. In effect, the MCALL Program was tested against only four teachers. It may be that with other well-trained teachers, the outcome may be different. On the other hand, the MCALL Program suffered a few setbacks placing it at a disadvantage. Due to technical problems, the MCALL students began learning five weeks after the teacher-taught classes had begun regular classes. In short, the MCALL students had a significantly shorter learning time, and the impact on their motivation during that time of inactivity could have been significant. During the course of the 11-week experimental period, a few software bugs (discovered including one that prevented some students from reviewing their progress online) were discovered. Such incidents would surely have impacted their motivation although the effect on their achievement could not be ascertained.

Conclusion

The results show that properly-used computers can be effective 'language teachers. Clearly, technology has become so powerful and flexible that, properly used, can replace ill-prepared people. Language teachers can only continue to ignore technology at their own peril. The onus is on teacher trainers in language teaching to incorporate this powerful tool into teachers' arsenals. The language teaching profession at large must start asking itself some hard questions as to its roles and cost-effectiveness. The computer is neutral; it can as easily be a friend or a rival to the language teacher. Ultimately, the choice is ours. But the time to make the choice may be running out.

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Review and Improvement of the Educational Practice System of the Normal College Education of R.O.C.

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Since the announcement of Faculty Cultivation Code of the Republic of China on February 7, 1994, it established the diversified development direction of the faculty cultivation of R.O.C. in Faculty Cultivation Code, the regulations governing the students of normal college in the future through education and practice in obtaining conforming teacher qualification would require the students to fulfill prior-to-function educational program who, through conformity of preliminary teacher appraisal, shall obtain practice teacher qualification (Article 7). A practice teacher shall go through one year of education practice; the one with conforming performance record and secondary teacher qualification appraisal shall obtain conforming teacher qualification (Article 8). One who wishes to obtain conforming teacher qualification shall go through preliminary appraisal, education practice and secondary appraisal; the teacher certificate system is therefore confirmed and established. (Ministry of Education, 1996)

The teaching practice and simulation of a student of normal college during schooling stage, and the practical teaching of the same student after fulfilling studies and assigned to a school for practice, shall form profound impact on his/her later teaching proficiency development. However, during the study program of the current normal college, the integral planning of combination of practice and theory and each education subjects is in lack that the practical experience of the students of normal college is in insufficient. Therefore, how to integrate the education subjects and practical program for teaching from freshman year to senior year in a normal college in the future, to strengthen the practical experience of a student; how to improve the function of practice guidance sector of a normal college and assist a student graduated from a normal college to develop his/her proficiency to successfully become a conforming teacher with proficiency; how to establish a sound mode of teaching practice system of a student of normal college in order to upgrade the faculty qualification of the high schools and primary schools.

Research Objectives

- Analyze the educational practice system of advanced nations to compare the difference of the education practice system of R.O.C. normal colleges.
- Analyze the appropriateness of the existing educational practice system of R.O.C. to serve as reference to improve education practice system.
- Provide a feasible mode for the framework and execution policy of the education practice system of the normal colleges of R.O.C.
- Propose substantial opinions of improving the education practice system of normal colleges.

Research Methods

Literature Analysis

This research mainly solicits the domestic/overseas periodical journal, magazine, academy report, and research report and paper, about the related education practice system data of a new teacher, and perform analysis and comparison of their characteristics.

Site Interview

Site interviews of the executive officers of the education and administration authorities of 12 normal colleges, teacher research institute, and school for practice, etc. to further understand the current condition of distributed practice of the students graduated from normal colleges and their difficulties.

Expert Symposium

Such related personnel as scholars, headmasters, directors and teacher representatives, educational administration personnel, etc. are invited to hold symposium. The obtained conclusions serve as reference for preparing questionnaire and research.

Questionnaire Investigation Method

This research, based on the self-edited "Research on Chinese Normal College Education Practice System" investigation questionnaire as the main research tool, divided into Questionnaires A, B and C. Questionnaire A is for the personnel of high school and primary school; Questionnaire B is for the scholars and experts; Questionnaire C is for the educational administration personnel. The research unit designs questionnaires, experts are recruited to perform review and comment, through pre-test and revision, the formal questionnaire investigation is carried out.

Conclusions

1. The main conclusions of expert symposium and site interview part shall be divided into the following items:
   1. Education practice target.
   2. Education practice organization.
   3. Education practice program.
   4. Education practice strategy.
   5. Assigned practice in the 5th year of college.
2. The main conclusions of questionnaire interview part shall be divided into the following items:
   1. Preparation education stage (freshman and sophomore years).
   2. Practice education stage (junior year).
   3. Comprehensive education stage (senior year).
   4. Assigned practice stage (the 5th year).

Recommendations

1. Construct education practice system, develop characteristics of normal education.
2. Propose education practice guidance strategy, reinforce contact of various sectors, actualize education practice guidance work.
3. Review education practice goal of normal college, actualize education practice function.
4. Install practice guidance office, reinforce education practice guidance function.
5. Improve prior-to-job cultivation education practice program, supplement basic capacity of normal college students, unify the education practice content of various years, supplement practical experience of the students of normal college.
6. Prudently select outstanding faculty to perform functions of teaching and guidance, upgrade teaching quality.
7. Improve education practice method, reinforce education practice performance.
8. Improve education practice guidance measures, actualize education practice guidance work.
9. Reinforce the communication contact and compliance among practice unit (office), practice school, Hsien/city education guidance corps, guidance professor, develop integral cooperation and guidance function.
10. Prepare and print related practice information manual, provide for reference to the graduate students and guidance professors.

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Applying Computer Multimedia for Fine Art and Craft Teaching in Primary Schools

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Fine art and craft teaching is a teaching activity dealing mainly with visual form, aided with various types of materials to engage in creative performance and evaluation. During teaching, the application of practical situations, object, picture, photo, slides various teaching media is very necessary. Due to the comprehensive scope of information, data collection is not easy. Besides, due to the restriction of traditional media, application and maintenance, the application and performance of teaching media is also doubtful. The operation of computer multimedia becomes simpler, but the functions become stronger. The application of the multimedia with digital style, rich information and active interacting function to fine art & craft teaching as teaching source or learning source is one of the feasible alternatives.

From the angle of the epoch, the Ministry of Education has been active in promoting computer education in primary and high school recently and the computer application has been more and more popular to help the children of the new generation to possess the capacity of using computer to process information since childhood. Therefore, as an educator to cultivate the citizens of the new generation for the 21st century, the application of computer as education resource or teaching tool is necessary. In the epoch of new media and traditional media, how to apply computer digital information to plan for a feasible mode the integration of new and old media to effectively upgrade the quality of fine art & craft teaching is the motivation of this paper.

Research Objectives

The main purposes of this study were as followes:

- to analyze the feasibility of computer multimedia digital information as a resource for fine art and craft teaching in primary schools.
- to analyze the feasibility of integrating computer multimedia with traditional media for the fine art and craft teaching in primary schools.
- to analyze the number of applicants relative and teaching requirements of the fine art and craft teachers of primary schools concerning computer multimedia.
- to submit the recommendations on the application of computer multimedia for the fine art and craft teaching in primary schools.

Research Methods

Literature Review. In order to attain research objectives, the literature review was used to analyze the feasibility of computer multimedia and its alternative strategies for fine art and craft teaching in primary schools.

Questionnaire Investigation. In order to attain our third research objective, an investigation questionnaire, *Applying Computer Multi-Media for the Fine Art & Craft Teaching in Primary Schools* was designed to explore the number of the fine art and craft teachers who would use the technology and their educational requirements.

Research Conclusions

There are five main conclusions of the study:

1. Application of computer multimedia in fine art and craft teaching activities in primary schools shall be necessary for an educator.
2. Applications of digital information relative to computer multimedia in the processes of fine art and craft teaching are feasible in primary schools.
3. The integration of computer multimedia with traditional teaching media is of worth in the application and promotion of current fine art and craft teaching.
4. The recognition, capacity, and teaching skills of the fine art and craft primary school teachers on the use of multimedia are insufficient and shall be upgraded.
5. The intent of computer multimedia teaching of the fine art & craft teachers in primary schools is high; therefore, the sound inservice study shall be duly planned by the educational administrative authority.

Recommendations

The study suggested that applying computer multimedia for the fine art & craft teaching of primary school in the future. This study mainly recommends its system structure is listed as diagram 1.

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Information Technology Used in Foreign Language Teaching in Secondary Education

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Shanghai is the biggest city in China. As the industrial and financial center and the foreign liaison window for China, Shanghai is in great need of qualified personnel with a good command of foreign languages. During the years of *open policy*, the requirement and training for all sorts of people with good English capabilities have both reached an unprecedented degree. There are more than one hundred thousand people who have successfully passed the Rank Examination in Proficiency in Commonly Used Foreign Languages of the Citizens of Shanghai with *fairly fluent primary English and Japanese*, *communication English and Japanese*, and *intermediate English and Japanese*, and so forth. And there are quite a number of people who have passed the qualification test for high-ranking English interpreter positions. Thus, foreign languages teaching (taking English as the dominant factor) in secondary schools, which are crucial in providing all sorts of talented people, has also attracted a whole lot of attention.

Secondary schools, including senior secondary schools, junior secondary schools and secondary technical schools, pay great attention to English teaching, which is indicated by the big amount of improved teaching equipment. As the degree of the technical advance in each school varies, so does the teaching result, due to lacking of funds; but the developing trend is very obvious. The following general characteristics are found in several schools.

- Shanghai School of Chemical Technology is a full time technical school. It has been acknowledged by the authorities as one of the grade "A" top ranking technical schools in China.
- Attached Secondary School of Shanghai Jiaotong University is one of the key schools in Shanghai. It has only senior secondary school students.
- Shanghai Guangming Secondary school is one of the key schools in Luwan District, Shanghai.
- Shanghai Secondary school No. 51 is an ordinary school.
- Quyang Secondary School No. 2 is an ordinary school that has only junior secondary school students.

The results of our investigation of the information technology equipment available for use in English teaching in the above-mentioned schools are listed in Table 1 on the following page.

From the result of the investigation, we know that there are considerable differences among these schools in their ability to make use of information technology. The teaching equipment is comparatively advanced in key schools, because of the considerable investment from the government and the help and support from the society. Because of the value placed on foreign language degrees, key schools often regard teaching equipment as the component part of school construction.

In those schools the use ratio of sound laboratories is high and there is a television set in each classroom. The students there have good conditions of learning English. For example, Attached Secondary School of Shanghai Jiaotong University sets up a special-purpose audiovisual teaching and research section that is specifically in charge of the management of sound laboratories, classrooms with electrical audiovisual aids, and computer rooms as well as some related teaching activities. Every student registers in English listening comprehension for one semester.

Market Calculation of IT in Secondary Educational Fields

What is happening in advanced schools of today is going to be seen in other schools tomorrow. With the social economic capabilities rising, and the price of semi-

Table 1.
Information Equipment Used in Five Schools

School	Sound Laboratory	Computer Room	TV Set	Other Equipment
Shanghai School of Chemical Technology	2	3 (100 computers, most of which are Pentium computers)	1 in each classroom	2 projective instruments with large screen, 2 pickup cameras, 11 videocorders
Attached Secondary instruments School of Shanghai Jiaotong University	2	2 (83 computers)	1 in each classroom	1 LD&VCD driver, 2 projective with large screen, 25 videocorders
Shanghai Guangming Secondary school	3	2 (100 computers)	1 in each classroom	
Shanghai Secondary School No. 51	1	1 (50 computers)	1 TV room	
Quyang Secondary School No. 2	1	1 (25 computers)	1 TV room	

conductor devices dropping, the requirements of students and the community will push the related government departments to invest in information technology for all schools. Guangming Secondary School, a district key school, is currently in the process of setting up a modern sound laboratory. Quyang Secondary School No. 2, an ordinary school that is situated in Quyang Residential Quarter in the northeast of Shanghai, had its sound laboratory and computer room built in 1996.

The knowledge of students and the community as well as the demands from the community will be the important power to reform teaching concepts, means and technical equipment.

Table 2 is the investigation results on the information equipment owned by the families of students from two schools.

Table 2.
Information Equipment Owned by Some Students' Families

Information Equipment	Quyang Secondary School No. 2	Attached Secondary School of Shanghai Jiaotong University
Own TV Set and Tape Recorder	100%	100%
Own Videocorder	84%	74%
Own Computer	10%	19%
Want to Own Computer	94%	100%

Attached Secondary School of Shanghai Jiaotong University includes some rural students, so the ratio of the families owning video recorder is comparatively low. The ratio of the senior school students owning computer is higher than that of the junior school. The ratio of the families from two schools owning computer is about 15%. It can be found from the investigation that there is not much difference among the family conditions of the students of various schools. The levels of their desire to understand advanced technology are almost identical.

It is estimated that the ratio of Shanghai families that own computers will go up to 20% next year. It looks as if the ratio of the families of senior school students owning computer will be higher than it. The increasing interest in home computer not only forms a new demand on computer course, and therefore, with the assistance of computer, supplies favorable conditions for English teaching, it also provides a huge market base for English teaching software.

The exhibitors selling sound equipment and computer took up about half of the exhibition hall of the September 1996 laboratory instrument and equipment in Shanghai. It is estimated that in next ten years, newly built key schools will put comparatively advanced sound equipment and computer networks into teaching; the already existing key schools will put the emphasis on building multimedia computer network while safeguarding the former sound equipment at the same time. A new type of sound laboratory which is controlled by computer is gradually but warmly received by schools, too. The installation of computer network will become imperative in other schools as well. All the schools are looking forward to more advanced and yet practical equipment, and combining sound equipment with multimedia computers.

In English teaching, the effects of audiovisual education technology are well known to the public. Tape recorders have become the tools that English learners can't be short of. In order to sharpen the listening ability of students, using tape recorder in English class has been greatly promoted in many secondary schools. English teaching programmes on radio and television have been effective instructor and helpful friend to millions upon millions of people. There is no doubt that most parents want their children to watch such programmes. In schools with good labs, sound laboratories become welcome study places of instructors and students. But at present, as for as English teaching of secondary schools, the pity is that mediums to provide visual stimulation seem not to have been made full use of. Some English teaching films can be made and shown properly in class without much change, and some other suitable English movies can be produced or purchased for students to watch after school. These visual aids will play an important role in students' English learning. It is estimated that, if there is a large quantity of suitable VCD teaching materials, the call "VCD Enters Classroom" will probably be raised in near future in schools where each classroom is provided with TV set, which will be more practical and convenient than letting computer software goes directly into classrooms.

The development of hardware will certainly bring along that of software. Both purchased and produced English teaching software is valued extensively.

The quantity of existing software for English study is so large that it has become difficult to add up. These existing software for English study may contain word study, reading comprehension, listening comprehension and multiple exercises training. Some software is used in one single school, while others have been exchanged among schools. Some software is popular and has gone through many reprints, and some has been upgraded as multimedia version recently.

One of the authors has helped to develop the software about English word structure. That courseware, which contains the entire texts of English textbooks for students of senior secondary schools, teaches readers how to distinguish the prefix, root, and suffix of a word, and learn to remember the words according to the three parts of meanings. We had some students been tested on it, and found that the number of the new words that could be memorized by the students per hour can add up to about one hundred when they were tested using the software for only fifteen minutes, after learning the courseware for an hour.

Quite a number of editions of learning software on different subjects of secondary education, including English, have appeared in recent years. Gold Disk English, the first set of laser disk of English teaching material for elementary and secondary education in China has been published by the People's Educational Publishing House. This set of disk can be further divided into two sorts: LD and VCD. LD adds up to ten pieces, and VCD twenty pieces. The former lasts one hundred and twenty minutes each, and the latter sixty minutes.

In Shanghai, in the past few months, the software of WST (meaning the content materials can be understood without instruction), which falls in the category of secondary education material, has got the highest sales volume of software overall. It contains two compact disks, one is aimed at English for students of senior secondary schools, the other for students of junior secondary schools. Each includes four parts: basic grammar, basic training of ability, simulated test and entrance examination questions. The texts of the courseware in multimedia format were prepared by a number of authoritative instructors in secondary schools. The students who have already used it indicated that they were interest in this type of courseware, and it can help them to get a deeper understanding of the content materials.

Prospects for English Teaching Technology

In foreign languages teaching, various schools have used information delivery methods to different extents. Both instructors and students are looking for the information technology that is more suitable for teaching and learning.

Different kinds of information technology have been accepted by schools. The whole process can be described as a fixed course of "Saddle-shape Process" (also called "U-Process"). Sound equipment has experienced its peak period and indifferent period, and now it is beginning to step into an improving and moderately developing period. Multimedia computer network is advancing towards its first peak period.

In November, 1996, at the mobilization meeting of "National Audio-Visual Educational Experimental School" held in Xuhui District Central Primary School No. 2, Shanghai Committee of Education made the following demands: enthusiastically advance the modernization of educational mediums such as projectors, televisions, videocoders, computers and so on, gradually have them take the place of traditional teaching tools such as chalk, blackboard, instructor's pointer etc., further promote the reform of the basic education and the all-round improvement of the knowledge of students in secondary schools and elementary schools.

In order to advance the modernization of the education, the Audio-Visual Educational Committee of National Committee of Education has lunched a project of National Audio-visual Educational Experimental School. In Shanghai, 52 schools have applied for it, and through experiments, over 70 percent of the experimental schools will become model schools of Shanghai, where the level of carrying out education with electrical audio-visual aids and the degree of modernization of education are both quite high. Shanghai Committee of Education will select a few from among those schools for applying for national audio-visual educational model school. By means of using the experience of selected units to promote work in the entire area, the level of the modernization of the educational mediums used in English teaching in secondary education of Shanghai will certainly be raised by degrees.

Features of Future English Teaching

Classroom teaching mediums are varied by degrees. Different kinds of mediums such as tape recorders, TV set, videocorders, multimedia computers and sound equipment will be applied increasingly in classroom teaching, instead of using blackboard and chalk only.

Study channels are gradually varied. It is no longer only from classroom that students obtain knowledge of foreign languages. Now they can also find supports from families and community. The increase of information mediums used in families, community and schools makes the classroom teaching lose its importance, while at the same time sets a higher demand on the efficiency of classroom teaching.

Individual study is strengthened. Students have the ability to prepare hardware and software themselves and study them individually. There will be more and more excellent students, and the overall level of students will be raised, too.

The work of instructors has changed to some extent. An increasing number of instructors divert some of their energies to the development and application of advanced teaching mediums.

By the year 2000, the value of the output of electrical computers of Shanghai will add up to two thousand million yuans, of which the value of software will amount to five hundred million yuans. We should catch this juncture in English teaching, make full use of new technology, and foster a good ability of English listening, speaking, reading and writing for our students.

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Massive Dissemination of Information Technology through Testing in Shanghai

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With the rapid development of electronic technology, the world has entered a new era of the information age that is exerting an increasing impact on our life styles, paradigms, and the modes of production. Yet, this impact reveals a huge inequity of technology access between the economically advanced nations and developing countries. Consequently, how to make the information technology benefit people of all countries becomes a new challenge in the information age. Furthermore, how to let information technology reach a developing country of 1.2 billion people makes the challenge even tougher. Due to the facts that there are very few technology dissemination programs that can be readily applied to China, the human resource engineers of China have to create their own. Among the successful out-research programs they have developed is the "Disseminating Information Technology through Testing" in Shanghai.

This paper analyses the Shanghai computer test program from the following four aspects: a. the background of the program which introduces the current stages of technology development in China and discusses the necessity of the program; b. the curriculum of the program which delineates the content and sequence of the program, c. the testing procedures and results, which deal with the operational aspect of the program, illustrate the results of the first 10 tests, and describe the demographic characteristics of their participants, and 4. the discussions of the model which put the initiation and success of the program in the social and cultural perspectives of the Chinese society.

The Background of the Program

Very few statistics are available regarding the current status of distant learning facilities and computer availability in Chinese schools and society. People's Daily reported in 1995 that by 1994, there were 7,100 educational television stations (including relay stations) and 53,000 TV viewing sites. They were mainly used to train 1,200,000 school teachers and provide agriculture technology for 20,000,000 farmers (People's Daily, 1995). According to the "Feasibility Study of the State Major Tasks for the 9th 5-Year Plan" of the Chinese State Education Commission, China has currently equipped 30,000 schools with computer labs and has a total of 300,000 computers used for the elementary and secondary schools (CSEC, 96). That indicates 30,000 labs out of 800,000 schools and one computer lab out of 25 schools. Most of the citizens have never used computers and will not likely possess one in the near future. Nevertheless, the world has entered an information age, and computing skills are required in almost all careers. With the booming industry in China, and especially in her most industrialized city of Shanghai, the need of information processing skills for a new generation of workforce is becoming increasingly demanding.

Shanghai is one of the largest cities in the world with a population of 12 million people. In spite of its rapid growth in industry, it is still a developing city in a developing country, which greatly limits its access to financial resources. In view of the great disparity between the need of economy and the exiting information skills of her citizens, how to disseminate technology among her enormous population is a daunting challenge to its human resource engineers. Searching around in the global technology market, there were hardly any technology outreach programs that could be readily applied to the economically booming, yet populationwise most burdened city of Shanghai. Therefore, the leadership of Shanghai decided to design its own programs of human resource development for the 90s, including training at least 10,000 much needed personnel for the key positions of Shanghai economy (Shanghai Education, 94). Naturally, information technology should be part of the training curriculum, yet Shanghai was short of both instructors and facilities for the grand task. Consequently, the Shanghai Educational Commission gathered its 8 experts in the educational computing field in 1993 and called for creative solutions to the challenge.

The Shanghai Television University (STVU) took on the challenge of massive dissemination of technology in

Shanghai with a creative approach involving a unique testing program. STVU was an open university under the Shanghai municipality to engage in distance learning by modern technology. It was one of the earliest radio and television universities in China. The President of STVU, Professor Huang Qingyuan headed the newly established Computer Application Testing Office that initiated the "Teaching Technology through Testing" program in 1993 to massively disseminate information technology to much needed specialists for Shanghai economy (STVU, 96). The outcome of the program greatly exceeded the expectations of the designers, and the past three years have seen a great success in this unique program.

The Curriculum of the Program

The designers of the testing course were very conscientious of the classical tenency in Chinese training programs, which, in the computer field, would have started from the binary systems or the BASIC language for the beginners. Nevertheless, the designers of the course made it very clear this time that it was the functional knowledge of computer and hands-on skills that were required for this program. Therefore, the learning objectives for the Basic Computer Course were to demonstrate the skills to use DOS, WPS (a Chinese word processing program), and the FoxBASE Database system. It was so designed that approximately 100 hours would be needed (50% of time in reading, and 50% hands-on experience) for an equivalent of a secondary school graduate to complete the course. After 4 months of joint efforts, the textbook for the Basic course was completed in 1993. The need for the course was so great that 900,000 copies of them were sold within 2 years (STVU, 96).

The Intermediate Course selected the upgraded version of DOS, Window, and FoxPro as their major software for training. Its textbook was completed by the faculty of STVU in 1994, and 100,000 copies of them have been sold since. Apart from the textbook, STVU also provided video tapes (34 sessions and 25 minutes each) for both Basic and Intermediate courses. These training sessions have been repeated many times on the Shanghai Education Television since 1993.

The Testing Procedures and Results

All tests were conducted on computers and each test lasted 2 hours. Of all the disks (21,000 for the first and 62,000 for the second) that were made for the first 2 tests, not a single one became problematic. The content of the Basic Computer Test was divided into 2 parts. The first part tested the basic knowledge that consisted of 25 multiple-choice questions which accounted for 25% of the total scores (25 points). The second part was divided into DOS Operation (10 points), Inputting Chinese Characters by Using WPS (20 points), Word Processing (20 points), and Using FoxBASE (25 points). The Intermediate Computer Test also consisted of two parts: The first part tested the foundation knowledge with 40 multiple choice questions (40 points), and the second part assessed the operating ability by asking students to demonstrate their skills to use DOS, MSWindows, and FoxPro database on computers. Each category in the operational part accounted for 20 points.

Due to the limited testing facilities and the enormous numbers of people that had applied for the test, the first test lasted 5 days with a total of 15 testing sessions. The second lasted 8 days with 24 sessions. As a result of this, evaluation software had to be developed and improved. The evaluation software currently used was a product of a comparative study of computer and manual evaluating on the basis of 1000 testing samples.

Because of the enormous population involved, it was impossible for STVU to offer all the hands-on training programs, therefore, it facilitated all the qualified adult learning institutions to accomplish the task. Before the first test, 140 training sessions with 4,000 computers were organized to prepare 15,000 participants. This number of training sessions increased to 250 with 7,000 computers to prepare 50,000 participants for the second test. Currently, 400 training sessions with more than 10,000 computers are preparing 300,000 trainees. Table 1 illustrates the number of participants and the passing rates of the first 6 tests for the Basic Computer Courses (STVU, 96).

Table 1.
Participants and Passing Rates of the First Six Tests for the Basic Computer Course

Test Order	Dates	Registered Numbers	Tested Participants	Passing Rates
1st	Jan. 94	18,225	16,266	73.15%
2nd	June 94	55,003	50,266	78.02%
3rd	Dec. 94	82,427	74,720	78.98%
4th	June 95	105,166	101,012	73.90%
5th	Jan. 96	104,578	93,904	78.41%
6th	June 96	98,206	90,277	68.25%

On the following page Table 2 displays the number of participants and the results of the first 4 tests for the Intermediate Computer Course.

The age of the participants in the first 5 tests of the Basic Computer Course is illustrated in Table 3 (STVU, 96).

Table 2.
Participants and Passing Rates of the First Three Tests for the Intermediate Computer Course

Test Order	Dates	Registered Numbers	Tested Participants	Passing Rates
1st	Dec. 94	8,808	7,518	35.25%
2nd	July 95	15,033	13,050	21.10%
3rd	Jan. 96	23,912	20,551	40.53%
4th	June 96	26,714	24,080	19.51%

Table 3.
Age of Participants for the First Five Basic Computer Tests

Test	Under 19 %	20-29 %	30-39 %	40-49 %	Over 50 %	Youngest	Oldest	Avg.
1st	19.8	50.6	22.9	6.3	0.4	9	65	22
2nd	14.0	43.8	28.7	12.1	1.0	10	71	28
3rd	22.6	36.0	27.0	13.3	1.2	10	68	27.8
4th	24.1	35.5	26.3	13.1	1.0	9	65	27.6
5th	28.1	32.7	26.4	11.9	1.0			

Table 4 describes the occupations of the participants in the first 5 tests of the Basic Computer Course (STVU, 96):

Table 4.
Occupations (%) of Participants for the First Five Basic Computer Tests

Test	Workers	Students	Administrators	Technicians	Unemployed	Others
1st	23.00	24.00	1.40	44.50	6.5	
2nd	15.15	14.94	15.63	45.95	6.33	
3rd	13.64	23.98	14.44	37.78	2.47	7.69
4th	13.76	27.00	13.82	35.11	2.38	7.93
5th	12.21	36.10	14.46	30.08	1.75	5.40

Discussions

There is little argument that the "Disseminating Information Technology through Testing" is a highly effective program in Shanghai. Its success can be attributed to, among others, the following 4 reasons: First, there is an urgent need for a new generation of workforce for the booming economy in Shanghai. The computer dissemination program is called upon by, and falls right into the essential curriculum of, the human resource training plan of Shanghai. The development of Shanghai economy demands millions of people who will be able to use various computer programs.

Second, Shanghai excels and leads the Nation in its distant learning and adult education programs. Currently, there are 258 adult learning institutions in Shanghai with a total student population of 160,500. Together with correspondence courses and other forms of training, approximately a million people are trained annually by one or more varieties of adult education programs (Shanghai Education, 1994). To many adult learners, the Computer Training Program is just one added curriculum requirement.

Third, there is a Testing Complex in the Chinese culture. From the Ancient Mandarin tests to the current competitive school exams, the test is always one of the central components of the curriculum. People are used to it. They readily accept it and work hard for it. Tests have more legitimate authority in Chinese culture and can generate more motivation in China than many other nations.

Lastly, the success of the program involves the team work of many people and organizations. After the course was designed, the formal notice of the course was passed on immediately to employees by all major related organizations. The Shanghai Education and Health Commission, Shanghai Personnel Bureau, and Shanghai Adult Education Commission jointly required their employees and all the administrators and technicians in Shanghai under the age of 50 to pass the Basic Computer Course. The Administration of Shanghai municipality recognized the two levels of computer certificates and connected them with employment qualifications and promotions. All the conditions mentioned above help create an environment that is conducive to the success of the program.

With the achievements of the Basic and Intermediate Computer Courses, the STVU recently released an Office Automation program that included basic knowledge of office automation, information processes in the OA system, OA hardware and software, Microsoft Windows 3.1 Chinese version, Microsoft Word 5.0 Chinese Version, Microsoft Word 5.0 Chinese version, and Chinese Star 2.0. Twenty testing sessions have been conducted on a server controlled network that no longer needs any separate disks. The server controlled network will replace all the disks in the future tests.

Together with the dissemination of technology among adults, the State Education Commission has just released a feasibility report in the Computer Aided Instruction field, which recommends 8 challenges as major tasks for the computer education in Chinese schools for 1996-2000. These 8 CAI tasks include:

1. Design software for the key courses in higher education,
2. Develop assessment software for higher education and test banks for key courses,
3. Design courseware for the secondary schools,
4. Develop courseware for the elementary schools,
5. Enhance the software engineering and development environment for educational software,
6. Increase the CERNT application and the distance learning,

7. Experiment the Local Area Network for elementary & secondary schools, and
8. Develop multimedia educational software. All projects will work hand in hand with the current adult technology dissemination programs and together they will make technology more accessible to the Chinese people.

The experience of the Shanghai computer training program demonstrates that disseminating technology in a development country calls for creative approaches and joint efforts of many fields. It is an achievable and a worthy cause. In spite of the fact that outreach programs may develop very unevenly in a developing county, and the curriculum of the Shanghai Computer Test Program is far from perfect, yet, it does reach people by hundreds of thousands in a very efficient and economical way. It is a highly successful program in Shanghai, and it has certainly brought information technology a giant step closer to the Chinese people.

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China 5000 - A Virtual Learning Center with China Related Materials

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China 5000 is the first and by far the only truly hypertext chronological timeline of Chinese history in the Internet community on the World Wide Web (WWW). It incorporates Chinese culture, art, education, science, and government reference related to China, Taiwan and Hong Kong. The user can simply click on one of the dynasty in the timeline to view materials related to that particular dynasty (Figure 1). Beside being a centralized site in the WWW community, China 5000 is further enhanced for educational purpose due to its Distributive Query Handling (DQH.) system. DQH utilizes the Intenet "reflector" feature to forward questions and requests received through China 5000 to appropriate experts in the Internet community. These experts can then assist in answering questions in different subjects. To date, China 5000 has received China-related questions and helped distributing these educational requests from/to Singapore, Canada, France, US, and Mexico (Chang & Tsao, 1996).

Information Technology and Chinese Studies

This year, under the author's recommendations, the University of Maryland hosted the 38 th American Association for Chinese Studies (A.A.C.S.) conference with two major innovations: first, a never-before conference theme - "Communicating in the Chinese-Speaking World"; second, an newly-added discussion topic - "Information Technologies". A theme provides focus on the presentation materials while new topics will provide new thoughts to the conference participants. The author is also happy to see both suggestions being well-adopted by A.A.C.S. board members and the conference participants, resulting more than twenty panels targeting on the conference theme and three panels on science and technology issues, particularly information technologies.

This discussion panel, "The Role of Information Technology (IT) in the Chinese-Speaking World", was also proposed by the author. The purpose is to present to the audience the importance, potential, and application of many aspects of IT in the Chinese-speaking world. Since this is one of the very first attempts to link IT into future A.A.C.S. conferences, the author decided to use the exact panel topic, with the traditional 6 W method, to elaborate on IT and its link to Chinese studies and the Chinese-speaking world. Throughout this paper, a project named "China 5000", an Internet World Wide Web (W.W.W.) based project initiated by the author in 1995, will be used as an example to support the author's points.

The 6 W's - What? Why? Who? When? Where? and hoW?

The 6 W method, is a rather old-fashioned way of discussing and analyzing difference subjects. However, the simplicity and clarity of such method makes it a very useful way of presenting newly-established concepts. The author is conducting the 6 W method in a questions-and answers format. The first 5 W's (What, Why, Who, When and Where) are intuitively acceptable. While the last W (hoW) will be somewhat controversial, the audience shall understand the author's assertions were derived from his own professional and scholarly viewpoints.

What (shall we do about Information Technologies and Chinese Studies)?

The questions derived from the word "What" can not be considered narrowly as "What is Information Technologies?" or "What is the Chinese Speaking World?" They should be rephrased as "What shall be done for information technologies" or "What shall be accomplished for the Chinese speaking world?"

"What shall we accomplished for the Chinese Speaking World (Chinese Studies)?" Below are three major directions proposed by A.A.C.S.:

1) encourage the study of subjects related to China, especially in American educational institutions;
2) advance such study and teaching through the exchange of information and scholarship across disciplinary lines;

3) promote understanding and communication between Western and Eastern scholars involved in Chinese studies.

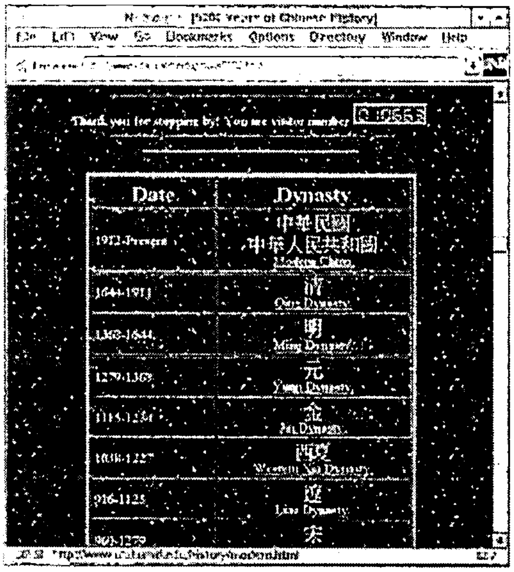

Figure 1. Sample WWW Home Page for China 5000.

"What shall be done for Information Technologies?" The answer can be generated by replacing the word "Chinese studies" with "information technologies" in the above three statements. In short, the application of information technologies needs to be promoted.

Why (do we want to associate IT with Chinese Studies)?

IT handles large size, long distance and provides high speed (relatively, in comparison to post-mail) in an inexpensive way. Table I contains an electronic message regarding "China 5000" delivered to the author in US from Singapore — an example for long distance and high speed communication. (Ron, 1996)

Table 1.
E-mail Question about China 5000 - Long Distance, High Speed

Date: Wed, 04 Sep 1996 14:45:36 +0800
From: Goh Rong Ren <rongyi@singnet.com.sg>
To: cschang@umd5.umd.edu
Subject: Chinese revolution
Dear Mr Chang,
Could you please post me some information concerning the Chinese revolution. (Meaning the overthrow of the Ching Dynasty and formation of the Republic Of China) My main focus is on the causes of this revolution, the consequences of this revolution and the significance of this revolution. Please return the e-mail as soon as possible. Thank

Who (should be involved in such effort to link IT with Chinese studies)?

This task will not be limited to a small group of scholars anymore. Whoever familiar with IT and is interested in Chinese study will be able to join the task force. Table 2, 3, and 4 contain E-mail message about China 5000 from different group of people. Such variety of participation proves the important role of IT to the enhancement and enrichment of Chinese studies. (Grunfeld, 1996; klstewartlggnn.com, 1996; benson@gsilink.com, 1996)

Table 2.
Everyone can be involved in linking IT to Chinese studies

Date: Sun, 28 Jul 1996 22:34:55 -0700
From: Beatriz Grunfeld <beagrunf@mail.retina.ar>
To: cschang@umd5.umd.edu
Subject: China
We write you to ask for information about the origins of both China Republics and Hong Kong and Macao. We'll be very happy if you answer our message as soon as you can.

Table 3.
Everyone can be involved in linking IT to Chinese studies

Date: Thu, 20 Jun 1996 19:25:05
From: klstewart@gnn.com
To: cschang@otal.umd.edu
Cc: kstewlll@aol.com
Subject: Re: Historical or fiction character
I must know if the character "Wong Fei Hong" (one of the tigers of Canton) was a real Historical figure or if he was like our Paul Bunyan, or Robin Hood-fictitious .

Table 4.
Everyone can be involved in linking IT to Chinese studies

Date: Wed, 7 Aug 1996 21:12:20 +0000
From: benson@gsilink.com
To: cschang@umd5.umd.edu
Subject: China's Legendary Age
Dear Sir,
I was doing a research on ancient China and in the course of my research I came across China's "legendary age". According to the book (History Of Asian Nations by Zaide), the unknown centuries prior to 2205 BC were known as China's legendary age. According to the legend China was successively ruled by "Five Good Rulers" namely Fu Hsi, Shen Nung, Huang Ti, Yao and Shun. I consulted another book (An Outline History of China by Bai Shouyi), it never mentioned the names of Fu Hsi and Shen Nung. Although it mentions the name of Huang Ti, Yao and Shun but they were only tribal chiefs. Can you enlighten me on this? Thank You.

When (should all these activities be happening)?

With the help of IT, Chinese studies will be a 24 hours activity! CHINA 5000 can serve as a typical example. (see Table 5; Goldman, 1996)

Table 5.
China 5000 (Chinese studies) - a twenty-four hour activity

---------- Forwarded message ----------
Date: Sat, 26 Oct 1996 21:38:47 -0400
From: Charles Goldman <chazz@otal.umd.edu>
To: root@otal.umd.edu
Subject: Oct 26, WWW log report for china5OOO
Total number of hits = 44

rcm-as7s25.erols.com [26/Oct/1996:00:06:08 -04001
nevis.u.arizona.edu [26/Oct/1996:00:43:19 -04001
ns.iceonline.com - - [26/Oct/1996:01:25:17 -04001 van-as-lOal5.direct.ca [26/Oct/1996:01:35:40 -04001
dialin9O86.slip.uci.edu [26/Oct/1996:03:40:22 -0400]
nari.kaist.ac.kr - - [26/Oct/1996:03:54:00 -04001 dpcll.110.sw-building.uh.edu - - [26/Oct/1996:04:26:49 -04001 nts-22.calstatela.edu - - [26/Oct/1996:04:43:54 -04001 pub-l-b-3l.dialup.umn.edu - - [26/Oct/1996:18:11:24 -0400]
levasseu.fxbbs.com - - [26/Oct/1996:20:46:47 -0400]
[more data continue]

Where (should all these activities be located)?

Such activity could happen outside of school or library. One can study and learn about Chinese history, culture, etc., whereever Internet access is available. (Table 6: Riva, 1996)

Table 6.
China 5000 (Chinese studies) activity in France

Date: Thu, 05 Sep 1996 15:25:42 +0200
From: riva <riva@riva.riva-multimedia.fr>
To: cschang@umd5.umd.edu
Subject: (no subject)
I HAVE FOUND YOUR SITE IN PARIS
SO I AM INTERESTED BY ARCHEOLOGY HISTORY AND ANCIENT COINS ABOUT CHINA IS IT POSSIBLE TO HAVE MORE INFORMATION AT MY POSTAL ADDRESS ?
MR MONJOIE DOMINIQUE
8 RUE DU POTEAU
75018 PARTS FRANCE
THANK YOUR FOR YOUR QUICK ANSWER
BYE BYE

hoW (could we accomplish what we want)?

Is the answer simply the word "Intemet"? No, it is not just "Internet"! The author proposes the need for greater efforts in the following three directions:

1. Chinese Language Unification (in spelling and writing)
   a. Character reunification: a follow-up of Emperor Chin's contribution thousands of year ago
   b. Pin-Yin or Phonetics?
   c. Both will simplify technology advancement and improvement in Chinese language
2. Chinese Studies Net (C.S.N.)
   a. Organizations like A.A.C.S. should take the lead in organizing Chinese-related materials on the WWW
   b. Scholarly involvement is the most essential topic
3. Information Technology Advancements in Chinese Language
   a. Chinese Speech Recognition
   b. Chinese Handwriting Recognition

Implications for Teacher Education

China is more than 4000 years old, while Information Technologies has no more than 100 years of history (Hafner & Lyon, 1996). To strengthen the link between IT and Chinese studies is like strengthening the relationship between a 100 year old lady and a two year old child. It is not impossible; it needs people's participation, time and effort. Having three science and technology related panels among the twenty-two panels in the AACS conference is an excellent start and a good example of people participation in linking IT with Chinese studies. Successful promotion and adaptation of an IT oriented educational project like "China 5000" will be a strong step in the direction of acceptance and advancement of IT in teacher education.

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Inservice Training through ODL Environments: From User Needs To Functional Specifications

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Open and Distance Learning (ODL) can be regarded as learning by means of telematics (the combination of means of telecommunications, information technology and multimedia), which identifies as necessary to the learning process all interactions between learners, teachers and courseware, all accessible and readable information and knowledge (in different representations), and a high degree of flexibility regarding place, time and pace of learning.

The ODL has four main objectives: to develop teaching frameworks and methods suitable for the use of technologies in different educational environments; to not only improve the organizational environment in which these new methods of education are applied but to enhance the quality and user-friendliness of multimedia applications and online services; to increase the skills of teachers and trainers in devising and using models for training relevant partners at all levels; and to encourage the recognition of qualifications obtained using multimedia materials and distance learning services.

The ODL's purpose is to develop and promote methods and techniques designed to increase the quality, efficiency, and flexibility of education. ODL is to be understood in two senses—the improvement and development of teaching methods in the educational system and the supply of distance learning services using information and communication technologies.

ODL does not necessarily mean that a student must study alone (at home, at school, or in the working environment) under the guidance of a teacher who is at a remote site. ODL can be best combined with other forms of education such as cooperative or distance learning. Using telematics is not a target itself, but one means of realizing educational goals such as renovation of the pedagogical methods and environments in educational institutions, stimulation for the dissemination of information among educational institutions all over the world, encouragement of collaboration, a very good educational technique, motivation of students through the use of effective and current technological equipment, and effective transmission and delivery of knowledge to students.

The educational systems must be urgently supported by effectively introducing the use of Information and Communication Technology (ICT) and by installing flexible teachers' training techniques that ensure equal opportunities for all without restrictions such as distance and time; cost effectiveness; and continuous improvement of teachers' skills and capabilities.

The TRENDS Project

At the time of this writing, in Europe, an attempt is being made through the TRENDS project to use ODL environments to reach these goals (Telematics Applications Programme - ET/1024 EC). The TRENDS project aims at the development and efficient delivery of inservice training to school teachers, thus improving the quality of the educational services of public interest and, at the same time, stimulating the creation of new jobs in the education and training sector. The methodology focuses on the enhancement of existing ODL techniques in the area of multimedia telematics by practicing the latest methods of Information Services Engineering in measuring the application as well as the socio-political feasibility in the domain of lifelong learning. The objectives of the project are:

- The development of an inservice, school based teacher training system based on multimedia telematics to support the continuous improvement of teachers' skills and capabilities in European secondary education.
- The implementation of distance learning techniques to provide viable and cost-effective school-based training.
- The establishment and operation of a European Teachers' Training Network to provide the distance training.
- The validation of the distance training services by training 2,400 teachers from 120 European public secondary schools.

Methodology to Determine User Needs

A very important phase in the lifecycle of a project relates to determining user needs. Since TRENDS is a trans-European project, the task of establishing user needs is even more complex and requires a great deal of organization and planning. Failure to identify the user needs is almost certain to lead to the project's failure. It is, therefore, imperative that utmost care is taken to determine all user needs at the onset of the project.

Determining user needs was adopted in the context of the TRENDS project by the participating countries with slight variations as dictated by the educational systems' differences. The method included:

- Questionnaires sent to key persons and experts (indirect users of the TRENDS project) from the fields of Education, Information Technology, and ODL about topics related to the teachers' work, initial training, inservice training, needs for support, and their new role as a teacher incorporating new technologies into the learning process. Master guidelines were based on the responses to the questionnaire.
- Organization of discussion panels/workshops with marginal extension of the numbers of these key persons and experts for brainstorming and discussion of the aforementioned topics.
- Questionnaires addressed to potential end users (school teachers) who were divided in two groups: users with and without experience in using ICT for educational purposes.

The justification of the outcomes for each of the participating countries was ensured by the involvement (discussion and/or questionnaires) of end users (teachers) to some extent and the involvement of indirect users (such as education policy makers, ODL and ICT experts, teacher training experts, and decision makers) by interviews and discussion panels/ workshops.

User Needs for the TRENDS Project

The user needs as expressed by the end users fall into two categories. The first contains needs expressed by those having little or no experience in the use of modern telematic technologies for improving the educational process. The second contains more detailed needs expressed by those who understand the possibilities offered by the use of telematic technologies. Following are, in brief, user needs:

- Acquaintance with the various tools offered by ICT and how these can be uniformly and readily used for improving the overall quality of the learning process.
- Creation of interdisciplinary courses on a national or international basis.
- Personal communications among teachers, school administrators, and curriculum experts to exchange ideas, information, plans, and techniques concerning the educational process.
- Additional scientific knowledge pertaining to particular subject matter (expressed by nearly all countries with only slight variations). This knowledge should either fill ascertained gaps in the initial training of teachers or contribute to their further education in the subjects they teach (Italy, Portugal, Spain).
- Participation in discussion fora dealing with educational issues to exchange information/opinions on educational matters with trainers and colleagues all over the world.
- Further education and updating for teachers on the new didactic methodologies developed and applied to each subject matter. The aim is to familiarize teachers with these methodologies and their contribution to the learning / teaching process with particular emphasis placed on those which help solve special problems facing teachers.
- Access to resources containing educational material (such as the Web).
- Transfer or exchange of educational material between teachers all over the world.
- Access to services offered by already established educational networks for using already existing, evaluated resources.

TRENDS Educational Network Services

To meet end users' needs, the following services will be offered in the context of the TRENDS project:

Interpersonal Communication Services

The following are the interpersonal communication services offered through the TRENDS project:

Off-line contact with a trainer. This service will offer the ability to register questions concerning the material they studied. The trainers will be able to answer and clarify any difficult points. This service will be implemented by employing already existing network services such as contact through e-mail with other educators and trainers. The e-mail service, enhanced by supporting multiple data formats (multimedia support), offers a fast path for the exchange of messages with other colleagues participating in the TRENDS project as well as personal contact with the trainer.

Access to multimedia information. Widely known Internet technologies will be used for implementing the access to multimedia information and for storing and making available the information that the TRENDS project will produce.

Creation of fora. These fora will exist in the form of newsgroups in which educators can participate. Also, the newsgroups can offer up-to-date information on educational subjects and policies adopted by each of the participating countries. The TRENDS project will produce its own fora for discussion and debate on subject matters mainly concerning the audience of the TRENDS project.

Access by trainers and educators to curriculum-related information. This will be accomplished by having access to other educational networks through TRENDS's educational network to already existing educational networks. This will facilitate the introduction of ICT in the educational process by enabling teachers to use already existing educational material and share experiences on similar approaches.

Multimedia Tele-training Tool

This tool will allow online delivery of remote training sessions from trainers to teachers. A training session offers both the trainers and the teachers the following services:

Preparation of the training session. This service will allow trainers to prepare training material containing multimedia information, making training sessions more attractive to educators. In this way, the immersion of the trainees is more complete and results in a better understanding of the material. The trainers will be able to customize the material, thus increasing effectiveness and making the material easy to update and reuse.

Participation in a lesson. Educators will be able to register in available services and to join an already-started training session at any time.

Automatic distribution of the training material. Educators who registered for the session will have access to training material that will not only reside in their workspace but will be available for later review.

Coordination of the training session. Trainers will be able to actively control the training session's speed to accommodate. It will also give educators to register questions concerning the session's material, and the trainer will be able to answer them online, thus aiding the clarification of difficult points.

Review of the training session's material. Those participating in a session will be able to review the training materials outside of training time. Thus educators will be able to prepare or review material after the training session to achieve a better understanding.

Distribution of Lessons Through Multimedia Distance Education Tool and Video

These tools offer a way to access off-line lessons residing in remote servers. These lessons will contain multimedia information and will offer the equivalent of an electronic textbook. The services include:

Lesson preparation. Trainers will use appropriate equipment and software for preparing lessons. The distance education tool will offer trainers the ability to create lessons containing multimedia material that may reside in various hosts. Also, trainers will be able to define the navigation flow that educators accessing this lesson will follow, thus guiding them to a better understanding of the lesson's material.

Searching for lessons. Educators accessing various lesson servers will be able to search for a lesson using search criteria such as key words, exact titles, and cross-references. This service will help the educators easily focus on lessons that interest them.

Access to a chosen lesson. After selecting a lesson, educators will be able to connect to the appropriate server and browse through it.

Navigation with the use of hypermedia semantics. After retrieving the lesson, educators will be able to use hypermedia semantics to browse through it. They will be able to either follow the trainer's predetermined lesson flow or to randomly access those parts of the lesson that are of major interest to them.

Continuation of a lesson. Educators will be able to quit browsing through a lesson and to save it for future review. In this way, educators will not waste time and can be more productive. Problems arising from limited inservice time may be overcome in this way.

Progress supervision. An evaluation tool must be available for multimedia distance education. The trainer will issue test to check trainees' absorption of lesson material. Educators will be presented with individual success statistics for reforming the lesson and will be informed about their success ratios, helping them to better review the lesson.

The TRENDS Educational Network

TRENDS services will be implemented as a set of software tools abiding by the client/server model. The use of the client part of the software tools will be through a common look graphical user interface (GUI) customized to fit each users' language.

The TRENDS project will establish a network based on existing technologies of EURO-ISDN. The connections will have a minimum bandwidth (such as 64 Kbps) to guarantee the proper delivery of the services. The underlying network will support various services aimed at training of educators. The implementation of these services is based on using existing software tools (modified for the purposes of the project) that are integrated under a common user interface and that give them the added value needed for the purposes of the TRENDS project. These services are complemented by the organization of already existing education material and the implementation of new material mainly concerned with educators using ICT.

Due to the nature of the planned services and applications, TRENDS network infrastructure will offer :

High speed. The proposed services and applications transmitting large amounts of data require a minimum network speed to provide timely responses to the user.

Multicasting. The nature of the distance training and education tools requires that the trainer's node must send data to the trainees' multiple nodes.

Trans-European interoperability. Trainees and the trainers will be distributed in various European countries, so the network infrastructures must admit a high degree of interoperability.

Certified quality of services. Since some of the educational services offered by the tools cannot function properly, if network services are not meeting certain criteria, the network infrastructure must guarantee these criteria are fulfilled.

Since the same services will be offered by the TRENDS Project on a pan-European level, the six national sites in Greece, Italy, Spain, Portugal, France and United Kingdom will be interconnected through mature network technologies (Euro-ISDN, TCP/IP protocol suite) providing service to teachers in their schools.

In each of the 120 participating schools, client software will be installed, giving a significantly large number of European school teachers the ability access valuable information available in cyberspace in a friendly, time-efficient way. These teachers will also participate in teletraining courses as well as interactive work sessions. The national site configuration consists of the following:

The Training Centre, the location of TRENDS servers. Concerning information providers, some of the TRENDS partners and the sponsoring partners (Ministries) will provide multimedia information (courses) through different servers. Although its implementation may differ depending on interests, this configuration is compatible with the model of the strongest network operators.

Participating Countries' Training Centres. Schools connected to their country's Training Centre where the necessary client for the TRENDS network is installed.

Conclusions and Future Work

The development and availability of high-quality equipment and software, the service environments in which these tools are used, and teacher training are a few of the many conditions studied in six European countries within the TRENDS framework. The use of distance learning technologies makes possible virtual mobility and wide-spread access to educational services. The greatest possible number of educators will eventually be able to benefit from an intercultural and multilingual education as part of their personal and professional development.

The aim of the TRENDS Project is a trans-European educational network working with already existing advanced network technologies. This educational network will provide a set of elementary and advanced services comprising the Distance Learning Environment of the project.

The implementation of these services will be based on the use of existing software tools (modified for the purposes of the project) integrated under a unified GUI. These services should be supplemented by the organization of already existing educational material and the creation of new material mainly concerned with educators using ICT as part of the learning process.

As a result of the TRENDS project, an educational network called the European Teachers Training Network (ETTN) will be developed based on Advanced Telecommunication Infrastructures.

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TECHNOLOGICAL AND METHODOLOGICAL ISSUES IN TELETRAINING: THE EXPERTISE EXPERIENCE

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Recently a new tendency has appeared on the labour market, timidly in Belgium and in Italy, more in other countries: telework, through the use of linked computers. There are estimates that more of 60 % of the work implied in the production of goods is processing of information. This information is increasingly computerized. The possibility of teleworking is therefore huge in principle. The employer can benefit from savings in investments and consumption in buildings and furniture and a largest flexibility. For the worker, one invokes also the flexibility that allows for better conciliation of work, family obligations and leisure. The diminution of travel is to the advantage of the whole society by decreasing the pollution and bottlenecks and to the advantage of the worker in avoiding the loss of time and money, the fatigue and the stress. The different advantages for the worker also benefit to the employer that can hope increased productivity and quality of the work.

For persons whose handicap reduces the mobility, telework is an obviously attractive solution. For those whose mobility is reduced or that ask frequent assistance and cares, telework from their domicile or the institution where they reside or pass the day is practically the only solution to participate in the economic life by an active contribution and to find at the same time a broader socialization. For a mobile person, telework can involve less social relationship compared with what working in the premises of the company could offer. But for some handicapped persons isolated by the impossibility of usual work relationships, telework allows a huge socialization compared to their isolation (Volpentesta, 1995). For these handicapped persons, telework offers therefore a unique chance to break barriers of their handicap.

Of course teletraining is the first necessary step to prepare disabled people to telework. As a matter of fact it makes trainees familiar with technologies, methods and organizational structures for teleworking activities.

EXPERTISE (EXchange and Promotion of TElematic and Robotic Technologies for vocational training and employment of the dISablEd) is a transnational project to promote high level formation and employment of handicapped people in the HORIZON/EMPLOYMENT Initiative of Europe Union. It involves many regions of different European countries (Spain, Germany, Austria, Belgium, Italy) and its main objectives are:

- to provide effective tools and innovative methodologies for the vocational training and employment of disabled people using the most recent technologies, and
- to promote exchange of technology and knowledge among all European regions involved in the project.

In particular in Wallonie in Calabria we've focused our attention on teletraining and teleworking.

In the rest of paper we discuss the technological infrastructures used at Le Réseau (Wallonie - Belgium) and at Brutium (Calabria - Italy) to support project activities; telematic services which are used either as communication media for distance education and as means for teleworking; and didactic methodologies and some considerations about first results.

Technological Infrastructures

Regional occurrences of the project in Wallonie (Belgium) and in Calabria (Italy) are based on the same starting architecture that has led to similar infrastructures even if they differ for some tech implementations. Project activities are hosted in a vocational center, where most training activities take place, and in some peripheral nodes (no-profit organization and trainees' home) for distance training and net services delivery.

The main center purpose is to have a place where trainees can meet and configure telework modules. As shown in figure 1, a digital laboratory has been set up in the center and can be accessed physically or virtually, with a remote access, by trainees. A coordination staff is always available to a trainee for tech or medical assistance. In the digital laboratory, a set of Web/FTP servers are installed for local

Intranet and world-wide Internet users ; the purpose is to make available a group of services to the trainees and to disseminate project results and some works developed by trainees themselves.

The labs aims to give many different kinds of support to disabled persons:

- selection and integration of new software/hardware technologies and useful aiding tools;
- as vocational guidance site;
- as an interface to possible interested enterprises which need teleworker;
- in coordination of training and work activities;
- in management of tech infrastructure;
- to arrange a physical place for periodical meeting and socialization;
- to make available a place where trainees can deploy part of their working modules;
- to make available computing and telecommunication resources ;
- as a router and gateway to ISDN and Internet ;
- to activate base network services as file transfer and e-mail;
- to promote local services;
- to disseminate information on available technologies;
- to adapt workplaces for disabled people; and
- to create job opportunities for qualified handicapped people.

Both centers, in Wallonie and in Calabria, use multimedia personal computers and workstations to enable audio/video interaction. Listed below there are some brief characteristics of each tech solution; you can note some little differences in technological implementations.

At Brutium we have installed a LAN extended all over the rooms in the laboratory building. The LAN is a Fast Ethernet 100Mb/s to allow video/audio conferences inside the lab. A gateway to Internet at 64Kb/s. We've plugged in to the LAN 15 Win95 Net Clients PC all with audio capabilities, two of them have speech recognition software, three have video grabbing cards, two have CD-R drivers for multimedia production. We've also configured three Internet servers one Intel Linux, one Intel Windows NT 4, one PA-RISC HP-UX. As additional accessories we make available digital cameras, color printers, scanners, VGAtoPAL converters, VCRs, and a LCD projector. Moreover, all recent Multimedia Technologies and Intranet and Internet facilities have been set up. We have provided the possibility for people with severe handicaps to remotely attend lab activities (teletraining) via HFTV and Intranet technologies.

At Le Réseau we've given each student at the site where he/she is receiving the teletraining (home or institution) a PC Pentium 133 with 16Mb RAM, CD-ROM drive and sound card, Windows 95 and a printer. In our center, (where we are also providing vocational training in classrooms) all the (about 40) computers (trainees, trainers, administration) are linked in a LAN Thin Ethernet 10Mb/s. At the software level, it is a mixture of Windows 3.11 and Windows 95, with a Windows NT 3.51 server. Our server is equipped with a DIVA Quadro ISDN card from Eicon Technologies, providing 8 channels (four 2-channels Basic Accesses). The remote students also have a Basic Access to the phone company and an ISDN card in their computer.

We do not use Internet or other private networks. People can get relatively cheap Internet Access through analogue telephone lines but ISDN Access is only proposed at corporate rates which are still rather expensive. Instead, the remote students call directly the phone numbers of our server. Belgium is a small country. Even with (not so long) long distance calls, we pay less that what we would pay to the Internet Access providers (plus local calls).

In both training centers we focus on outcoming professional profiles in these sectors:

- digital audio-visual production;
- system and network administration;
- office and home automation;
- software design and prototyping; and
- CAD, computer graphics.

Telematic Services

Some basic and advanced telematic services have been made available to TEACHERS, TUTORS, TRAINEES AS SUPPORT IN TELETRAINING AND MANAGEMENT/COORDINATION PROCEDURES and to promote socialization through entertainment. Such services have been based on the usage of suitable telematic software tools.

The first set of tools integrates Internet technologies. In particular it essentially consists of some Internet modules and interfaces between them (Fasano, Frega, Greco, Volpentesta, 1996). On the Internet side we've built-up a Mailing List (to broadcast e-mail messages among Internet Horizon subscribers) and a Web Board (to let users browse all messages and bulletins from WWW).

Other tools, we've called WebRobots (Frega, 1995), let users publish full HTML pages without requiring HTML knowledge at all Della Gala, Frega, & Volpentesta, 1995)(Frega, 1995); they consist in a pages slider/randomizer and a HTML editor on line with preview and upload utilities; another tool is essentially a multi-user program that allows anyone with a Java-capable browser to draw on the same canvas for collaborative drawing.

At Giuda Lab. we've developed an entertainment shell where we inserted on line a couple of interactive card games (Frega, Greco, Pisculli, Volpentesta, 1996). The system may be regarded as an environment that allows users to communicate each other by a chat service, while they are playing some card game on a virtual table.

We have also developed a tool for collaborative drawing, called CODEE, it is essentially a multi-user program that allows anyone with a Java-capable browser to draw on the same canvas (Frega, Greco, Pisculli, & Volpentesta, 1997).

The last prototype we have developed and used in EXPERTISE is MAGDA: a multimedia collaborative agenda (http://tre7.deis.unical.it/magda/magdafrm.htm). At a local level the agenda is used as a support tool to project management; to coordinate teachers, tutors, trainees and their teletraining activities; and didactic collaborative work to let trainees groups to create and present multimedia material about topics selected and scheduled by teachers and tutors.

At a transnational level the agenda is used to setup european partners meetings; to give each subscriber a view at meeting schedules; and to multicast messages to predefined workgroups.

We do not use videoconferencing. As mentioned below, our training is largely practical. Trainees and trainers interact mainly by sharing directories and files, by e-mail and by phone. We thought that videoconferencing was not the priority in our situation. Another issue related to videoconferencing is that this medium is most appropriate to broadcast real-time teaching. On the contrary, we want to allow our remote disabled students to adapt their time schedule to their particular situation and their learning rhythm.

Didactic Methodologies

In the starting phase of the project most of the trainees didn't have a clear view of what computers are, what they are used for in the economical world, and how they themselves will fit in. Still, if they did come to us, they had a project or some hope to find a job after training. It is along their training that we're examining and developing their project with them. We help them to gradually better understand where they go and what training is needed to go there. There is no a priori program (except for the first weeks). The program is tailored to each individual following his (her) needs, inside what the centers is able to offer.

In regard to the didactic method we use, it is very different from classical one-way knowledge transfer from one teacher to all students; it's quite individualized anyway. Trainers give few classical lessons. They give explanations on some points and then tasks that allow students to try by themselves. This is the method that we are transposing in teletraining, providing multimedia materials instead of spoken informations and instructions: the trainers give to distant trainees, through the network, explanations and instructions to allow them to work autonomously, in principle for one day. These works are retrieved, through the network, to be evaluated by the trainer who decides about the next step. Of course, writing information and complete instructions is a huge work and we are searching for all existing pedagogical tools that could ease us from part of this task. It is true also for the work in the center : all the time that the trainers can save by using the existing pedagogical tools, is more time devoted to individual follow up. Individual training on the job and group collaboration are also encouraged by providing network application and communication tool for promoting exchanging with other EXPERTISE partners.

Trainees are also encouraged to use e-mail between them. Distant and in loco trainees keep tracks on the agenda to record all their training activities. This diary can be accessed at any moment by the staff. Meanwhile, a recording software traces all actions on the computer.

Formation

Since we deal with persons with more severe handicap, we think that the training could be slower. Some of them receive cares that take a good part of their daytime. For its content, the training benefits from the competence that both centers have developed. Globally, the objective is to master the use of networked computers and traditional software in business work (word processing and electronic publishing, spreadsheets, databases, accounting software) giving access to a large variety of jobs in the tertiary sector. Other possible training orientations are analysis and programming, the computer-assisted design (DAO) or computer graphics. Possible basic training shortcomings are taken in account in the project to make it accessible to the largest number, including the most disfavored.

Conclusions

In this paper we have discussed some technological and methodological solution we have adopted for the execution of teletraining actions in a european fomation project.

Issues about such solutions have dealt with:

- a telematic infrastructure (Internet/WWW/BBS) linking all interested sites and relevant public and private institutions (for ex. HANDYNET nodes) involved in the project;
- experimentation of teletraining and other distance education activities;
- usage of telematic software tools in order to support teletraining and management/coordination procedures; and
- providing technical aids to prepare people with sever handicaps to telework.

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First Steps of New Information Technologies in a Russian Teacher University

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Rostov State Pedagogical University (RSPU) and affiliated science organizations such as South Department of Academy of Education (SDAE), Don Devision of Academy of Informatization of Education (DDAIE), train teachers for all stages of education - for Nursary Schools, for Primary Schools, for Further Education Colleges and advance the science and education level of the magistral staff, graduate and post-graduate students. One of the ways to advance this level is the using of new information technologies such as telecommunications in education and training.

The team of Nets Technologies are included to the University program for students of some faculties. It is focusing on the using metropolitan (MAN) and global (WAN) nets at the lessons, for researches and the professional growth of school teachers. Unfortunetly, the practical learning of nets is applied for the local University net (LAN) only for our students, because of the low technical provision of computer classes. For some graduate students (Magistrants), which specialize on Informatics, there is the add entire course with the practical opportunity to work in global nets. The goal of this courses is provide a starting point for the future teacher.

Magistrants are working with one of e-mail cirriculums and at first are accessing with Internet services by e-mail. This skills are very important for future teachers because most of schools and colleges in Russia don't have a direct connection with Internet resources today. At beginning new users learn the network with newsgroups in the Usenet hierarchies (most of them there are on the newsserver of our service provider) and choose one or more groups for subscribing. Looking through the articles from these newsgroups (especialy the moderated newsgroups) students obtain appropriate information for future search or retreival - addresses of FTP sites with necessary files or programs, URLs of WWW sites with the indication of the path to necessary files etc.. Then they learn to access various Net resources using E-mail servers (FTPmail, Wais, Gophermail, WWWmail, Listserv, Mail-server) by specified commands in the message (Krol, 1995). Throughout this course Magistrants develop knowledge on the global network, with identified search tools for the navigation in the Internet and material for the execution of their science work.. We hope that our students as Network specialists after graduating from University will advance the new information technology in education or in spheres other than teaching, for example in industry and government.

The University theoretical research project which involved the creation of the educational net among regional pedagogical colleges entering our University system, has developed some practical steps for advancement of educational telecommunications. There are part time University students, who work as administrators or teachers of Informatics in regional colleges. The University information technologies laboratory is the place to receive technical and practical support (books, shareware and interchange of information) in the fields of pedagogical information. This project is the first step in creating an information and provider center on based at the Pedagogical University.

For the nature and humanitarian post-graduate students and teacher educators of our University there are a number of teaching methods, using interactive communication technologies. Students and educators have opportunities for full Internet access, which is one of the best methods for quickly finding appropriate information for their science researches, development and professional growth. The task of University specialists in telecommunications is to provide instruction on search techniques both off-line and on-line accesses. The University specialists recommend a starting point for items of scientific interest (Lambert and Howe, 1993). Educators in the Humanities have specific problems with telecommunications, because they are far removed from the computers' terminology and also often don't know English. There are a few special guides for humanitarians which have been written or translated and published in Russian and also some Russian nets with electronic versions. Tutoring begins with checking and/or improving definite computers and English language skills.

The second step is determining a chain of keywords of science interest and tools for beginning a text search on the Internet. Usually 5-10 lessons are allowed for new users to work individually with popular WWW, FTP and Gopher search engines and hypertext links.

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Something New in Russian Universities: Progress of Technological Reform

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Recent social and political changes in Russia have lead not only to radical transformation in the other countries, but in Russia as well. New educational paradigms realized today in these institutions and in teaching preparation programs determine the major goals. These goals include development of not only the students' personality and creative ability, but also the ability to solve scientific, practical, educational, and social problems through technology to meet the needs of a developing and changing world. educational systems in secondary schools and universities.

Aspects of the Educational Process

These new paradigms affect three aspects of the educational process: content, structure of programs and technology. The reorganization of the first and second aspects made after rapid social changes of the late 198Os and early 1990s has stabilized, and the development of content and structure, although slow, is extensive. The development of the technological component in education is the subject for intensive research and projects at Federal and regional levels. Technology is becoming the leading and most important aspect in determining educational strategies and concepts. Utilizing computers to work with databases, global networks, multimedia, and other software gives students and professors more opportunities to analyze information and to work with more complex decisions and problem solving. The ability to design and simulate phenomena and learn multi-processes are important in all aspects of Russia's educational changes, and the technological direction is rapidly becoming a priority, especially in terms of developing an open society.

Description of the Situation

In the past, Russian educational institutions had a few computers made in Russia; however, they were not compatible with computers made and/or used in other countries. Much progress has been made in this area since the 1980s. Today Russia is 6th among the European communities and second only to Germany in using computer technology. Schools and universities in St. Petersburg, Russia now have access to computer laboratories. Herzen State Pedagogical University has recently connected to the Internet and Runnet (a network among twenty universities in several regions of Russia). At this time, IBM compatible hardware is used more often, but other manufactures, i.e., Mcintosh, are becoming available.

Problems, Trends, Perceptions

Using Herzen State Pedagogical University in St. Petersburg, Russia as an example, it is possible to show general current situations and trends in Russian educational settings. In order to determine the use of computers and the types of software used in major content areas by university staff, professors and lecturers from the departments of Science and Humanities took part in a survey questionnaire and participated in personal interviews.

Analysis of data collected from the participants indicate that currently the main use of computers is as a word processor. However, such a one-sided use of modern technology cannot be considered completely effective. This situation is common, not only in Russian schools, but in other educational institutions as well (Mims & McKenzie, 1995). Perhaps an understanding of why this is common practice among faculty in universities and how to alleviate the lack of computer use should be the starting point for further studies and in deciding how and what to teach university personnel

According to the data collected from the questionnaire, computer use by university teaching personnel most often involves the following: word processing- 9%; qualitative and statistical data -5% each; although the staff are aware of e-mail, few have direct access on a daily basis. The majority of university professors have not been trained in the various aspects of multimedia and other more modern technological uses. The main direction of computer use by university faculty is in training perspective teachers of mathematics and computer programming. This may be due to the fact that those professors seem to know more about mathematical implications than their colleagues in more humanities-based courses; however, more faculty are beginning to give lectures based on computer learning, and they are using, when possible, computer in their disciplines.

Teachers of subjects to be taught in English are the curent leading users of software. This is explained by the fact that there is a strong motivation for students to study English as the language of international communication. Also, there is more English language programs available due to gifts to local schools by visiting American educators. The percentage of use in computer labs by faculty and students in teacher preparation programs is low. For example surveys indicate that 5 % of the Math and computer teachers use the labs. One percent use the lab for training in computer skills for other majors, and 1 % of the faculty use laboratories for software training for specific areas. Science and Humanities faculty and students account for 5% of the lab use. Also, 95 % of teaching in this discipline is devoted to the teaching and learning English as a second language.

Problems

The use of computers in teaching other disciplines is determined by availability and the amount or lack of quality software. The greatest number of educational software programs (made by known international companies such as Microsoft), are most often used in the areas of English and Business. Conversely, professors in the area of Science education, at this time, must write their own programs. Perhaps the primary reason for this is because of the popularity of English and Economics as majors most often selected by students at Herzen University as well as other Russian universities, and these students' awareness of international uses of these subjects. Therefore the demand for software in these areas is great, but there is a great need for software in other disciplines as well.

In summary the use of computers in specific academic disciplines, where there is available software either self-designed or commercially produced, is in the areas of Math, Science, Humanities, English, and Business.

Other Concerns

Certainly the use of educational software is not the only direction being realized in the educational process. University professors and personnel would like more access and availability of computers for their own research. The majority of professors would like to have the ability and resources to integrate their teaching with computer technology and a variety of software programs.

Data from the survey and interviews with selected faculty and staff at the university indicate that there are many expectations for future use by university teaching personnel. These university personnel listed the following as their perceptions of how technology could help them in the immediate future:

- use educational software in class
- organize educational and planning process
- participation in teleconferences
- and distant communication with other professionals
- evaluation of students work
- improvement of technological qualification
- work with " local network "
- CD ROM
- multi media
- multi media
- internet
- e-mail
- use educational software
- learn to use different software program
- work with word processor

Future Training

Advanced educational technologies require appropriate qualifications. In accordance with the problem of running effective programs such as in-service training regarding use, and in overcoming barriers for use is most urgent. Data from the survey also indicated that a majority of professors would like to learn more about the integration of multimedia. Barriers, or more precisely, the main reasons for non-use of computers included the categories of psychological and professional qualifications: lack of motivation, and a lack of both computers and appropriate software. Most faculty indicated that the number one "Barrier" to computer use is "not enough personal qualification."

Implications

Education in the former Soviet Union is rapidly changing. New standards and goals are slowly being met by individual regions, and there is a growing pride in the accomplishments of students as they prepare to take their place in a global society. On the other hand, political uncertainty and related economical concerns continue to plague the minds of educators who are eager to use the most modern equipment possible. While computer labs do exist, more powerful computers with CD-ROM capability are scarce. It is imperative that sponsorship and funding be found to assist Russian university faculty in educating students using up-to-date equipment and relevant software. Without the proper equipment, the training of higher education personnel will continue at a slow pace and possibly place students in a position far behind other countries in the use of technology.

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EXPERIENCING THE VIRTUAL CLASSROOM AS A TRANSLOCAL FIELD

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Because of the recent developments in information and communication technologies using video conferencing and audiographics, Finland has been experimenting with joining separate classrooms in an educational environment where classes situated at different sites participate in the same lessons through a video link. In autumn 1994, the lower secondary school of Kilpisjärvi, a small isolated rural village in the Finnish Lapland, was linked with the Teacher Training School of Helsinki University, a large urban school in the Helsinki metropolitan area (Kynäslahti & Salminen 1995). Although the teacher is usually situated in the Helsinki classroom with a group of pupils, the Kilpisjarvi teacher has taught several lessons. As a result of this and several other collaborations with Finnish schools, student teachers at the Teacher Training School not only practice the use of communication and information technologies in education but support the delivery of education to small schools. The results presented in this article are based on participant observation and interviews of pupils, teachers, and parents during a period of over two years.

Virtual Classroom

Like other terms popular terms in academic and social discussion, the concept of virtuality has both specific, narrow definitions. Many people, especially in the field of technology, regard virtuality as something relating only to advanced technology like data helmets and suits. Others, however, defined this word in a much broader sense. For them, the pompous and richly decorated baroque churches are examples of the virtual feeling of Heaven (Huhtamo, 1992).

The word virtual is derived from the Latin word virtualiter, used in metaphysical discussions in the Middle Ages concerning the dilemma between our worldly experiences and the true state of the entities. Martin Kusch explains this as the relationship between our world and (other) possible worlds (Kusch & Hintikka, 1988, p. 15). Possible worlds can be thought of as alternatives for our real world, or, on the other hand, our experienced world can be considered as an alternative from an endless number of options (e.g. Kusch, 1989, pp. 93-102). When constructing possible worlds, we can construct them with recognizable elements from our real world; as a result, the possible and real worlds seem similar. However, it is possible that other worlds are completely different from our real world; in this case, constructed worlds are very different from what is familiar to us.

The idea of possible worlds is interesting when considered within the context of virtuality and the virtual classroom. Many experts in this field consider the virtual classroom a version of virtual reality and replace the word virtual with the phrase as if. Because of illusion, we experience the virtual reality and environment as if we were actually within that environment. In contrast, Tiffin & Rajasingham (1995, p. 3) emphasize that virtual means reality in effect, not in fact. This interpretation suggests virtual reality and virtual environments work well when dealing with subjects such as virtual buildings and cities.

But what about social environments and virtual communities? Reid (1995), asserting that virtual environments are a question of imaginative experiences, approaches virtual reality as cultural constructs that emphasize users' experiences in the virtual world. The illusion of a real environment, she claims, depends on "the user's willingness to treat the manifestations of his or her imaginings as if they were real" and the degree to which users relate the virtual to their real world environment, an important point in experiencing virtual reality (Reid, 1995, p. 166). In the Multi-User-Dimension systems Reid investigated, users created an imaginary social and cultural world where they reacted to other users' moves. Towne puts it, "Typically, VR implementations attempt to maintain a realistic representation of some segment of a real or imaginary world as a participant moves about and operates upon that world." (Towne, 1995, p. 12). It is true that those who experience the virtual environment tend to emphasize elements resembling real situations and want to act as if they were in real life circumstances. On the phone, we override silence by constantly talking to maintain the illusion of being together. How does this apply to the virtual classroom?

The term virtual classroom originates from using computer-mediated communication to establish an electronic environment where classroom communication, like discussions and lectures, are possible (Hiltz, 1986, p. 95). Similarly, Tiffin and Rajasingham state that in a virtual class everybody can talk, be heard, and be identified as well as see the same words, pictures and diagrams (Tiffin and Rajasingham, 1995, p. 6). "The virtual class is a meeting place for virtual communities of learners with a shared interest in the same subject." (Tiffin & Rajasingham, 1995, p. 177). Before I try to answer the question I posed previously, we should consider virtual environments as an ethnographic research field.

Translocal Fields

Traditionally, in ethnographic research, a field has meant a geographical area, its people, and its community or culture. In the context of educational research, the field is often one or more classrooms or schools. However, Marcus and Fischer break with tradition and use the term multi-locale ethnography rather than field (Marcus & Fischer, 1986, p. 93). In these cases, no interaction between the localities is required. While conducting my research, I faced the problem of defining the ethnographic research field, the virtual classroom. In a way, this field has no location. In my case, field referred to two groups of pupils (one in Lapland and the other in Helsinki) lived 1200 kilometers apart and a teacher who worked within a "non-location" field, the virtual classroom.

Dahlén, Hannerz, and Lindquist (1995) speak about translocal fields based not on geographical areas or localities but on common ideas, interests, and interaction between the sites. Another uniting element of this field type are social relationships for creating social order. The role of some active persons, agents who take care of the performance of the field as mediators between the different localities, is important. They are the heroes of the field.

During my research, I used an approach derived from the ideas of Dahlén, Hannerz, and Lindquist to investigate the experience of the virtual classroom.

Virtual Classroom as a Translocal Field

The idea of bringing together the Kilpisjarvi and the Teacher Training School is to enhance the quality of the rural students' education (Kynäslahti & Stevens, 1996). Because the Lapland school does not have enough resources to deliver competent education in a variety of subjects, joining the rural classroom with the university classroom enables pupils to participate in lessons taught by teachers who are experts in their field. In this experiment, teachers and the rural and university students actively participate in the virtual classroom, but the rural pupils and the teachers are completely engaged in the program. Both student groups are focused on the teacher and the instructional process, so the teacher, who actually serves as a type of mediator between the students, becomes a significant element in the quality and maintenance of the virtual classroom. Using the vocabulary of translocal fields, the teacher is the hero of the virtual classroom.

The teachers' pedagogical approach is characterized by the intention of uniting the two student groups into one virtual class. The link between the teacher and the pupils in the remote site is intense, and the telepresence of the teacher is obvious when the experiment is viewed from the remote students' perspective (Salonen & Kynäslahti 1996). The pedagogical goal of joining the two groups into one adds new elements to the instructional process and to the virtual classroom. As stated before, in virtual environments people tend to emphasize those elements that creates an illusion of real world. In virtual classrooms, teachers try to manage the situation as if the pupils were in the same room. In this process teacher's role becomes more verbal as they guide students by often asking questions to reinforce student learning (c.f. Husu, 1996). In their efforts to create one virtual environment all participants, the teachers seem to enforce unintentionally their role as an uniting element (Kynäslahti, 1996, p. 131).

Linking two classrooms as one is not an easy task, especially if the groups differ in their cultural or social background. Therefore, a teacher in a virtual classroom may be in a situation similar to that of a teacher in a multicultural classroom. However, the virtual classroom can be even more complex because students cross two borders: first, they move to a virtual environment, and second, they are placed in an environment where they face people who come from different life experiences. For the Lapland pupils, the virtual classroom represents not only a version of their classroom but a different (other) world. Sensing this, teachers recognize the cultural differences and the distinctively different environments where the pupils live. In uniting student groups with respect to cultural and other differences, teachers risk segregating the pupils if they overly consider the local circumstances, needs and interests of each pupil because by doing so they simultaneously emphasise the students' differences (e.g. Schiffauer, 1996). Perhaps this phenomenon is an example of politics' difference with respect to education where the "guiding principle would be openness to differences rather than the urge towards sameness" (Nicholson, 1991, p. 47).

The relationship between the pupils at the different sites is a bit problematic and reflects the research discussed above in regard to students becoming segregated (McHenry & Bozik, 1995). The lack of spontaneous interaction between the two groups confirms the teacher's central role in this educational process. The students do share common Self with the teacher viewed as Other. Rather, each student group seems to be its own Self with Other being the other student group. The teacher exists somewhere between Self and Other. Interestingly, because the students have now participated in the mutual virtual classroom for over two years, they a common history, which is very important in developing a sense of community (Nicholson, 1991).

During the experiment, other heroes (usually the class clown or students with distinct personalities) emerged through the use of humor, which seems to be an important uniting element both for the pupils and for the teachers as evidenced by the repetition of inside jokes. This factor seems to have contributed to the students' emerging sense of the common Self in the virtual classroom.

Conclusion

In general, this virtual classroom resembles the traditional classroom because it is a virtual version of the "real" classroom with which they are familiar. The virtual classroom, a possible world, enhances the quality of education in the Lapland school by linking rural students with teachers who are experts in their fields. Because the virtual classroom is similar to a traditional classroom, participants recognize those elements that remind them of the real classroom and easily adapt to the virtual classroom.

Despite the similarities between the traditional and virtual classroom, the virtual classroom creates new environments with community patterns and forms of socialization, which until recently had been unknown. People from different environments and distinct cultures are brought together by common interests. Virtual classrooms, unknown possible worlds ready for educators to explore, are full of opportunities for developing social relations and new virtual educational communities unfamiliar to the context of traditional classrooms.

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The Pedagogical Context of the Virtual Classroom

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During the past few years, the transition from print and postal-based materials traditionally used in distance education with adult learners to the more interactive and technology-based systems has been apparent. Modern technology used in classroom settings seems to open new possibilities for teaching and learning. Although there has been discussion about the use of telecommunications in education (e.g. Mason 1995), further research in different instructional and institutional settings is still needed.

The basic approach of this study focuses on three education families— conventional classroom education, distance education, and virtuality in education. The basic approach of the study comes mainly from conventional classroom education. However, it should be noted that the concept conventional is used to relate the dominant educational format both with the distance education and the emerging forms of virtual classroom. Conventional does not include any value aspects or preferences and conventional education is neither good nor bad. According to Keegan (1989, p. 13), the idea that distance education can correct what is "wrong" with conventional education is "a dangerous cul-de-sac for distance educators and should be abandoned."

Tiffin and Rajasingham (1995) emphasize that virtual classes are not intended to replace conventional classrooms. In fact, they can not do that because both the established and the emerging modes of education have a particular communication system for learning. Besides their differences, they do share similarities, particularly in interaction.

This paper presents an interactive framework which brings together parallel features of these three educational modes: conventional education, distance education, and the emerging forms of virtual classroom. Furthermore, the framework aims to integrate and balance the elements from these three education families of education into one experiment where new ideas and technologies in teaching and learning in a school environment are tested.

Coming to Terms With the Case

Practically, this paper is based on a three-year pilot study where two schools are linked together for common instruction with the help of video conferencing and audiographics. The project began in 1994 between a group of four pupils at the Kilpisjärvi school in the northwest Finnish Lapland and a group of thirteen pupils in the Teacher Training School of Helsinki University 1200 km away.

Parents and local authorities in geographically isolated Kilpisjärvi wanted to establish a secondary school (grades 7-9) in the village so children could stay at home instead of living in a boarding school 180 km away. In the village, A modern primary school could offer support to the secondary classes. As the resources of subject teachers available for secondary stage instruction were limited, a cooperative project with the Department of Teacher Education, University of Helsinki, was planned and implemented.

The Training School of Helsinki University, one of the two training schools belonging to the Department of Teacher Education, University of Helsinki, agreed to become the cooperative agent in this venture. With modern communication technologies these two classrooms—one in a large urban school, the other in a small rural school over one thousand kilometres away—were joined to form one virtual classroom.

The kind of arrangement where one teacher simultaneously teaches two groups of pupils, a local and a distant group, can be defined various ways. Previously we have used the term classroom focused distance education (Husu et al. 1994; Husu 1996a; Meisalo 1996) to distinguish between distance education occurring in a school environment from distance education occurring on higher and adult educational levels. The study focused on the question how these two groups of pupils can be handled simultaneously by one teacher.

Theoretical Approach

In this project, the elements of distance education are integrated into the conventional education taking place in classroom settings. The theoretical framework tries to capture key features of conventional education, distance education, and virtual reality. The approach is twofold; first, this chapter describes essential and common characteristics of these three families of education, and, second, in the following chapter, these key features are related to each other within the interactive framework.

Education at a Distance

Distance education in school settings is a strange phenomenon. According to Keegan (1989, p. 9), within distance education there is a strong tendency to separate two distinct dimensions— conventional group based-education and individually oriented distance education. Conventional education is mainly associated with children and adolescents in school settings while distance education is usually associated with adults and their professional training in its various forms. While school education is mainly compulsory, distance education is usually voluntary. Keegan (1989, p. 13) argues that this distinction has led to a crude dichotomy according to which pupils either attend educational institutions or study from a distance.

With the emergence of modern information and communication technologies, conventional education teachers and pupils find fewer practical concerns with delivering education at a distance. Consequently, the methods used in distance education are becoming more like those used in modern conventional group-based education. For example, the technology used in this project, video conferencing, can be viewed as a group method of teaching and learning providing real-time interaction between the teacher and pupils in a manner similar to traditional classroom instruction.

The blurring of boundaries has made it more evident that the major and the most common feature in both forms of education is the process of interaction among teacher, pupils, and subject content. The main difference is that the majority of interaction between teacher and pupils is mediated by communication technologies. According to Shale and Garrison (1990, p. 31), "education and distance [between teacher and student, implied] are concomitant features but it is clear in practice that we are attempting to provide educational opportunities for pupils who just happen to be physically separated from a teacher" (or from other pupils). They argue that the definitions of distance education usually tend to reverse this emphasis and are preoccupied with various features of distance. Therefore, Shale and Garrison (ibid.) argue that "viewing distance education from the perspective of the technological media used to achieve it obscures the fact that in all instances the goal is education."

This kind of definition does not necessitate a reconceptualization of the ed cational process itself. Rather, it emphasizes the basic feature of the educational process—how interaction between the teacher and pupils as well as among pupils themselves can be facilitated. Whenever the teacher and pupils are physically separated, distance education must rely on technologies to mediate the interaction process between both parties. Reviewing the literature gives the impression that considerable attention has been given to the use of technological media while less attention has been paid to the nature of interaction processes and the role of technologies supporting it. However, it is not the technological solution in itself that can be regarded as education, in most cases not even educational, but the subject content and the appropriate pedagogical use of the medium applied.

Virtual Classroom

The term virtual classroom originates from the use of computer mediated communication to establish an electronic environment where communication forms of a classroom, like discussions and lectures, are possible (Hiltz 1986). Hence, the basic patterns of virtual classroom are technology and communication (Tella 1995; Tiffin & Rajasingham 1995). Technologies such as video conferencing allow a virtual class where teacher(s) and pupils can see and hear each others in real-time.

The issue of virtuality is interesting. Its background comes from the linguistical and philosophical problems of the Middle Ages to explain the relationship between the actual reality and other possible worlds. Virtual means an interpretative and mind-mediated version of the surrounding world as it is experienced by the individual. In other words, virtual reality is individually constructed in much of the same ways as our 'ordinary reality'—if we accept the basic lines of constructivism. Following Bruner (1986), both are 'possible worlds' constructed by our 'actual minds'. Reid (1995) points to the imaginative aspect of experiencing virtual environments. She claims that the illusion of reality lies in the willingness of the participants to "treat the manifestations of his or her imagining as if they were real" (Reid 1995, p. 166).

Today, the term virtual has gained a more specific meaning where the aspect of replacing is also present (Huhtamo 1992, p. 38). Virtuality has some sort of capability to replace something that isn't physically present. Something in virtuality 'triggers' an interpretation in the individual, and this interpretation then dominates individual's experience of that virtual situation, event, or object. Accordingly, virtual classroom creates an illusion as if we were in the real classroom. Rajasingham (1996) states that virtual in this context means reality in effect, not in fact.

Going back to Hiltz' definition, the virtual classroom is created by communication, and the use of technology gives an illusion of a "real" classroom. When two separate classrooms are linked together, as in our case, to form one virtual classroom by using video conferencing and audiographics, means that the virtual classroom "feels" like a "real" classroom. The question is about the factuality, not the physical situation, of the experience.

In sum, our approach can be described as experience-oriented and interpretative (Husu 1996b). When defining our virtual classroom, we acknowledge with Rajasingham

(1996, p. 33) that a classroom is a communication system making it possible for people to come together with the intention of learning something. According to her (ibid.), "the idea of a virtual class is that everybody can talk and be heard and be identified" during the course of the instructional process. Consequently, the concept of interaction is crucial.

A Network of Interactions

The importance of interaction in education these three education families is practically taken as a "given." Theoretical statements in both forms of education emphasize this. In its most basic form, education is a process of interaction between teacher and pupils to provide the subject content of teaching. It is clear that these three "poles" of interaction - teacher, pupils and subject content - cannot capture the total complexity of the instructional process taking place in various educational settings. At first sight this stance seems to be quite reductionistic but, as Moore (1989, p. 100) states, interaction is a term that "carries so many meanings as to be almost useless unless specific submeanings can be defined and generally agreed upon."

Both in conventional and in distance education the interactions between the named three 'poles' can be conceptually and empirically analyzed not only from a theoretical and philosophical perspective but also from a practical and functional perspective. According to Wagner (1994), the functional perspective is important because different variables of interaction need to be empirically examined to discover the impact of interaction in different educational contexts.

Interactive Framework

Interaction during the instructional process can be either intentional or unintentional. Whenever interaction is connected with some purposes or a set of purposes for which teaching occurs, it can be viewed as intentional. Teachers' and pupils' intentional communication is often tied to practical activities—teaching is the activity of teachers, and studying is the activity of pupils.

In our approach, the addition of a distant classroom to the instructional process changes the scene of interaction. The instructional process is extended for two reasons: 1 another group of pupils at a distant place is added to the process, and 2) a new dimension of interactions, the mediated interactions of distance education, occur simultaneously with local interactions of conventional education. The research focuses on the question of how these two communicational elements—local interactions and mediated interactions—between two remote classrooms can be handled simultaneously. Because of the importance of interaction in educational processes, in general, it is necessary to investigate how the mediated forms of interaction can be fitted into the instructional process of virtual classroom.

It must be noted that mediated interactions differ from interactions taking place in conventional face-to-face teaching. The medium mediates, and anything that mediates changes what it conveys. In terms of instruction, it is not only a question of transmitting content knowledge from teachers (encoders) to pupils (decoders), but rather the establishment of an effective two-way communication dynamics in the circumstances created by the medium. With the use of the term "mediated interactions" instead of "distance interactions" it is intended to emphasize the aspects of communications over the aspects of physical distance between the two classrooms. Still, we should not forget that even the physical distance itself brings a significant impact to the elements of the instructional process, because it has implications for the teaching role, teaching methods, pupils« studying methods, and pupils« expectations. The extent and the meaning of this impact is also an important research task. In our case, the virtual classroom consists a network of interactions (Husu 1996c) when mediated interactions are integrated with the basic elements of conventional education.

The basic elements of the instructional process—teacher, pupils, and subject content—are embedded in the interactions of the virtual classroom. Although there are now two types of interactions handled concurrently by the teacher and pupils, the classroom where the teacher is situated is primarily an area of local face-to-face interactions. However, in our case, the teacher is simultaneously connected to another classroom. As Figure 1 shows, the two forms of teaching, local and mediated, are simultaneous versions of the same teaching act. In the remote classroom, the pupils' studying acts are mediated to the teacher. The teacher in the local classroom and the pupils in the remote classroom only meet virtually. Further, there are two kinds of pupil-pupil interactions occurring in both classrooms: 1) pupil-pupil interactions within both groups and 2) pupil-pupil interactions between the groups.

In sum, the instructional process of the virtual classroom consists of two classrooms with a different interactive network in each one. This means that both the teacher and the pupils must cope with these two distinct networks of interaction. This kind of teaching and studying practice especially emphasizes the role of the teacher because, according to our experiences based on this testing case, the teacher seems to be the main critical factor in the success of distance education.

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A WWW-Supported Course: Graph Theory for Teachers

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Towards the end of this year about 6000 German schools will be connected to the Internet (Initiative: Schools on theNet, 1996). This initiative is sponsored by the Federal Ministry of Education and Deutsche Telekom. 40 millions dollars will be spent in the next three years. Simultaneously the federal state of Northrhine-Westfalia has founded the initiative Media NRW (Northrhine-Westfalia, 1996). Many teachers do not have any experiences in using this new technology. This is one reason why the World Wide Web is not very accepted by teachers (Goldberg, Salari & Swoboda, 1996). Furthermore, a great number of courseware are made for universities and not for schools.

We developed a WWW-supported course about graph theory, which can be used in two different contexts at two different levels. The teachers or prospective teachers are able to use our course to get familiar with graph theory and WWW-based courseware. Additionally they can use a light version of this course in the classroom.

We have designed this course as a WWW-supported course for several reasons. Teachers cannot participate in a regular university course, because of lack of time. Updates of the courseware can be delivered to the user very easily. Beyond WWW-based learning material, we integrate electronic mail and bulletin-boards to improve the communication within the learning group and to support teamworking.

Conception of the Course

Graph theory plays an increasing role in German schools. We have chosen this subject, because it meets with a good response from the students and graph theory finds its way into the curricula in Germany. In our course we study some basic problems in graph theory from an algorithmic point of view.

The contents of our course are the following:

1. Basic definitions.
2. Basic graph algorithms (e.g. depth first search, breadth first search).
3. Shortest-path algorithms (e.g. Floyd's algorithm, Dijkstra's algorithm).
4. Graph planarity (e.g. path addition, vertex addition).
5. Network flow (e.g. Ford's and Fulkerson's algorithm, Dinic's algorithm).
6. Tours in graphs (e.g. Euler paths, Hamiltonian tours).

The course is split up into three phases.

First Phase: Learning the Basics

In the first phase of our WWW-supported course the teachers use the learning environment to acquire basic knowledge in graph theory in individual work at home or in their schools. The content of the courseware is modularized into small pieces of information, called learning units. A learning unit consists of a presentation of a learning subject by text, illustration, animation, and simulation of dynamic models. Further learninf¾nits contain exercises (see Figure 1). Static exercises deal with problems which require a special constructed example to explain special cases. Randomly generated exercises make it possible that learners make the same exercise with little variations several times to improve their skill. In user defined exercises lea□ers can adapt the degree of difficulty appropriate to their knowledge. Every learning unit ends with an automatically generated test which gives an immediate feedback (VanLehn, 1996).

The high degree of interaction and the final test in every learning unit improve the motivation and enable the self-control of th□e learner. Guided tours help the teachers to navigate through the range of learning units in an ingenious order. But due to the fact that teachers are skilled in self-organized learning, the teachers have no restrictions moving within the courseware. Already in this early phase of the course, the cooperation between the participants is supported by integrated electronic mail and bulletin boards (Chee, 1995).

We have implemented the courseware in Java. The underlying data structures are adopted from LEDA, a library of efficient data types and algorithms already used by a great number of research groups (LEDA, 1996); hence our courseware can be easily extended to related topics like geometric or search algorithms.

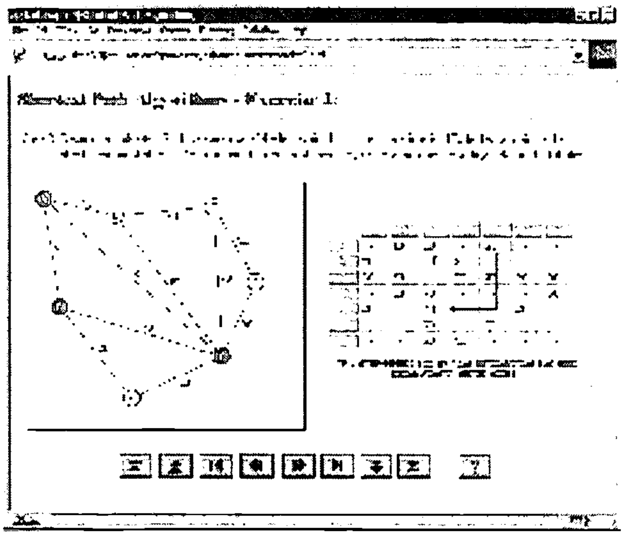

Figure 1. An Example of an Automatically Generated Exercise.

Second Phase: Compact Seminar

In the second phase, the teacher should acquire a deeper knowledge of some special subjects of graph theory. To achieve this, small groups of three or four participants elaborated seminar papers to special subjects and their pedagogic issues. During the preparation of the seminar papers, the learning environment supports the communication between the users in case they do not have the possibility to meet each other. For questions concerning their special subject every group has its own bulletin board. Afterwards a compact seminar at university takes place where the seminar papers will be presented to the whole course.

Third Phase: Completion of a Common Document

At the end of the course all the groups have to work together to create a final hypertext document about the elaborated subjects. There must be common notions and the interfaces between the topics of each group have to be brought into a line. The more communication in the group takes place, the smaller are the problems concerning coordination and decision making (Gruenfeld, Mannix, Williams & Neale, 1996). The application of the communication facilities of the learning environment can be useful here. The final document will be published in the World Wide Web. In this way the pedagogic knowledge increases from course to course (Boys, G., 1996).

Time Schedule

We suggest the time schedule, which is shown in Table 1, to carry out the course. During the whole course the participating teachers have to be present at university only for the few days when the compact seminar takes place.

Table 1.
Time Schedule for the Course

Week	Activities of the participants
1-4	Learning the basics
5-8	Preparation of the seminar paper
9	Compact seminar
10-12	Completion of the common document

Using the Courseware in School

The WWW-based learning environment is appropriate to teach graph theory in school. To acquire basic knowledge in graph theory the students can use a light version of the courseware. It differs from the teachers version in some aspects. The content of the course is reduced to topics of a level of difficulty which is adjusted to the students capabilities. The possibilities to move around the learning units are restricted in the student version of our system, because students do not have the necessary previous knowledge to choose an appropriate tour through the course.

When the students have learned fundamental principles in graph theory, we suggest that they get the opportunity to apply their new knowledge in a project. An example of such a project might be an information system for the local public transport.. The communication facilities of the learning environment open the possibility that students from different schools work on common projects. So, for example, students from different schools might combine their information systems to a single information system for the regional public transport. The World Wide Web provides an opportunity for students to publish the results of their work.

Conclusion and Future Work

We have described a WWW-supported course for teachers and prospective teachers in graph theory. The teachers can use a light version of this courseware in school. We are working on a visual software developing tool which enables the learner to program graph algorithms independent from a specific programming language. A transfer of other subjects in mathematics and in computer science to our WWW-based course concept is in work or planned. A next major step would be the integration of an authoring tool which enables the teachers to develop new learning units and to embed them in our courseware in the third phase *of our* course.

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Can I Go In Your Suitcase? Technology Takes Us All To Scotland

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Chatham College is a small liberal arts college for women in Pittsburgh, Pennsylvania. In a small college, access to research materials is vital to the academic enterprise, more important indeed than the simple acquisition of data. At Chatham College, technology now provides an equalizing tool in keeping the college community current with developments in all fields. Providing across-the-board access to all members of the college, Chatham has recently invested in developing a strong campus network using fiber optics and Microsoft NT networking software, installing a new telephone system by Siemens-Rolm, and placing high and multimedia PCs in faculty offices, student computer labs, and classrooms. The entire college community now has electronic mail available as a resource as well as full network access to the Internet. Furthermore, resident students can access the campus systems from their own rooms as well as through more public computer clusters.

Applying Technology to Curricular Programs

A vital part of the undergraduate program includes the Junior Interim Abroad, offered during the January term, which gives Chatham juniors the experience of living and learning abroad with faculty and classmates. Chatham Abroad is a series of academic courses focused on interdisciplinary topics, enabling students from every field of study to integrate a travel experience into their education. The courses, topics, and foreign sites vary from year to year, depending on faculty interest and expertise, the global economy, and international political conditions.

In recent years course offerings have included *Spain: Past and Presentt*; *Women in Public Life: Dublin, Ireland; Morocco: Cultural Crossroads; History, Art, and Literature of London;* and *Belize: Reefs, Ruins, and Rainforest.* Students have also traveled to the Galapagos Islands and to Egypt. Prior to their study abroad experience, students participate in classes where they learn about the customs, language, and lifestyles of the country they will be visiting. They also undertake research projects to be completed or presented on site, and maintain personal journals. With the exception of a small administrative fee, Chatham Abroad is offered at no extra cost to all full-time students. A timely enhancement to the Junior Interim was, however, added for the January, 1997 trip to Scotland: the instructors incorporated Chatham's technological advances into the program of study.

Junior Interim Abroad

For the last two weeks of January, 1997, professors of education and modern languages led a group of students to Scotland on a course entitled, *Castles, Clans, and Culture of Scotland.* The destination was chosen because of Pittsburgh's cultural legacy. Many of Pittsburgh's influential philanthropists during the Industrial Revolution came from Scotland and the students and faculty have been eager to learn more about the ethnic heritage of Pittsburgh's founding fathers. The college students began their intercultural living experience in Edinburgh, where they spent some days with a family before traveling north to Inverness via Dunfermline and Stirling. Andrew Carnegie, the founder of Pittsburgh's first public library which opened in 1895 (Gangewere, 1995), and of over 2000 libraries in the United States, was born in Dunfermline and emigrated to the United States at the age of 11. His birthplace, now a museum, documents his family's journey to the United States and details his role in the steel industry and his meteoric rise to international prominence. Pittsburgh is home to Carnegie Mellon University, Carnegie Music Hall, and the Carnegie Museum which includes natural history, science and international art collections. After Edinburgh, the students traveled to Inverness, where they were received at Skibo, translated from the Celtic as "place of peace." Skibo is the summer retirement homestead purchased by Andrew Carnegie in 1898 after the birth of his daughter intensified his desire for a Scottish Highland family home

(Curran, 1996). Carnegie called Skibo "heaven on earth" (Curran, 1996). The next stop for the juniors was Glasgow, where they met the students and teachers with whom they had become acquainted via e-mail.

The trip was enriched throughout by university lectures and school visits in Edinburgh and Glasgow, stops at castles and cathedrals, tours of parliamentary and city chambers in Edinburgh and art museums of Glasgow. As part of the pre-trip preparations, students worked together on individual projects of their own choice and presented part of their research to the other participants before departure. Topics included comparisons of the educational systems, the history of the music and dance of Scotland, family and clan structure, medieval history, and the history of England and Scotland. In their personal journals, the students documented their perspectives and experiences of the trip abroad.

While we felt that this program of study certainly had academic value for our 24 college juniors, we decided that with the technology's aid we could take more students along on our trip to Scotland...albeit not in a suitcase. And for this, they did not even need a passport. By infusing technology into our trip planning and the actual Junior Interim Abroad, many could experience Scotland along with us.

In preparation for the course of study abroad, we relied heavily on technology to communicate with the students and with our connections in Scotland. We used faxes, e-mail, and voice mail with all members of the group. In order to more quickly survey the students' areas of interest and apprise them of meetings, Scottish events in Pittsburgh, or a new article on reserve in the library relevant to their research, we used e-mail to communicate with them promptly and efficiently. They also replied, equally promptly—there seems to be no doubt that students read their e-mail. We also created a site on the Chatham College homepage (http://www.chatham.edu) on the Internet to announce the course expectations and syllabus, post reminders of passport deadlines, and alert all participants to any other information relevant to the upcoming trip. Later information on the homepage included biographies and pictures of all the participants and their particular area of interest, a detailed itinerary, and summaries of student research.

Access to the Internet enabled others participate in the Scotland trip. With this availability through technology, we invited classrooms whose curriculum included studies of Scotland to "come along" on our trip. Prior to the departure, one professor visited a sixth-grade elementary classroom and introduced the students to Chatham College's homepage on the Internet and to Websites that our college students were accessing for research and information about Scotland. The elementary students could learn what preparations had been undertaken, see what it is like to visit there, and ask questions directly of Chatham students before departure. During the trip, the elementary students daily tracked the itinerary and viewed photographs of the group in Scotland and even communicated with them via e-mail. Biographies about the travelers on Chatham's homepage enabled the elementary students to be personally connected via technology.

For the trip itself, we carried a digital camera, a Macintosh laptop computer with adapter for the local power supply. We needed only a network connection to the Internet once we were in Scotland. During the trip pictures were taken and transmitted back to the Chatham web server, which then made them available with their accompanying narrative to all network citizens. There was then opportunity for direct interaction not only between the college students and faculty at home and abroad but also between classrooms in both countries—with the proviso that schools both in Scotland and the USA had e-mail accounts established for them and access to the Internet. Any schools so equipped may access Chatham College's own homepage and any other information there on other programs of study abroad, including that for the two other trips to Belize and the Bahamas that were also taken in January, 1997. The transmitted documents were saved as they were sent and copies are available from the authors.

Pre-Trip Travel on the Superinfo Highway

Students were also encouraged to explore Internet Web sites to prepare them further for their research and travels. Some favorite web sites included:

Scotland: (http://www.autumn.scotland.net) This beautifully designed homepage of the Scottish Tourist Board offers practical information about traveling in Scotland, including places to stay and travel tips. Also included is a weather map.

Scotland: (http://www.scotland.rampant.com) This web source offers a large index of "the best" of Scotland, including whiskies and haggis, rugby and golf, clans and tartans, Gaelic and Celtic culture, and history, castles, and museums.

Scotland: (http://www.biostat.wisc.edu/~cuthill/) This homepage on the web was designed by a Scot living in Wisconsin. From this site, one can link to other locations for information on castles, ancestry, history, Edinburgh, famous Scottish people, and inventors. It offers a wide variety of topics.

Scotland: (http://www.scotland.org) This electronic signpost for Scotland, funded, managed and built entirely on location, provides an extensive directory of electronic resources relevant to Scotland which are accessible via the Internet. A variety of topics from education to culture, commerce, government, society and politics and tourism. By clicking onto education, one reads that in 1492, the Scots introduced compulsory education, the first people in Europe to do so. A link from this site connects one to "personally Scottish," where people of Scottish heritage can be found in all corners of the globe.

Scotland: (http://www.geo.ed.ac.uk/home/) Provided by the University of Edinburgh Department of Geography, this site offers interactive maps of the country, including details of suburban and rural areas. On-line newspapers, information about famous Scots, Edinburgh, local time, and even the Royal Scottish Geographical Society's upcoming programs and other topics of interest also may be accessed from this site. The Society has an e-mail address for membership information.

Scotland: (http://www.lonelyplanet.com.au/dest/eur/sco.htm) This site has reader-friendly information about the people, history and many places, including off-the-beaten-path destinations. Make a stop at this site and take a "virtual trip," viewing slides and maps of Scotland.

Scotland: (http://www.expressmedia.co.uk/) At this web site, world renowned golf and leisure resorts such as the Turnberry Hotel and The Carnegie Club are reviewed. Information about ticket and bookings is given.

Andrew Carnegie: (http://www.clpgh.org/exhibit/carnegie.html) This site gives a biographical sketch of Mr. Carnegie, including a scanned-in image of the man. Physically, he is described as a man standing between 5'2" and 5'6" but with determination and discipline that made him a giant. A man of contradictions, committed to the notion that education is the key to life, he was a shrewd and tough businessman who lived through the industrialization of America.

Conclusion

This paper provides a paradigm for infusing technology into study abroad. Such a model can undoubtedly inspire more educational professionals to investigate the possibilities for technological enhancements of their own curricula. Furthermore, it addresses the interests of a diverse audience of educators by linking elementary schools in the United States with comparable classrooms and teachers in Scotland, through the technology provided by a small college. Indeed, technology may be used effectively as a tool to change the educational process, to link students of different cultures while they are actually abroad, and to take everyone along "in the study abroad suitcase."

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Using the Internet to Extend our Horizon: From E-Mail to Global Video-Conferencing

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Since the earliest days of the Internet, there has been an almost universal interest in finding ways in which "The Net" can be used to enhance education and children's knowledge of the world in which they live. Interest in other cultures dates back to early pen-pal schemes, that are still very much alive right the way through to sophisticated data communications that we have available to us today. The challenge that we face as we prepare to enter the next century is to have a clear vision of where the technology is going, how the children of today relate to that technology and how we prepare our intending teachers to make effective use of it. In doing so we may also need to reappraise our own view of technology and the way in which we as both teachers and teacher educators respond to its challenge.

What are the issues that access to online "experts" may have for the self esteem of the classroom teacher, and how do you regard such a person? Are there real benefits in terms of understanding different cultures and developing curriculum materials.

The end result of this cooperation is the proposed development of shared curriculum materials to be used in two elementary schools, one in New Jersey, the other in Wiltshire, with the Internet providing the communications channel via the University of Southampton. It is hoped that this will provide a useful model for others crawling in the slow lane of that "Information Superhighway".

This paper, written by myself as a teacher trainer in the UK, alongside a teacher in the US and two of her pupils puts the technology firmly in its place and gives the perspective of the classroom teacher and the pupils in this brave new world of global communications. The paper was jointly written using the facilities described within and even survived a crashed Mac in the process!

There is currently a great deal of hype surrounding the concept of an "Information Superhighway" with a belief that some sort of Utopian ideal, where all information will somehow be available through an electronic medium, can be reached.

> Through cooperation between schools, colleges, universities and industry, we can pilot new ways of teaching and learning using the new communications technologies. We in Government shall be ready to fund the evaluation of innovative new proposals: this paper sets out the criteria by which we shall assess them. (Gillian Shephard MP., DfEE, 1995)

> I challenge you, the people in this room, to connect all of our classrooms, all of our libraries, and all of our hospitals and clinics by the year 2000. We must do this to realize the full potential of information to educate, to save lives, provide access to health care and lower medical costs. (Vice President Al Gore Royce Hall, UCLA Los Angeles, California January 11, 1994)

It is evident from the comments above made by both American and British governments, who appear - certainly in the latter case, to have little understanding of what they are talking about or proposing. Once again, as with the emphasis on programmed learning of 20-30 years ago, technology is being hailed as a universal panacea for the perceived failings of the education system as a whole. Here, we have governments talking about installing networks capable of transferring data in the Mbit/second and above ranges, and yet there is still little real understanding of what the technology can be used for.

> Information superhighways offer the potential to deliver widely and cheaply a vast range of services, including education. ...network capable of transferring very large amounts of information - including video, still images, audio and text between users. (DfEE, 1995)

Having set the scene for the U.K., the paper then goes on to consider how schools are placed to deliver an information technology entitlement to pupils, but by its own admission it states:

> Evidence from HMI... and independent sources indicates that schools are not finding it easy to offer all pupils appropriate opportunities for using IT in

the curriculum…. It is readily possible to identify exciting educational possibilities… but in each case decisions have to be taken about whether the value added justifies the cost in money and time involved. (DfEE 1995)

The consultation paper finishes with a consideration of the I. S. as a vehicle for offering both initial and in-service teacher training, and as a management tool. Clearly governments see many possibilities. the Information Superhighway is paved with good intentions!

Where are We Now?

If the concept of video on demand from an educational information service is beguiling, it is also some way off. Fundamental questions about who will provide the service, who will pay for it, the equipment needed and the infrastructure to support it have not been adequately addressed. Many schools in both the UK and the US are still pitifully equipped with computer equipment that is out of date or simply not generally accessible; teachers themselves find that they are under increased pressure to deliver more curriculum materials with less resources, and the children are disillusioned with the teachers and the equipment. This is especially so in more affluent areas where the students may have far better facilities at home than the school, what signals does this send to them?

At present, the emphasis on the Information Superhighway can be thought of as building motorways when few have cars, those that do can't drive, and the ones who can drive cannot afford the petrol! It will be great at some point in the future, but not yet for the majority. The *National Information Infrastructure* (NII) promoted by the current US administration integrates computer, television, telephone and telecommunication technology with a promise that every school, library, hospital and clinic in the US should have access to the network. But, has any consideration been given to how this impacts on the school curriculum and teachers in general, indeed how long will it be until teachers have both the resources (equipment and time) to integrate this vision into the everyday life of a classroom.

Some Fundamental Questions

How many teachers make regular use of the existing communications channels that are available to schools with the equipment that they currently have in their classrooms?

What can we do to promote good practice and the development of skills that will be invaluable when someone gives them access to the highway?

It is obvious, but worth restating, that in order to utilise technology, we must first know that it exists, we must understand both its potential and its limitations and we must have a vision of what we wish to achieve with it; having got thus far, we must then have both the skills and the equipment in order to realise that vision.

Technological change continues at a breathtaking pace, hardware becomes both cheaper and more powerful, software becomes more sophisticated and easier to use. New communications channels are being opened up and the advent of cable modem technology will increase the available network bandwidth to a level enjoyed by those on Local Area Networks (LAN's) and new 'providers' are currently giving the everyday user cheap and effective access to global communications.

How do we as Teachers and Teacher Educators Respond?

Since many of today's schoolchildren have a grasp of this technology already, many have access to equipment that is more sophisticated than that found in their computer labs in school, many are linked to the Internet at home and have a better understanding of how to use it and of its implications than the teachers themselves:

- How does this leave the teachers feeling?
- How are we, as teacher educators, responding to these developments?
- Are we taking on board the new communications medium, or are we ignoring it?
- Worse still, are we just not aware of it? and
- Do we believe that it is of no significance to us as teacher educators?

This study is about how teachers and children use worldwide communications in the classroom and attempts to push the existing (as in 1996) technology as hard as possible, to find out what can be practically achieved and what the training and resource implications are for schools and teacher training institutions, and then to look ahead 5 years.

What Can Existing Technology Offer in the Classroom?

In order to appreciate how the technology may facilitate worldwide communications, it is first necessary to understand what is possible and what follows lists what can be done now, with equipment and telephone lines that are currently in place. What the project set out to achieve was a model of classroom practice for teleconferencing, and worthwhile curriculum activities based around such a model.

E-mail. There have been many schools that have communicated using e-mail, right from the early days of Compuserve until the present time. Software allows files to be 'attached' to e-mail documents to allow the transfer of images, word processor documents and programs to take place, and is the most widely used way of transferring files between users.

Telnet. The facility to remotely access one computer from another in order to access files or e-mail from a remote computer, not very user friendly.

Usenet News. Newsgroups appeared in the late 80s, allowing groups of like minded individuals to "Post" messages to other members of the group. The users were then at liberty to read the heading and ignore, or to look at the whole posting, which could also include encoded files.

Chat or Internet Relay Chat. Can be considered as analogous to the multiparty chat lines that are available over the telephone, where a group of people join in a group discussion. The 'chat' is text on a screen that a l can see, preceded by the name of the person who made the comment, with the opportunity to chat on a 1 to 1 basis, to send files and to launch sound events, that will play a predetermined audio file on each person's machine. The text appears in 'real time' with typically a sub 10 second lag, users may be from all over the world, and at any one time there may be 7000+ chat channels.

Audio. As technology has advanced, the possibility of sending live audio across the Internet became a reality, and in the past 18 months there have been a number of developments in this area. The most important of these has been the "Internet Telephone", allowing users from around the world to talk to one another for the cost of a local call. The audio quality is very variable depending upon the line quality and the computer's capability to encode and decode sound into Internet data packets. More sophisticated software allows users to interact through a shared white board, to transfer files and to "chat"- useful when spelling is important. This same technology allows audio to be broadcast from a central location, with software such as "RealAudio" it is possible to listen to a conference or even a radio station across the net.

VideoPhone. There are two approaches to sending video from point to point, the first is to use a dedicated videophone, a major expense in itself, and an ISDN line. The line will cost in the region of £400 per annum in rental before call charges are added, and this alone puts such equipment outside the reach of many schools for whom the expense could not be justified.

Video and the Internet. The second approach is to add a video capture card and video source to an existing multimedia computer and use the Internet to transfer the images.

Software to do this has been under development for the past few years with Cornell University taking the lead with its CUSeeMe software, now being marketed commercially by "White Pines" software, features of the software include a "whiteboard", file transfer and a text based chat mode. A number of participants to a single site, allowing for a multi user conference to take place.

Classroom Activities

Since the school in NJ was communicating successfully with the University using e-mail, it was decided that we should attempt to use "Chat", "Internet Telephone" and "Internet Video" with a group of 8th grade pupils, giving them the opportunity to ask questions regarding life in the UK. They felt this would be most valuable - having in the first instance, an academic online to talk to and answer specific queries; and once an understanding of the technology had been achieved links would then be established through the university's partnership scheme to local schools in the UK.

This had to be done using existing resources in order to see what the current technology could offer, and to help shape future activities and subsequent bids for funding, without the hype and rhetoric of the Information Superhighway.

Chat - This is the simplest of the facilities, and had the advantage that the whole class could see by using an overhead projector and a projection tablet. In all, three sessions were organised with questions ranging from school through to politics and pop groups. The time delay of 5-15 seconds made little difference to the activity, and in the end whoever was asking the questions simply asked the next question whilst waiting for a response. This gave a very real feeling of conversation taking place, with low cost equipment and a local (free) telephone call to the provider.

Internet Phone - At the time, this was less successful, but was used with the same 8th grade group in order that they could "hear" what the person they had previously chatted to sounded like. The technology has improved but really needs a Power PC or a fast multimedia PC. It has the great advantage that it will work across platforms, and even with a 14.4k modem the results are acceptable. As before, the class room activity was kept to a question and answer format, with students taking turns to use the microphone, and the whole class could hear the replies.

CuSeeMe - Was the most ambitious attempt at linking the school and the university, and as with Iphone met with varying levels of success. At its best, using a Dual ISDN line at a local high school it gave acceptable levels of voice and slow scan image (approximately 5fps), along with a facility to jointly edit a document using a shared white board. On a regular phone line it was very frustrating, and a way of working using both "text chat" and "video" was developed, in order to prevent the lines being swamped with data and the system grinding to a complete halt.

From an academic point of view, we pushed the technology to its limits, but what about the view from the classroom?

Teleconferencing - A Classroom Perspective

Debra Resch, Computer Teacher:

As an educator, I have found the Internet to be a valuable, exciting and sometimes overwhelming environment, and after stumbling about for almost a year with a popular commercial service called America On Line, I finally became aware of other provider options that were far less expensive, but required a little bit more computer savvy on my part! Through the necessity to keep up with some of my more able students and with the trends in computer education, I was forced to spend the time and effort to learn about various areas of telecommunications and the Internet, this has been a voyage of discovery over the past year.

During this time I have learned how to utilize e-mail to communicate with friends, colleagues and students, as well as using Netscape Web Browser to access Internet sites. I was amazed to find that much of the basic Internet software I needed could be found somewhere on the net. I learned to use a list serve and to access news groups to get the most up-to-date information on a specific topic and was astounded that I could talk to people all over the world by using an Internet chat program. I was now able to talk to my students about the Internet and all it's amazing possibilities (at least the ones I know about)!

As students become more proficient in their basic computer usage, it becomes more of a challenge to keep up their level of interest and enthusiasm in the basics. The Internet opens new doors for students to be able to locate a wealth of information and to utilize the skills they have learned in order to arrange this information in a presentable, understandable, and orderly fashion. The search for information on the Internet requires language and cognitive skills equal to or greater than those required to locate information in a library. As a result:

- students must possess adequate keyboarding and language skills;
- they must learn to narrow their topics, be specific in their searches for information; and
- how to focus and discriminate information that is relevant or irrelevant to their topic.

Although these search techniques require skill, training, and teacher guidance, the payoff is the quality of information obtainable. Students will have electronic access to an almost limitless amount of textual, graphical, audio and video resources regardless of their physical geographic location. Teachers should find that students who participate in online telecommunications will eventually demonstrate improved writing skills because they will be writing to an audience made up of other students and adults who can be from anywhere around the world. This will make the task of writing more important and relevant to the student, who will also take pride in their work (art, writing, etc.) when it is published online for all the world to see.

But, searching the net for information is just one aspect. Through e-mail, teleconferencing, and chat, students may have the opportunity to learn about people from anywhere in the world. Rather then just read about the customs and traditions, races and religions of other countries, it is amazing to actually talk and correspond with a person who lives in that country. The friendships that can develop are invaluable in understanding and accepting the world as it will be in the 21st century. I am still somewhat surprised sometimes at the lack of knowledge, understanding and tolerance that students of middle school age have of people from other countries and cultures. They may have learned the geography (hopefully) and maybe a few facts but that is not enough to cultivate true understanding and tolerance in today's world. This is evident to me and my colleagues through observation of student behavior, interaction, and reactions to material discussed and presented in our schools.

Through the recent advances in technology, students have many more options than the pen-pal format of the past since they can now speed up their correspondence with e-mail which may include sending attached documents, photographs or artwork. They can also have real time conversations through chat programs which require typing or through 'Internet Telephone' software which allows the user an inexpensive way to speak with people around the world. The final extension is video-conferencing programs such as CuSeeMe which allows the users to actually do video conferencing which involve both seeing and hearing the other person along with the possibility of sharing files - providing the line is both fast and good enough.

In my own school, we have a PowerMac connected to a regular phone line at 28.8k and use one of the local New Jersey Internet Providers, this enabled me to see if e-mail, chat and video conferencing could be achieved. I have demonstrated some of these features to my 6th, 7th and 8th grade classes, even allowing them to ask questions and have controlled interaction in a telecommunications setting such as chat, e-mail, and even teleconferencing. This type of activity required planning, preparation, and follow-up activities in order to be successful. Teacher's who attempt this need to find reliable contacts who will be able to contribute and interact in a positive and productive manner with their students. An introductory lesson is imperative to teach students proper net etiquette as well as to have a basic background understanding of the culture and geographic location of the participants on the other end. It is important that students have input in the planning of such an activity and spend time in advance formulating questions and ideas for meaningful correspondence.

Two of my 8th grade students in particular, Scott Hayes and Kathleen Whalen, were very interested and helpful in setting up and evaluating this process. As Scott and Katie became more experienced with the Internet, they advanced from just e-mail to the most up-to-date features of CuSeeMe. We all profited greatly from CuSeeMe because it includes real time audio and video conferencing by way of a user-friendly interface with many useful features. Although it will work on a 28.8 kbps line under ideal conditions, it really an ISDN line to get video and audio on a satisfactory level.

With CuSeeMe, my students have communicated with David Brunner at the University of Southampton in England. They found this technology very exciting and interesting. They were anxious to have other teleconferencing experiences with students from other countries and expressed to me that they felt it was an exceptionally motivating educational experience in which they could improve their communication skills and learn about other cultures and lifestyles firsthand.

Of course, it is possible to get inappropriate responses from other people, just as it is possible, even with the aid of 'filtering' software, to come across negative information on the net. The person who teaches or supervises Internet usage will have to deal with such issues. Students will need clear direction, constant supervision, and motivation to stay on task. Class rules will need to be very specific and appropriate sanctions will need to be enforced without delay should a rule be broken. Hopefully, the climate of such a classroom will be a positive one where students are too busy and excited with the task on hand to stray to the less desirable aspects.

All of these possibilities are exciting but they require teachers to take the time and initiative to learn how to use the hardware, the software, and to calculate ways to integrate these possibilities into busy schedules and overburdened curriculum guides. It also requires that boards of education, administrators, and people of the community to understand the financial commitment that must be made. Of course it can and must be done, money spent on Internet training and access in a school is worth an amount that cannot be measured by a dollar value. The access to these resources will open up a world of information, arts, literature, culture, etc. The quality of these resources are not only immeasurable but we cannot even begin to make any comparison with the current resources of the most affluent up-to date school library. Dollar-wise, telecommunications technology is the best educational investment that a school can make at the present time; however, the financial funding commitment at the National as well as state level (at least in New Jersey) continues to be one of large volumes of verbal rhetoric with relatively small amounts of real dollars allocated to the educational levels Pre-K to Grade 12 and even to the higher educational institutions. The words alone will not replace the dollar amounts that are needed to prepare students at the various education levels for the "technological 21st century."

Technology now offers many possibilities for students and educators alike - it is an especially exciting time to be a "Computer Teacher" and have the joy and occasional frustration of trying to share a vision of the "Global Village" of the future with others in the field of education. I can see people coming around slowly but many are still resistant, frightened and easily overwhelmed by the technology and the opportunities it provides. Fortunately and unfortunately, the children are not usually the ones who are frightened and overwhelmed - they are excited and anxious to discover! The only things holding them back are the financial restraints, a lack of commitment to teacher training and resistance on the part of many teachers.

Teachers must be given the time, encouragement and support to feel comfortable and less threatened by technology, the curriculum of the past and present must be integrated with the technology of the future, and as educators we have an obligation to really make it a "small world" after all!

David Brunner:

Providing an Infrastructure and Developing a Curriculum Model

In any project, there is a need to establish the ground rules and common goals and objectives. This was highlighted by Meadows in 1992:

> Teachers and tutors may need to spend a long period communicating with each other before being ready to start work with their pupils or students on a twinned project - patience and commitment are important here, and so is support within the school...

Having established that transatlantic telecommunications was indeed possible, the fundamental question arises, "what do we do with it?" This may best be illustrated by the project proposal outline from another NJ elementary school:

> ...a theme of "Lifestyles" will be the topic for study, a monthly topic will be established and researched by each school. Classroom time will be devoted to the development of the questions and answers while computer lab time will be devoted to their production (artwork and text) and subsequent communication. The theme of Lifestyles provides a broad spectrum of activities: School & Home (students details), Geography (Local Industry), Recreation, Holidays & Festivals, News & Current Affairs,

Language (Meanings, Differences, etc.) covering the whole curriculum.

Goals:

- The underlying theme of this proposal is enhancement of the curriculum and school resources; not only in terms of equipment available but through developing teachers' skills and understanding of computers, and by offering students a wider view of the world.
- By incorporate telecommunications technology into the classroom in a meaningful way in order to extend teachers and students understanding of computers in general and their application to communications in particular.
- To improve the skills base of the teachers within the school through training and the opportunity to become involved in an exciting and motivating activity.
- To give students a greater opportunity to understand and explore the Internet.
- To enhance the provision of the schools computer lab for the production of a wide range of computer based activities throughout the whole school, this will have an impact on the school in general and enhance the quality of teaching an learning.

Objectives are to:

- Establish the communications links by providing the hardware, software, Internet provider
- Undertake necessary staff training and development - and enable both sets of teachers to communicate.
- Develop suitable curriculum materials for use by, and using computer technology.
- Maintain a weekly dialogue with a UK school, initially through e-mail, that will enable files to be transferred between the two schools.

This has provided a focus and a starting point for activities that are both practical and attainable within existing resources and curriculum constraints, and it is hoped that it will allow for the development of a wide range of activities and sharing of curriculum materials.

Issues to Be Addressed

Social and Moral. Providing access to the Internet and online resources can have many and varied benefits, but there are fundamental questions about how contacts are established and maintained, who exactly are students talking to and what exactly is being discussed. This can be controlled in a text-based e-mail environment, but just as with the 1-800 telephone SEX LINES, WE ARE NOW BEGINNING TO SEE THE ADVENT OF VIDEO BASED INTERNET PORNOGRAPHIC material. How do we prepare our children and educate our teachers to be aware of the potential risks involved in accessing the Internet, and to promote values that will ensure that it does not become an issue?

Training. There are a number of states in the US that have well developed training schemes for existing and trainee teachers alike. Research shows that unless teachers are given the opportunity to use teleconferencing in a very real way, then they are unlikely to continue with its use (Schrum,1995). Teachers need to be shown how to access data, how to incorporate it into their existing schemes of work and how to make use of one of the most valuable resources that will ever been available - other like minded individuals.

What Lies Ahead? The Information Superhighway promises much, but before we begin to contemplate its use, we must first understand and use the Internet of today. The skills of data handling and retrieval learned today will prove to be invaluable tomorrow, the conceptual framework and principles remain the same whether data is sent at 3k or 100k bytes per second. Classrooms will not change radically in the next 3 years as we approach the new millennium, but our perceptions, and those of our students can and should.

Starting Points, World Wide Web Sites

Internet Relay Chat:
www-2.nijenrode.nl/software/mirc/index.html

Internet Phone: www.vocaltec.com
CuSeeMe www.wpine.com

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The New Challenges to Information Technology Departments in a New South Africa

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South African educational institutions' Information Technology (IT) departments are not providing enough African IT graduates for the South African industry. This paper investigates this situation and highlights the fact that, although more African students are enrolling for IT studies, the failure rates are very high. Some of the major reasons why many African students fail their IT studies are their previousschooling, and their social and cultural background. In facing the challenge the Department of Computer Science and Information Systems at the University of Port Elizabeth has implemented some practical steps. In addition to this the department has also identified some research areas. These include academic development and support, the influence of home language, methods of lecturing, the psychometric profile of students as well as the training of teachers in disadvantaged schools.

In many aspects of their lifes South Africans have experienced some kind of change, accompanied by new challenges, expectations and difficulties. The Information Technology (IT) industry has not escaped this. The lack of computer literacy in the African community is alarming, and the IT Industry is expected to do everything in its power to train mamy more African IT professionals (Van de Werken, 1994). The politicians are appealing to the IT industry to use technology in uplifting people's socioeconomic conditions. Ofir (1994) states that the importance of technology in improving daily life must be visible especially in rural or poor areas.

The predicament of the South African IT Industry is highlighted by the fact that in 1995 it had less than 1000 nonwhites out of approximately 20000 personnel, with no real expectation that this ratio could change considerably within the next 5 years. (Kun, 1995). This racial balance is obviously far from desirable in a country which, through affirmative action, is attempting to correct the racial imbalances of the past.

Because affirmative action candidates (African candidates) are in tremendous demand, they tend to change jobs frequently, causing additional skill development difficulties for companies. To add to the human resource problems of the South African IT industry, local businesses must compete with much bigger international companies. Ten surveyed companies lost 1254 skilled IT workers to international competition in 12 months (Gary, 1996). The industry is thus depending on universities and technikons to supply them with IT graduates and, more specific, African IT graduates.

A Rapidly Changing Environment

As a result of the social changes throughout the nation, higher education has become much more available in South Africa. As a result of this, universities and technikons have seen tremendous changes in their student populations. They are going through a process of rapid transformation with immense new challenges (Fish, 1996).

The University of Port Elizabeth (UPE) is also experiencing dramatic changes in its student population. In 1987 less than 10% of all freshmen were African students. This has changed dramatically to the current scenario where more than 50% of freshmen are African (UPE Academic Records, 1996). This increased African enrollment is also experienced at other South African universities (Brummer, 1996).

According to projected headcounts, the number of African students who pass their matriculation exams will increase from 190,000 in 1995 to 470,000 in the year 2005 (National Commission on Higher Education, 1996). This will definitely create a further influx of African students to universities and technikons.

UPE is also experiencing a growth in African first year enrollment in IT courses. The Department of Computer Science and Information Systems recorded 13% (98 out of 767) African first year students in 1995. This figure has nearly doubled to 24% (174 out of 715) in 1996 (UPE Academic Records, 1996), and predictions are that the figure could again double in 1997.

The Lack of African IT Graduates

Despite the ever increasing number of African students enrolling for IT courses, South African universities and technikons are not producing enough African IT graduates. A very high failure rate is experienced amongst African IT students (Venter, Blignaut, 1995). In 1995 the white first year students in the different IT courses at UPE had a pass rate of 80%, while the African pass rate was 30%. Of the 53 African students who enrolled for the first year programming course in 1996, only 10 passed the course at the end of the year (UPE Academic Records, 1996). The major challenge facing many, if not all, South African university IT departments, is therefore the problem of increased African student enrollment, with consistently low pass rates.

Major Reasons African Students Fail IT Courses

Schooling

It is generally accepted that African students in South African universities come from a disadvantaged schooling background, as a legacy of the Apartheid era. The old African education system in South Africa has been described as a "national catastrophe" (Mazwai, 1990). Some of the problems experienced at historically African schools include the following (Verwey, 1990) :

- textbook shortages and poor textbook management;
- inadequate school management;
- poor qualifications of teachers;
- financial disparity and inequality, compared to white education.

Garson (1995) reports that the first national teacher education audit to be conducted in South Africa, uncovered alarming inadequacies. The quality of teacher education was found to be very poor, with a dire shortage of teachers in mathematics, science, and technology. Of specific importance to IT departments is the underachievement in mathematics by African students. Maree (1995) points out that for every 1000 African scholars entering school at grade 1 (first school year), we can expect only 1 to matriculate successfully in mathematics. Although the different education departments throughout the nine provinces of South Africa are no more racially segregated, the above mentioned problems will definitely not disappear overnight.

Psychometric Profile

Holland's profile of successful South African IT personnel identifies them as being investigative, enterprising, and realistic (Prediger, Swaney, & Mau, 1993; Taljaard & Von Molendorf, 1987). Although research at UPE has found that this profile has changed (Calitz, 1996), the investigative skill is still highlighted as very important.

In light of the above, Castle's (1992) observation on the African schooling system in South Africa is alarming. According to him, the school system for African students emphasizes rote learning, strict discipline, and one-way communication (teachers to learners). Students are discouraged from asking questions and using their initiative or imagination. Clearly such a learning culture in schools will limit scholars' investigative skills.

Social Background

Again, because of South Africa's past, most of the African students come from a disadvantaged social background. Many of these students come from communities where they have very little exposure to technology in their daily life (Venter, Blignaut, 1995). The influence this has on their ability to cope in the computer world was strikingly emphasized in an exercise done in 1996 at UPE with first year programming students. The students were asked to come forward with a specific problem in their daily life which could be addressed by writing a simple C++ program. The examples chosen by some of the African students indicated a lack of frame of reference in which they could place the use of a computer in their daily life. The following are only two of these examples :

- Write a program which asks you how many children you are in your family. The program must then tell you whether you are a big family or not."
- Write a program which asks you what your life expectancy is. If you say less than 80, the program informs you that you will live longer than that. Otherwise the program will inform you that you will die younger than you think."

In addition to a lack of frame of reference, computers are perceived by black students as a "white thing". According to research done by Ofir (1994) technology is seen as a tool of the white community to ensure their superiority.

Cultural Background - First Language

Research in the Department of Computer Science and Information Systems at UPE, found that a student's ability in English is a good predictor of success in IT studies (Calitz, 1996). Most of the African students in the department have the ethnic language Xhosa as first language with English as a second language. It is interesting to note that for most of these students English was officially the medium of instruction for many of their senior years at school. Strevens (1980) points out that in such a situation, where English is not the mother tongue, the scholars learn and use it as a general or cultural language. A student in science, and in this case Computer Science, however, needs to be skilled in scientific or technical English. The obvious problem that African students experience concerning language is simple mutual communication. In addition to not being able to follow the contents of the lectures, they have difficulties articulating the problems they experience with the course content. This is mainly experienced during one-to-one discussions with lecturers as well as with communicating with their assistants during practicals.

When being taught science in a foreign language, the problems are more complex than the difficulties in mutual comprehension between lecturer and student. These problems also include (Strevens, 1980):

- the absence, in the student's own language, of a word or expression;
- the absence, in the student's own language or culture, of a necessary concept. e.g. infinity or gravity;
- the indifferent use of key words such as "if", "when", "whenever" etc.;
- the counting system used in the student's own language.

Selection of Students

Matriculation (school-leaving) results have widely been accepted as good indicators for identifying successful students in IT (Calitz, 1992; Butcher, Muth, 1985; Evans, Simkin, 1989). Various studies have identified specific subjects as good indicators for success. Of these, Mathematics has been identified as the most important (Kovalina, Wileman, Stephens, 1983). Other subjects such as Science or a combination of subjects have also been identified (Calitz ,1992).

In recent research done at the University of Port Elizabeth (Calitz, 1992, 1996), candidates' ability in English, in addition to the other subjects mentioned above, was also identified as one of the most important indicators. Table 1 shows the subjects entered into stepwise regression analysis for identifying successful programming and computer literacy students.

Table 1.
Stepwise regression analysis for identifying successful programming and computer literacy students

	Programming		Computer Literacy	
	Multiple R	Frequency	Multiple R	Frequency
English	0.32*	583	0.36*	583
Afrikaans	0.18*	390	0.25*	390
Mathematics	0.44*	817	0.39*	817
Science	0.55*	644	0.51*	644
Accountancy	0.43*	562	0.45*	562

** indicates significance at the 0.01 (99%) level*

A disturbing find in this research was that matriculation marks of students from historically African schools are not as good indicators of performance as those of white students. Because of limited numbers, this must be viewed as an initial finding. Obviously this creates new challenges for IT departments in South Africa. Without being able to use matriculation marks as good indicators of success, two obvious errors could be made in the selection process:

- selecting students who have very little chance of success, resulting in even higher failure rates and creating a negative atmosphere in class; and
- disallowing students who actually have the potential of being successful.

Facing the Challenge

It is clear to us as a university, and as a department, that the problems mentioned above need to be addressed if we want to achieve success in the challenge of a new South Africa. Certain practical steps have been taken by the department as well as the Faculty of Science in to address some of the problems mentioned above (Greyling, 1995). These include the following:

- Extended IT first year - students may do their first year over two years (Department of Computer Science, 1994);
- Summer and Winter Schools - students who fail their first year, are given the opportunity of redoing the course material during their recess periods (Wesson, 1994);
- Extended BSc Curriculum - in their first year students do credit bearing courses such as Mathematics Special, Technical English, Life Skills and Computer Literacy Special.

In addition to the above steps the IT Department at UPE has also identified the following research areas:

Academic Development and Support

A research project has been proposed on the academic development and support in the Science Faculty of UPE. This research would entail establishing the current state of academic development and support in South African universities, designing a structure of academic development and evaluating the implementation of such a structure in the Department of Computer Science and Information Systems.

Language and Its Influence

As mentioned earlier, most of the African students at UPE have Xhosa as their first language. This language is in many ways very different from a typical Western language such as English. This was illustrated in an experiment with first year students where they were asked to translate a simple while loop into their home language. The Xhosa speaking students had difficulty in translating this concept and programming structure into Xhosa.

Many solutions have been proposed to the problems of teaching science in a medium of instruction which is not the student's home language (Kotecha, Rutherford, & Starfield, 1990). There is definitely a possibility for a linguist to do research on the influences a language such as

Xhosa has on a student's ability to program. Such research could assist us in bridging the language gap in university IT courses.

Different Methods of Lecturing

The obvious solution to the language problem we experience would be to have Xhosa speaking lecturers and assistants in the department. Up to now we have, unfortunately, been unsuccessful in obtaining either. The department should have a few senior Xhosa speaking students soon who could be used as assistants. The author, however, is not so positive concerning lecturers. Because they are in such demand in industry, it is very unlikely that African IT graduates would chose a less-profitable academic career.

Eliminating the lecture method in favour of self study modules for discussion in cooperative learning groups is being investigated. This will allow students from the same cultural and linguistic background to discuss problems in their own language.

An experiment at group work in the first year classes proved to be very successful and interesting. During these sessions it was natural that students speaking the same language would gather together. It was exciting to observe how especially the Xhosa speaking students would explain certain programming concepts to each other. The best example was explaining the if statement by using the analogy of a man standing at a door, asking people a question in order to decide whether they were allowed into the room.

Psychological Research on the Reasons for Success and Failure

In cooperation with the Department of Psychology at UPE, as part of their honors program, we are doing research on the different aspects which might cause success/failure amongst first year Computer Science students. This includes the following:

- Quantitative tests on the 1997 first years. These tests include a new test on simultaneous and successive processing skills, which we feel might be correlated to the ability to program;
- Qualitative research on 1996 first years, through interviews. The focus of these interviews would be to determine students' perceptions and experiences of computers as well as their backgrounds (personal, social, cultural etc.) and how this influences their interaction with computers.

Computer Literacy of African Teachers in Disadvantaged Schools

The department is involved in computer literacy training of teachers at several disadvantaged schools in Port Elizabeth as well as in the surrounding rural area. In addition to the practical assistance given, this is also seen as a potential research area. The aim of this research is the development of an effective introductory Educational Computing course for disadvantaged teachers, using global Educational Computing models (Cowley, 1995).

Conclusion

The Africanization of South African universities has been in the spotlight for the past decade. This concept embraces the integration of universities into the culture of Africa, reflecting the changing needs of Africa and commitment to the needs of the whole community (Farquharson, 1990). South Africa needs more African IT graduates, and to the industry it is of utmost importance that standards are not dropped.

Responding pro-actively to socio-political changes in the country and the imminent restructuring of the tertiary education system, the University of Port Elizabeth has adopted far-reaching policy resolutions and taken a wide range of action steps to promote the institutionalisation of the process of change in South Africa (Kirsten, 1996). In correspondence with the changes of the new South Africa and the general atmosphere at UPE, the Department of Computer Science and Information Systems is ready to face the challenge. It is very important to the IT industry and the economy of South Africa as a whole, that we, as well as our colleagues at other universities, are successful.

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Pedagogy of Informatics: Preparing Educators to Face the Challenge

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Through this presentation, we will discuss the challenges facing educators to incorporate informatics (we have used that term because it represents information and automatics, all together, placing computer education in the broader context of information and technology) into the curriculum, the capacitation—neologism for continuing professional development which enables and empowers teachers to action—of teachers to face these challenges, and review a new educational program in Northeast Brazil. We will present a package of teaching and student materials which formed the basis of a course in informatics for K-12 students. These materials which were developed in Portuguese are currently being translated into English at the University of Oregon.

Perspectives/Theoretical Framework

In Brazil (as in USA), computers were introduced into educational programs for children with the promise or belief that through the computer students would learn more, read better, and work more creatively and cooperatively. However, the computer, reified in this way, has not corresponded to people's expectations of its potential in the learning and teaching situation. Recent research in the US, Japan, Israel and some countries in the Europe Union shows that the main focus of computer education in schools has been on computer skills, e.g. word processing or information management, and little attention has been given to developing a pedagogy which integrates the teaching of computer skills with an understanding of informatics and its place in our society. Little or no attention has been given to a Pedagogy of Informatics which takes into consideration learning and teaching processes, organization of curriculum, and reflection on people/machine relationships in learning and in the wider community, as well as developing children's ability to use computers competently. In addition, the responsibility for computer education and use in schools has been left in the hands of technical experts working from computer labs, rather than incorporated by classroom teachers into the curriculum (Pelgrum & Plumb, 1991; Anderson, 1993; Lund & Wild, 1993; VISION TEST, 1990; Office of Technology Assessment, 1995).

The challenge facing educators today is not just to use computers at school, but to use computer education and informatics to mediate improved social and learning relations in schools. The introduction of informatics into the curriculum can assist schools to change from a traditional way of teaching and learning, to one that provides students with an ever more cooperative apprenticeship in the learning and teaching process, and prepares them to be lifelong learners, explorers and integrators of learning and experience. Key factors in assisting teachers to respond to these challenges, are (1) the production of resource materials which express didactically the basic educational concepts that will facilitate the processes of working, teaching, communicating, and learning, and (2) the capacitation of teachers (Jurema & Costa Lima, 1993).

Foundational premises for developing a program based on the Pedagogy of Informatics include:

- The interdisciplinary nature of informatics knowledge involves a range of subject areas and processes, including but not limited to mathematical, historical, linguistic, logical, conceptual, and graphic.
- Learners are active participants who in the course of their learning structure their experience and knowledge.
- The cooperative work of students and teachers creates a new cultural resource which is greater than the knowledge and understanding that any of the individuals possessed before.
- Approaches which are based on the social and cognitive reality of students will develop learning experiences that are challenging and open-ended, enjoyable and playful, cooperative and socializing.

- Computers are a means not an end. In the educative process they do not replace people but assist them in reorganizing interactions, thus reorganizing the teaching and learning process (and the play).
- The content of knowledge and its daily application are intrinsically related. Therefore teaching and learning programs in addition to providing information about computers and information technology, must be functionally constructed (authentic learning), and also challenge learners to reflect on social impacts and implications (i.e. the relations of people with the machine and with one another).
- Informatics in schools are not an appendix to the educative process, but an integrated element of the school curriculum which must enrich the teaching and learning situation.
- The capacitation of teachers is essential. An approach based on the pedagogy of informatics requires teachers to develop their knowledge and understanding of informatics in our society, to rethink their roles and practices, and base their teaching on their students' curiosity and active involvement in their learning (Jurema, Costa Lima, Dalmau & Jurema, 1995).

Developing a Pedagogy of Informatics involves collaboration in learning at a number of levels, i.e. the collaboration of educators as they work together on the conceptual and operational changes required if they are to teach both about the computer and with the computer; the collaboration of students as they learn together through activity-based and challenging learning opportunities; the collaboration of schools and communities as they come to terms with the role of education and schooling in the information society; and interdisciplinary collaboration in the development of curricula and educational programs.

Methods and Data Sources

A computer education program, produced by the Institute of Technology in Informatics (ITECI), based on this emerging pedagogy of informatics has contributed to our knowledge about the use of computers and information technology in education. These materials were developed by a cooperative, multidisciplinary working team of professionals from the areas of informatics, cognitive psychology, education, visual programming (graphics), history, and production of didactic materials. They were trialed through an intensive course, and then successfully used for more than five years in seventeen Elementary and Middle Schools, with approximately 20,000 children and adolescents in the states of Alagoas, Pernambuco, Rio Grande do Norte, and Ceará. With some adaptations the course was also taught to a group of children with special needs (Jurema, Jurema & Longman, 1992). Our observations are based on the conceptual framework on which the program was based, the multidisciplinary and collaborative approach to the program development and implementation, and the follow-up evaluation of ITECI's methodology and courses.

The program integrated three key objectives:

- Informatics education: to provide students with access to systemic knowledge about computers and information technology;
- Educative informatics: to use computers and information technology as an educational resource for students and schools;
- Capacitation of teachers: to assist teachers to become users and teachers of informatics, through understanding the philosophy, ideas and skills on which the program was based.

The program. The Introductory Informatics Course for Children and Adolescents (Jurema & Costa Lima, 1993) included both, a methodology for teaching informatics to children and adolescents (K-12), and a series of teaching and learning programs across the age-range. It was designed (1) to assist children and adolescents develop the abilities, understandings and values necessary to participate effectively in a society infused by computers and information technology, and (2) to assist schools and teachers to develop informatics as an integrative element across the curriculum. The course was designed around three thematic nuclei:

- Foundations of Informatics (history, functioning and uses of the computer),
- Informatics and Society (social impact and vocational and work market analysis),
- Interest centers (workshops on many topics, including but not limited to, art, games, literature, mathematics, pedagogical support, library).

The program materials include a kit of didactic materials: text books (reference books for students and teachers), activity challenges for students, manuals of methodological orientation and educational programs for teachers, and a support kit of educational software. The software developed are simple, requiring the teacher to explore the ideas they represent and integrate them into the learning program. The teachers' manual presents, besides suggestions for activities, some alternative suggestions about ways to work with students within each subject, and the integration of the program across the curriculum. Collaborative processes are built into all activities of the program so that the cooperative and cognitive elements are intrinsically united, e.g. when children work in teams to create databases, they generate findings which have to be discussed, analyzed and communicated, and require their active involvement in the reasoning process.

Capacitation of teachers. The capacitation of teachers is the key to the success of the program. If informatics is to become and intrinsic component of schooling, it will not be enough for schools systems to merely train computer experts. All teachers must be given the opportunity and the encouragement to the develop the conceptual understanding and technical skill necessary to integrate the computer into their educational programs. The Teacher Capacitation Program developed by this project assisted teachers to develop their own knowledge and understanding of informatics in our society, to rethink their roles and practices, and base their teaching on their students' curiosity and active involvement in their learning. It is an ongoing process, including a practical course of informatics (40 hours), monthly teacher meetings (3 hours), and end of semester workshops (6 hours).

Educational Importance of the Study

As stated above computer education in schools has not lived up to the high expectations with which it was introduced. In many cases as the speed with which the technology is developing simply means that teachers and schools get left further behind. The emphasis has been given in equipment. We propose a shift, building a pedagogy of informatics in a permanent program of teachers capacitation. This project has been successful in both, the capacitation of teachers, and the development of a Pedagogy of Informatics—assists students to conceptually understand the structure and functioning of computers and software in both historic and contemporary contexts, and be able to infer, take risks and face new challenges creatively. It is important that educators are given many opportunities to discuss and contribute to the emerging Pedagogy of Informatics, and to learn from successful programs such as this one.

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The Instructional Technology Department: The Management Experience at ITESM-CCM

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The Monterrey Institute of Technology at Mexico City (ITESM-CCM) has faced a great challenge creating a department whose aim is to offer service to faculty who want to create educational technology materials for their courses and to direct instructional technology projects that enhance students' learning. This effort brought together people from several backgrounds including computer engineering, instructional design, graphics design, psychology, and the humanities as well as academics and administration. The result is a well organized department that continues growing and producing better results in terms of the administration, faculty participation from several disciplines, and the creation of interdisciplinary groups in the generation of instructional technology projects.

The Virtual University Department at ITESM-CCM began as the Educational Technology Center two-and-a-half years ago. Originally, its purpose was to provide the equipment for high school and undergraduate students to work on technology-based aids for their classes. The end products included PowerPoint presentations and Magic interactive programs to work with laser disks, computers, VCRs and projectors. Today, this department houses the Instructional Technology Department, which offers services to academics and directs projects in the area, and the Distance Education Department, which manages the administrative and academic functions of receiving courses from our system's main campus.

The Instructional Technology Department, previously called the Multimedia Lab, consisted of a coordinator and two assistants who helped faculty create class projects and use multimedia tools for making better materials for their classes. Although the general administration had asked the department's director to incorporate multimedia applications into the everyday classes and encourage using the equipment in classrooms, few teachers used the facilities because not only did they know little about this department, but they also claimed they were too busy with classes and did not feel the use of technology in their classrooms was very important.

First, to promote the department, teachers attended several seminars where ideas for using interactive multimedia programs as part of their regular classes were presented. A contest was held for other classroom applications, and the winner would receive the multimedia center's support for making the program a reality. It was emphasized, however, that such developments would have to be of a multidisciplinary nature in order to succeed. For example, the notion of instructivist vs. constructivist vs. cooperative education, where the well-known dispute over teaching-learning vs. learning prevails, was introduced to build a debate that would allow the faculty to evolve. However, no leave time or money was offered to those participating in the program.

Almost at the same time, the school's system launched a program for financing educational technology projects, and several professors at our campus submitted proposals. Since many projects proposed creating interactive tutorials or multimedia programs for their classes, the administration asked the multimedia center to concentrate its efforts on one project that encompassed the submitted proposals. The center began an organization of an interdisciplinary group to devise Toward the Virtual University (TVU), which focused not only on the creation of multimedia programs but also in the pedagogical validation of the products and in the technological investigation.

The Educational Technology Center support area, still consisting of only a director, and a coordinator with two assistants, administered the project. As the administrative base of the project, they concentrated their efforts on the faculty who were to create the projects, investigate in the pedagogical area, and assess the technological needs for establishing the Virtual University.

Initial Difficulties

At the beginning of the project and at the implementation of the new department's administration , several difficulties arose:

1. The initial inability for defining a virtual university, and thus for creating a predictable plan for the project in terms of its financial, managerial, and operational essence.
2. The faculty's cultural resistance for using computer technology.
3. The financial difficulties for finding funds for the new technologies.

Although the term virtual university is quite fashionable, it is still undefined in terms of its technical-soundness, standardization-procedures, and educational-potential assessment. From the start, the team refused to adopt the simplistic view of the virtual university as a distributed multimedia and hypermedia environment. Therefore, research and practical results were necessary to make our grant sustainable, and the group decided to assume the risk of an experimental-oriented focus. It was unclear how the final programs and released products would be implemented, and although the scenario presented uncertainty in both financial and operational aspects, the work started.

Lack of defining the virtual university prevented the TVU project from implementing a defined publicity campaign among the faculty, which resulted in misunderstandings about the project's purpose. Many professors thought that the new paradigm would destroy teaching—that the computer would be used a substitute for the real teacher. Therefore, it became increasingly important to erase these myths. However, the cultural resistance was, as it is now, resistant to the program.

Another stumbling block to the TVU project was Mexico's economic crisis in late 1994, which pushed the national computer industry to its limits. It became obvious that a sophisticated laboratory and development software/hardware infrastructure was required for the research to be successful. The team started to work with a limited set of resources, using campus-supplied computer equipment, appropriate only for general purposes as it is not configured for the project's specific needs. This has caused operational and logistic problems in the long run. However, since the project is so important and its future so prominent, the team adapted the available resources. Because of this crisis, the project and the team learned to use only necessary materials, equipment, and human resources.

Cultural Shock Before the TVU Project

Once the multimedia-equipped classrooms were inaugurated, professors were expected to use a PC or Macintosh computer and standard multimedia software to enhance their courses. The campus administration launched a complete training effort , and a campaign was begun where teachers could purchase desktop computers.

The technological aspect of this training was complemented with aspects of a permanent program, Professor Training Program, which emphasizes courses aimed at enhancing the faculty's potential and profile improvement. There was, however, a lack of synergy between the computer and the educational enhancements, probably due to the lack of understanding of the concept virtual university. As a result, the cost-benefit usage of the multimedia classrooms deteriorated because the technology was used simplistically or because its educational, pedagogical, and social values were ignored.

The System-wide Virtual University

The Instructional Technology Department is not alone as a project. The system's policies have recently shifted for the Virtual University to happen, and a generalized acceptance of the constructivist school (Reeves, 1994) where discovery, self-administration, and learning-to-learn are key factors for a paradigm change has been accepted.

ITESM fosters through its distance education programs and virtual courses new learning paradigms. It offers courses on the high-school, undergraduate, and graduate level. In the distance education programs, depending on the level, students attend class from one to three times a week, and they are responsible for their learning. A teacher who instructs from the main campus and a classroom facilitator guide student learning. However, in some classes, students, especially those on the graduate level, are by themselves.

Virtual courses focus on the idea of teachers acting as advisors. The programs developed at our campus fall into this category, and other system locations will use them next semester. To develop these courses, teachers go to our department, and we give them technical, pedagogical, and instructional design help and produce the computer programs.

To function, the Virtual University at ITESM works as an interdisciplinary group. People who work in this new area come from different backgrounds and different campus locations. To renovate and improve the teaching-learning paradigm, faculty, administrators, technicians, and many more work together to save and improve available technology. The Instructional Technology Department follows this structure and way of working. Although it developed independently and fulfills other needs, this department fits perfectly in the new management guidelines where improvement in the use of resources, teamwork, and interdisciplinary groups are the basis for its functioning.

Retraining Within the TVU Project

It became necessary for professors to adapt to the new methods of teaching. Of the 17 professors who began the project in 1994, few had notions of multimedia computing; some others had notions of instructional technology; and almost none had combined notions. A leave-time scheme was planned as shown in Table 1.

Table 1.
Leave-time Scheme.

Human resources	#Professors	Professor Salary*
Leave time (1 group)	17	$639.20
Total		$10,866.40

*Figures shown in US dollars.

Although $639.20 is about seven times the minimum wage, or enough to pay for retraining, the learning curve was too steep for professors to adapt to multimedia programming, instructional design, and testing (an average of more than 16 hrs/week). The conclusion was that faculty needed additional support strategies for effective teamwork. The teachers used seminars to offer feedback on current development and on pedagogical and social issues. The first meetings centered on adapting to basic multimedia concepts. Today, the faculty has shown a higher level of criticism toward the use of multimedia. One of the main conclusions reached was that technology alone would not trigger educational development.

The Next Step

As a result of the project's success and the new needs, the Educational Technology Center turned into the Virtual University Department at ITESM-CCM, and the Multimedia Lab became the Instructional Technology Department (DTI) with the laboratory assistants becoming part of expert development teams who familiarized and tutored professors with the new technology. Because the development of the project involved not only technology but also pedagogy, instructional design, and graphics design, the interdisciplinary teams became one of the most important characteristics of the work.

The DTI itself has not grown in terms of full-time people. As part of the budget for the project, we hire graphics designers, an instructional designer, an educational psychologist and a couple of programmers. This allows the Institute to minimize costs and the results, up to now, have been very positive. We have proved that there is no need of a large full-time staff when good planning and teamwork are emphasized and promoted. In addition, the academics who participate also allow us to do without hiring experts in certain areas. They help us and share their expertise not only in general knowledge but in specific topics.

Financial Issues

With an initial budget of $108,000.00 USD, the project has been able to produce great results in the development of:

1. Three virtual university software programs.
2. One complete in-class social, educational, pedagogical validation of all three programs.
3. Six international and six national publications.

This project demonstrated that it is possible to have an increased $/man/hour throughput when a good administration strategy is applied. Given the high cost of technology, we reduced purchases but effectively used existing expertise and resources. Although some people were hired to become part of the development groups, most program participants were already part of the Institute. It is important to mention also that the administration and academic departments gave professors leave time for participation. This can be considered a great achievement in terms of administration, and the conjunction of these factors allowed the project to handle its finances more efficiently.

Conclusion

The TVU project has helped us to innovate administration techniques which at the same time helped us to consolidate the new Virtual University at the ITESM-CCM. The experience we gained has allowed us to contribute to the new scheme where interdisciplinary groups, teamwork, and effective use of available resources are vital and necessary.

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MATHEMATICS

Section Editors:

Michael L. Connell, *University of Houston*
Susan Williams, *University of Houston*
Ruth Gannon Cook, *University of Houston*

In examining this years papers it was fascinating to observe the emergence of several themes which have been present in the process strands of Mathematics education in general. Since their inception in 1989 the NCTM Standards for Curriculum and Evaluation have been quietly (and in some cases quite vocally) changing the face of what constitutes mathematics and how we think about its teaching and learning. This is not, in and of itself, surprising. What is surprising, however, is the degree to which these themes parallel larger themes within Instructional Technology.

At the risk of sounding like a content chauvinist it does indeed seem to be the case that good thinking in mathematics is good thinking in general. To see what we are referring to, consider the following: mathematics is communication; mathematics is reasoning; mathematics is problem solving; and mathematics is connections. These statements are drawn directly from the process strands of the 1989 Standards document. Now, let us consider how the following sounds: technology is communication; technology is reasoning; technology is... somewhat eerie, isn't it?

Taking a cue from this observation we are organizing this years papers around these strands from the standards: communication; reasoning; problem solving; and connections. Admittedly we have had to "stretch the envelope" a bit beyond what a literal reading of the standards might suggest but we have found this to be a helpful organizing device for this years crop of papers and hope that you find it to be, also.

Communication

A key part of the communication process lies in insuring that the same mental referent is present in the minds of both parties to the communication. One of the places in mathematics where this rule is most easily violated is in the visual display of quantitative information. Unless clear understanding are present regarding what the data is intended to represent — coupled with standard presentations — it is unlikely that successful communication will take place. Hosticka and Clark take this issue head-on in their paper. This paper is a must read for all of us interested in using graphs effectively.

Following up on Hosticka and Clark we see that, without a shared literacy, it is doubtful if communication can be effective. Halpin describes efforts at promoting the dual goals of increasing computer literacy and in preparing teachers to effectively use computer applications in the elementary classroom via a technology integrated methods course. The findings of this study should be carefully examined by all looking at course and program revision.

Of course one must also look at what it is that is being communicated. The role of communication is much different when the students role is to commit items to memory than when the role is to be an active sense maker and problem solver. Connell looks at two broad categories of technology use, Artificial Intelligence (AI) and Intelligence Amplification (IA), and describes impacts upon teacher and student communication which follow from each type of use. These categories have shown to be especially useful groups for opening communication with preservice teachers in their examination of educational technology and its impact upon teaching and learning mathematics.

One of the more fascinating aspects of communication in mathematics lies in the symbol systems used to create representations of mathematical situations. The role which technology might play in this process is detailed by Prokhorov who describes a fascinating object oriented environment within which such representation may be built. This system is well worth a careful investigation. As an added bonus, the supporting software PYTHAGORAS in included on the CD-ROM edition of the annual.

Reasoning

In Wentworth's paper we are reminded to expect a J-shaped change curve in moving teachers toward the standards. Change clearly takes time and this should be planned for and it is far too easy to shortcut reasoning by expecting a quick fix. A goal of reasoning is to give the teacher candidate the tools for self-reflection. The described approach to video tape usage can be helpful in this effort as it provides a context within which to reason. As a part of this process the teacher candidate was expected to observe and analyze a range of approaches, examine and revise existing assumptions, work with diverse thinking, analyze existing thought, and examine dispositions toward teaching mathematics.

If we are to expect our future teachers to employ and teach mathematical reasoning effectively we must also adopt new approaches in their preparation. One such approach, MATH-PLACE (Measuring, Analyzing, and Training Heuristically: Professional Learning Assessment, Computer and Equity Education), is described in Freeman's paper. This project and the technology and manipulative rich environment it creates are worthy of note. In particular, the teacher candidates are given the opportunity to reason with the same tools which they will later be expected to teach with. Such an approach is highly important, as it is doubtful that teachers could effectively reason and teach with a tool which they have not experienced.

An environment for teaching linear algebra to preservice teachers, MATLAB, is described in Bouniaev's paper. Here we read a thorough description not only of what was done but of crucial importance as to why it was done. Although the content analyzed in this paper was linear algebra, the sections describing the manner in which actions are developed at various stages of instruction offer insight into the learning of mathematics in general and the application of technology in this process in particular.

Finally, unless teachers can help their students to reason mathematically, we cannot claim success in our efforts in teacher preparation. Vidavocik, Berenson, and Blanton provide an excellent description of a course which was both technologically intensive and geared toward giving teacher candidates specific methods for later use. The creation of the "complex" investigations and activities described in this paper are well worthy of emulation.

Problem Solving

Technology changes the playing field of mathematical problem solving in a significant way. Problem solving methods shift from the passive and algorithmic to interactive and generative. Kennewell explores how improvements in learning mathematics may be made by inclusion of technology in problem solving. In doing so he lays out a clear picture of the ways of knowing which are developed by the use of technology and provides well thought out advice and caveats for technology implementation.

One of the problems which must be squarely addressed in applying technology in the mathematics classroom is the alignment between the technology usage and the underlying instructional philosophy of the class itself. Connell presents results from two classrooms sharing a common constructivist philosophy who had agreed to use technology in different fashions. Although significant gains were made in both classrooms, the data clearly supports the need to align the technology use with the instructional strategies.

The beginning teacher faces many problems to which technology could be a helpful ally, but often lack the experience to know where and how. In Milligan and Robinson's work we see how many of the typical tools of technology can be helpful in addressing these very real teacher concerns. In particular, use of the Internet as a resource; effective use of such tools as databases and spreadsheets; technological enhancements for teaching algebra and geometry; and the more staid uses of technology for classroom management purposes. Clearly technology has a place in problem solving — bringing the context of the problems to those relevant to a beginning teacher will go far to helping them realize this potential across the curriculum and teaching process.

Connections

In Bloom and Handler's work we see a process described wherein connections are made, not only within the mathematics content, but within one's circle of professional colleagues. Clearly the integration of technology into methods courses will require a team effort which cannot be limited to mathematics experts. A team approach between IT and content is not only helpful it is essential. As we are reminded in their closing statements: "Spread the word about what you are doing. Open communication with other faculty and encourage their efforts at integrating technology." We also see the importance of making connections between the needs and requirements of a single course to the larger program of teacher education to which it is a part.

This connections theme continues in Aotani's paper where we learn of a program which takes the theme of connections and expands it to include connections between institutions. Mathematics educators planning similar programs should read this carefully as a possible guide for their own efforts. In today's increasingly "virtual world", a key element of this success appears to be making an old-fashioned "physical" site visit. This institution-to-institution and person-to-person connection must not be short cut.

One of the major ramifications which technology has made in mathematics lies in the connection between the tool used to think with, in this case technology-based, and the content itself. Algebra provides a compelling case in point where we see radical changes proposed in both content structure and recommended teaching methods. This interaction between content and technology is carefully examined and analyzed by Williams. We see in this paper a strong argument that inservice and preservice teacher preparation must prepare teachers to make regular use of technology in their own methods. If this is not done it is doubtful that their students will succeed in the changing algebra content which the technology has enabled.

Math Central is a World Wide Web site designed as a meeting place for mathematics teachers and students from kindergarten to grade twelve. Here connections with other professionals may be made to share resources and information. In Maeers, Weston, and Hanson's paper we read of this sites history, structure, and use since its founding. This site will quickly be added to the bookmarks of our browsers!

Finally, in her description of SkyMath; Lynds remind us that although connections in mathematics education generally refers to mathematics itself there are many other "educational" connections that enhance the learning process. In particular, this paper describes the connections made possible by this project between middle school teachers and university faculty, SkyMath and the Internet, and with SITE itself.

Summary

We hope that this use of the process strands from the standards will prove useful to you in your reading of these papers. Now, as was done in the Standards, let us each remember the content themes which we are each responsible for teaching. This years papers contain a wealth of information to draw from in this effort and should certainly be carefully examined concerning the light they bring to bear on each of our course and program responsibilities in teacher education.

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Using Technology to Create Effective Graphs: Issues to be Considered

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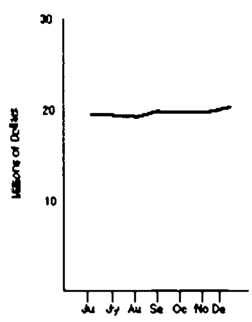
The new educational reforms in mathematics (NCTM Curriculum and Evaluation Standards) and science (AAAS Benchmarks) focus on the improvement in understanding of the content and the integration of technology into instruction. An area of content in mathematics, the display and interpretation of statistical data, is a tool in science to display information resulting from data collection. With the advent of graphing packages and data base and spread sheet programs with graphic capabilities, many teachers are using graphic generation as an integration point for technology. These packages help the user make graphs attractive, accurate in their measurements and eliminate much of the tedium of creating a graph. With the increased use of graphs in information dissemination the need for understanding the correct use of the graphs, the type of information they display, and the likelihood of misinterpretation becomes increasingly more important.

Graphs can do much more than simply substitute for numeric information. At their best, graphs are instruments for reasoning about quantitative information. Often the most effective way to describe, explore, and summarize a set of numbers is to create at a graphical representation of those numbers. Of all methods of analyzing and communicating numeric information, well designed graphs are usually the simplest and at the same time the most powerful.

Reporting of data is used to influence people in areas from politics to consumer choices. When this data is reported with inappropriate graphs it is misleading. Misleading information gathered from inappropriate graphs then leads to uninformed choices. This misleading data can be presented either intentionally or accidentally. The two graphs that follow both present the same data, yet the messages received by the viewer are very different, as indicated by the titles.

Govt. Pay Rolls Up!



Govt. Pay Rolls Stab

Creators of graphs and interpreters of graphically presented data, both need to be informed of graphic principals in order to protect against misinformation being disseminated and acted upon.

When using a graphic package to construct graphs the user is given many choices of types of graph and special features within each type. Making poor choices when using the graphic packages often leads to graphs that are easily misinterpreted and are created in such a manner that may inadvertently misrepresent the information contained in the data. The special skills and understandings necessary to insure that data is **accurately** transformed into graphic format at a level of sophistication accessible to the user is both an art and a science - and a skill that all makers and consumers of graphs should posses.

This paper will discuss and illustrate principals of graphic design, and the issues and concerns in making choices in types of graphs used to present data.

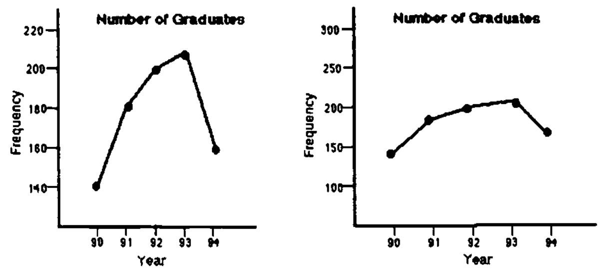
Principles of Graphic Design

In order for graphs to be effective, students need to know how to convey quantitative data. Quantitative data may be presented in bar and column graphs, line graphs, pie graphs, and pictorial graphs. Each graph type has its restrictions, advantages, disadvantages, and data that is appropriate for it's use. It is these mathematical considerations and how they translate to the use of graph producing software that will be the focus of the following discussion.

Graphical Integrity

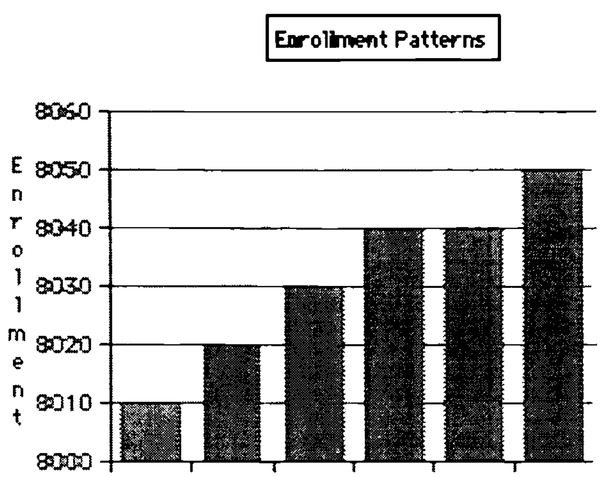
Graphics for presentation have one of the following purposes (Clagett, 1989): to show component proportions, item magnitudes, trends or time series, frequency distribution of items over ranges or relationships. Incorrect choices and/or decisions in graph construction can produce graphs that present erroneous information and lead to misinterpretations. To address this issue, Tufte (1983, p 77) developed six principles of graphical integrity to ensure that graphs tell the truth about the data:

1. The representation of numbers or axis intervals, as physically measured on the surface of the graphic itself, should be directly proportional to the numeric quantities represented.



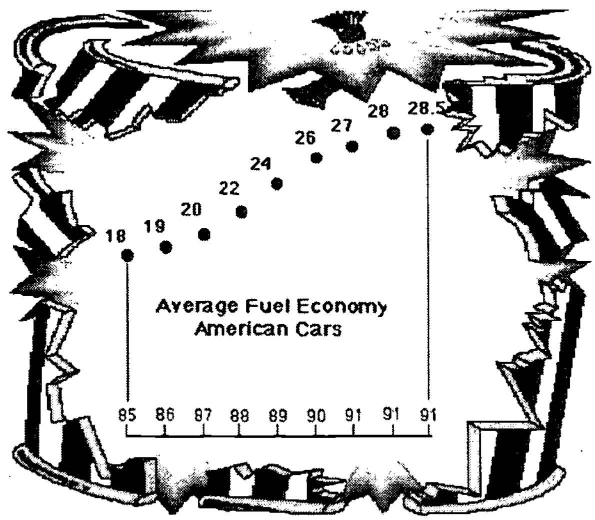
The more vertical the slop the more one believes that the change is great. In the first graph, the slope is greater than what the data would suggest. In the second just the opposite is true. There seems to be no change. By changing either scale the physical appearance of the graph and the visual impression of the data is changed.

2. Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.



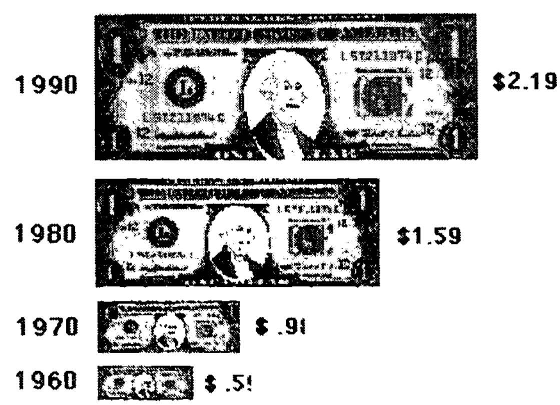
When one reads this graph the horizontal axis interval is unclear and therefore the pattern represented is unclear. Is the information gathered quarterly, yearly, or over the decades.

3. Show data variation, not design variation.



The importance of the data is lost in all the bells and whistles of the graphic display. The interpreter need to works harder at getting the information than should be necessary.

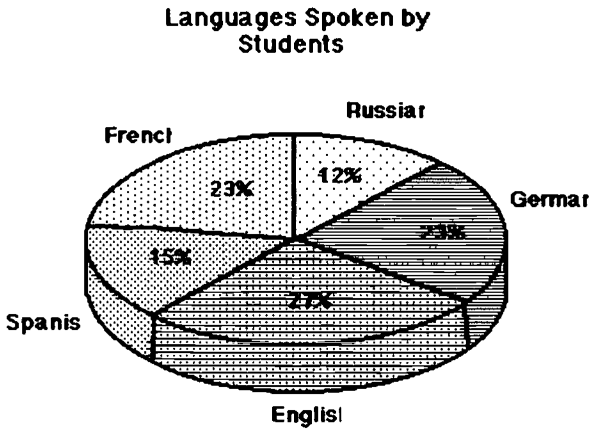
4. In time series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.



The Rising Cost of a Hamburger

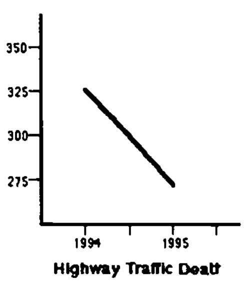
While the cost of hamburger has increased, the graph suggest a much larger proportion of the resources going toward the item than in fact is true. If the cost and income are adjusted for inflation the data suggest that the percentage may have increased only slightly or in fact may even have decreased.

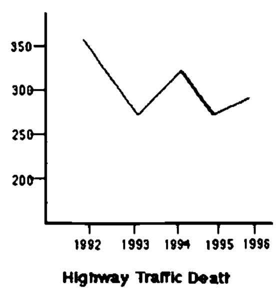
5. The number of information-carrying dimensions depicted should not exceed the number of dimensions in the data.



At first glance of this three dimensional graph, the section of the graph that shows the depth looks like a larger portion than the one where the depth is not shown. This is due to the fact that the third dimension on the graph is incorrectly read as part of the area that represents the data. In the above graph the 27% and 23% are much closer numerically than the area of the graphic suggests. Third dimensions should not be used if the data is two dimensional.

6. Graphs must not quote data out of context.





In looking at the graph above the reader would assume a drastic decline in traffic deaths occurred. The interpreter does not know what came before, after or the cause of this decline. Looking at the larger graph (above, right) the interpreter sees that this is an anomaly and that in fact the deaths have not significantly declined over previous years.

In addition to not distorting the data, graphical excellence for Tufte consists of communicating complex ideas with clarity, precision, and efficiency.

Type of Graphs

The most commonly used graphs include bar, line, pie, and pictorial and their variations. The choice of which type of graph to use is dependent on the type of data and the kind of comparison to be shown. While the data should determine the types of graphs that are valid to use, research and experience suggests some types of valid graphs are more effective than others.

Criteria and Consideration in Choosing a Valid Graph Type

The major criteria in choosing valid graph types is the type of data to be displayed and the interpretation to be shown. Data types are discrete - things that can be counted to be quantified, (item magnitudes, frequency distribution of items), and continuous - things that must be measured to be quantified (trends or time series, frequency distribution of items over ranges or relationships). Interpretations of discrete data, answer questions of the type; how many? how many more? ... . Continuous data, is used to show trends, predict future situations, and interpret data between two represented data points ... When the interpretation, is related to part / whole information, what is greater / less, then the graph choice is not solely dependent of whether the data is discrete or continuous.

Picture graphs are used for displaying discrete data. This display uses pictures or symbols associated with the subject matter to show quantity. They are less abstract than other types that may show the same data. When picture graphs are used the author must be careful that the representation of numbers, as physically shown on the surface of the graphic itself, should be directly proportional to the numeric quantities represented. i.e. 3 dimensions of a picture should not change for a simple additive or multiplicative numerical difference. In picture graphs, keys always need to be presented. When an icon represents more than a unit, and a part of the icon is shown, the graph will give a general feel for the quantity expressed, not an exact amount.

Bar graphs are used when discussing discrete data in exclusive categories. Their strengths lie in their versatility and effectiveness, especially for showing item comparisons. Bar graphs are the easiest to read and interpret when data is being compared. However, **segmented or stacked bar graphs** which are a variation of bar graphs, are often used when subcategories within a data field are to be shown. While they show the subcategories they lose the common reference line for the subcategories and make comparisons among the subcategories for all but the bottom segment difficult. This makes interpretations of the complete graph problematic.

Line graphs are used for showing continuous data such as time series and frequency distributions. When discrete data is represented on a line graph connections between categories that do not exist are often mistakenly made.

Pie graphs are used when we are comparing parts to a whole. Generally they are good for gross comparisons. Many people get confused when a large number of segments are used or exact quantities of data are desired.

Pie graphs with more than three or four segments can become ineffective in communicating the information desired. The human eye has a hard time discriminating between small angles and comparing the many segments.

Three-dimensional displays are available on many of the graphic packages and are appropriate for use when the data has three or more variables that needs to be represented on a two dimensional graphical display mode. Many of the graphing programs that give a 3 dimensional display option are not true 3 dimensional graphs. To be a true graph you need a third axis that can show variability. This three dimensional feature is inappropriate to use for cosmetic aspects of the graph and can lead to misinterpretations.

Classroom Considerations

Graphing packages allow for any type of data to be displayed in any type of graphic format. Technology is making the problem more pronounced by offering so many choices with a simple click of the mouse. The decision making necessary for correct use of graph types must become a main topic of instruction.

When teachers use graphic packages in classroom instruction the focus of instruction in mathematics can shift from **how to draw** the graph to **how to interpret and display information** for quick retrieval and through understanding. The choices we have when presenting data, the display features to best convey information, the titling of the axis and the graph all become the topic of the lesson. Students learn that transforming data into useful information is both an art and a science - and an essential skill. This knowledge of graphing will then be available to the student as they gain information in other areas from graphic representations. Uses of graphs for propaganda purposes will become less effective and the public more informed. Unfortunately, these skills are rarely taught in public school classroom and teacher education programs.

Teachers must also be careful when using and selecting teaching materials. Commercial materials often violate these principles and teachers need to be comfortable in identifying when graphs are inappropriate and helping students to make the same identifications. The following graph was taken from commercially available elementary teaching materials. One wonders what the points on the line graph between the zebra and the bear represent and just how fast that hybrid animal is.

This paper has presented considerations and examples for both teacher consideration and translation into curricular issues when teaching about and using graphic output.

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INTERDISCIPLINARY APPROACH FOR INTEGRATING COMPUTER LITERACY IN ELEMENTARY MATHEMATICS METHODS

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The National Council of Teachers of Mathematics Curriculum Standards states "...today's society expects schools to insure that all students have an opportunity to become mathematically literate, are capable of extending their learning, have an equal opportunity to learn, and become informed citizens capable of understanding issues in a technological society. As society changes, so must its schools." (1989, p. 5)

Importance of Computer Literacy in Elementary Mathematics Methods

The recent reform in mathematics education to include the use of computer applications in mathematics instruction has been led by the National Council of Teachers of Mathematics (NCTM). The effective use of computer applications has become a focal emphasis in K-12 schools. Because of this emphasis, teacher education programs are expected to provide future teachers with an education that includes an understanding of how to effectively use computer applications. Across the nation, teacher education programs have addressed this challenge in various ways and at different rates. NCTM publications such as the Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) and the Professional Standards for Teaching Mathematics (NCTM, 1991) provide guidelines for preparing inservice and preservice teachers to teach methematics so that precollege students are provided with the skills needed to successfully compete in the 21st century workforce. The new standards focus on teachers encouraging students to explore and discover information using computer software such as wordprocessors, spreadsheets, electronic mail, and network browsers. Given this current emphasis for computer integration into precollege classroom instruction, the question arises whether the use of computers as an instructional resource should be taught in a separate course or integrated into the current courses. Some researchers have supported the integration of technology across teacher education courses (Brownell & Brownell, 1991; McEneaney, 1992; Schmidt, Merkley, Strong, & Thompson, 1994; Russett, 1995; Wetzel, 1993). The integration across the curriculum provides preservice teachers an exploratory and discovery environment to become confident in their ability to use different computer applications for instructional purposes as opposed to viewing computers as an isolated part of instructional resources. One concern that needs addressing is if the use of computers is not connected to the subject matter, will preservice teachers understand the value of computers as an instructional resource?

Researchers have found teachers' attitudes toward computers affect their willingness to use computer applications in their classroom instruction (Boone & Gabel, 1994; Kluever, Lam, Hoffman, Green, & Swearingen, 1994; Hunt & Bohlin, 1993; McEneaney, 1992; Okinaka, 1992). Therefore, educators must remain focused on how computer applications can be incorporated into the current curriculum. A set of guidelines has been identified (Niess, 1990) that can be applicable to all teachers, regardless of grade level or subject matter, for integrating computer-assisted instruction into the curriculum:

1. Fit the computer to the curriculum rather than the curriculum to the computer,
2. Use the computer as a personal and professional tool, and
3. Use the computer in the learning of subject matter.

These guidelines are important as preservice teacher training programs are modified to incorporate components for training teachers to use computer applications. Such changes will be more effective if the computer becomes a familiar supplemental tool that the teacher considers useful and applicable in their classroom.

Purpose and Objectives

The purpose of this study was to evaluate the effectiveness of preservice teachers' ability to use various computer applications and apply these applications for teaching mathematics, science, social studies, and language arts after completing an integrated senior-level *Block* of method courses. In order to provide a problem-solving environment in the mathematics classroom, elementary teachers must feel confident in their ability to use computer applications as tools for solving problems. Thus, the primary focus of this study was to produce preservice teachers who were computer literate and confident in their ability to use several computer applications as an instructional tool and gather data in an effort to determine how to effectively prepare preservice teachers to use computer applications in the elementary mathematics classroom. Research studies have reported that most preservice teachers entering today's teacher education programs are familiar with using a wordprocessor (Fox, 1996; Sheffield, 1996) more than any other computer application. However, there has been a need to investigate the most effective approach for integrating computer training into preservice education (Waugh & Rath, 1995); specifically, elementary mathematics education. Therefore, the objectives of this study were to expand the current research and (1) assess elementary preservice teachers' computer skills when they enter into the integrated mathematics methods course, (2) determine if elementary preservice teachers' computer skills improve after completing a technology integrated mathematics methods course, and (3) evaluate preservice teachers' ability to develop an opinion of how technology should be used in the elementary classroom.

Method

During two semesters, pre- and post questionnaires were administered to the preservice teachers completing an integrated elementary method courses in mathematics, science, social studies, and language arts. These courses were taught as a *Block* each semester. A questionnaire was designed to assess students' use of computer applications prior to entering the senior *Block*. Students were asked to choose from the following computer applications and to check all that they felt comfortable using: wordprocessor, spreadsheet, e-mail, and World Wide Web browsers. This pre-information was used by the faculty to develop interdisciplinary instruction and assignments emphasizing the effective use of computer applications in the elementary classroom. As part of the course, all students were provided an e-mail account to be used during the semester. At the end of each semester, students completed a post questionnaire. They responded how frequently they used the computer applications during the semester, their post-comfort level on using the computer applications, and their opinion of how they would use these computer applications in the elementary classroom.

During each semester, the students used computer applications to complete assignments in all four method courses. These assignments ranged from using the wordprocessor for lesson plans and spreadsheets for graphing to communicating with peers and completing assignments via e-mail. As an example of an interdisciplinary assignment, an observational experiment and graphing assignment was designed by the mathematics and science instructors. During the Fall semester, the students conducted an observational experiment as part of the science methods and graphed the results as part of the mathematics methods. All of the students were shown how to use spreadsheets and required to use the computer application to complete the assignment. During the spring semester, the same assignment was given and the students were introduced to spreadsheets but were not required to use the computer application to complete the assignment. The purpose was to assess if the students would transfer their computer skills and choose to use spreadsheets even though it was not a requirement of the assignment. At the conclusion of each semester, the post-questionnaire provided the preservice teachers the opportunity to describe their perception of the role of technology in the elementary classroom based on their experiences during the semester.

Results

The students' responses prior to the class and at the end of the class concerning their level of comfort in using the various computer applications are given in Figure 1. As reported in the research, a majority (76%) of the 73 students reported they were comfortable using a wordprocessor when they entered the semester. However, only 31 (42%) reported they were comfortable using e-mail and only 23 (31%) were comfortable using a World Wide Web browser. After completing the *Block* of method courses, the students were more comfortable using all three computer applications.

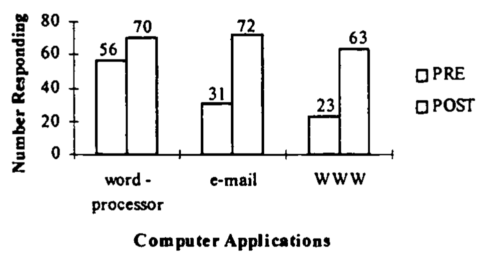

Figure 1. Students' Reported Ability to Use Computer Applications.

The students' pre and post responses for using spreadsheets are given in Figure 2. The purpose for reporting the preservice teachers' use of spreadsheets separately was to compare their reported ability to transfer the use of spreadsheets for instructional purposes based on whether they were required to use the application to complete an assignment.

During the fall and spring semesters, 18 of the 40 students (45%) and 6 of the 33 students (18%), respectfully, reported they were comfortable using a spreadsheet when they entered the *Block*. During the fall semester when the students were required to complete the graphing assignment using the spreadsheet, 78% reported they were comfortable using the computer application by the end of the semester while only 45% responded in the same manner after having the option to choose their method of graphing. Of the 33 students during the spring semester, 13 (39%) chose to use the spreadsheet as a graphing tool even though it was not a requirement. The remaining students turned in hand drawn graphs.

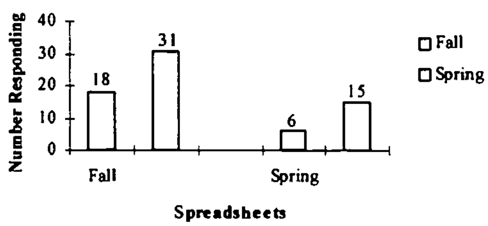

Figure 2. Students' Reported Ability to Use Spreadsheets.

The students' were asked how frequently they used the computer applications during the semester. It was not suprising that all of the students reported they used e-mail and wordprocessors often because so much of their work required them to do so. However, the students' responses to their frequency for using spreadsheets supports the results previously reported. During the fall semester when the students were *required* to use spreadsheets for an assignment, the frequency of use was higher than during the spring when the use of a spreadsheet was optional. The use of a World Wide Web browser was approximately the same during both semesters and this was expected considering the primary use was to option lesson ideas and plans to use in the classroom. The application was not used by the preservice teachers as an instructional tool with the students in the elementary schools.

Table 1.
Frequency Students Report Using Computer Applications During Semesters

	None	Sometimes	Often
Fall 1995			
wordprocessor	0	3	37
spreadsheet	5	6	29
e-mail	0	0	40
WWW	2	22	16
Spring 1996			
wordprocessor	0	0	33
spreadsheet	7	18	8
e-mail	0	0	33
WWW	0	25	8

A content analysis was conducted to determine the preservice teachers' perception of how they would use the computer applications in the elementary classroom. Some of the preservice teachers gave more than one purpose. The results are given in Table 2. The results suggest that the preservice teachers responded based primarily on what they had observed and experienced during the semester. However, the responses relating to using computer applications as an enrichment, remediation, or research tool was not discussed during the semesters. Therefore, these responses reflected the preservice teachers' ability to transfer their knowledge and think about other purposes for using the computer applications in the elementary classroom. Based on informal discussions with the students, a note should be made that the students probably responded based on one or two applications that they felt were *most* important. All of the preservice teachers reported that they felt technology has a place in the elementary mathematics classroom. Even though the question was not asked, many of their responses included a sentence explaining the importance of teachers entering the classroom with confidence to use these computer applications if they expect the students to learn how to use computers.

Table 2.
Frequency of Preservice Teachers' Responses on Role of Technology in Elementary Classroom

Purpose of use	Fall 1995	Spring 1996
Instructional tool with students	30	16
Research tool for students	24	17
Enrichment/remediation for students	11	2
Spreadsheets as a gradebook	38	29
World Wide Web for lesson plans	37	27
E-mail to communicate with teachers	39	30

Summary

The results of this study can assist other preservice education programs as modifications to elementary teacher education programs are made for incorporating the usefulness of computer applications so preservice teachers can enter the 21st century classroom with the positive attitude and confidence needed to teach mathematics in a technological society. The data suggest that it was important to integrate the use of computer applications into the already existing preservice methods courses as opposed to teaching the computer applications as a separate course without connections on how to use the technology in the elementary classroom. Furthermore, the interdisciplinary approach provided the preservice teachers with the much needed emphasis on the importance of teaching mathematical concepts as an integrated topic with other subjects in order to provide precollege students with the understanding and appreciation for mathematics. Based on the preservice teachers' responses, they entered student teaching with experience and knowledge of how to use computer applications in the classroom based on their own experiences and the demonstrations used during the semester. The author is presently collecting follow-up data to determine how frequently the preservice teachers are applying their computer skills in the classroom as an instructional and management tool and transferring their knowledge in order to discover new ways they can use the computer applications.

A note should be made concerning the importance of having an accessible computer laboratory for the preservice teachers to use. This was a major problem during the fall semester because the preservice teachers found the computer laboratory closed at 5:00 p.m. and was normally reserved for instructional purposes during the afternoons. For the spring semester, this problem was slightly improved when the computer laboratory extended the hours of operation until 9:00 p.m. However, the preservice teachers still commented that they do not have easy access to the computers during the afternoons. This is an important concern and should be addressed by preservice education programs before the use of computers are incorporated as a major component of the curriculum.

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AI OR IA: THE CHOICE IS YOURS!.

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In this paper I would like to propose two major categories to use when considering instructional software for use in mathematics education. I have found them to be simple to remember and reflective of much of the current thought regarding uses of technology in mathematics education. Furthermore, they make for an easy way to describe organizing systems for use by in-service teacher candidates. The first of these categories is Artificial Intelligence (AI). The second proposed category is Intelligence Amplification (IA). The same two letters, but reversed, and oh what a difference that reversal makes!

AI and IA: A Working Definition of Terms

AI in Education

AI in education has a lengthy and prominent history. Thanks to the significant impact from the cognitive advances of the last 15 years we are now able to provide integrated learning systems (ILS) of great complexity and power. As systems become more and more powerful, the justification for their use as a teacher replacement model of instruction gains in popularity. It is ironic that some of the findings from the cognitive flexibility lab, which stress the importance of a personal interaction with the material and the role of the teacher as guide and mentor, have been used to create ILS systems with the explicit goal of teacher replacement.

Given the strength of parent perceptions supporting the computer-as-teacher replacement model (Wentworth & Connell, 1995; Harnisch & Connell, 1991), it is not surprising that growth in this area is inevitable. In part this growing trend can be directly traced back to the AI and cognitive philosophy which undergirds much of the AI and computer-aided instruction (CAI) program development. Despite an interest in inner mental representations, most educational AI programs have focused on how to guide a learner across a complex domain area in the same fashion as an expert in that field would guide them. As will be shown, this is diametrically opposite from the IA perspective.

IA in Education

IA in education has a much shorter and less lofty history. To be frank, I believe that as I am using IA it is a new term (having been just coined it for this paper). Intelligence Amplification refers to increases in one's personal understandings and productivity - an amplification of one's native intelligence, if you will. I view this as occurring by using the computer as a tool to construct personally designed and tailored solutions to personally important problems. Here you will note the conscious emphasis upon several themes. First, the problems themselves should be relevant to the student. For those of us in mathematics education this is no surprise as the Standards have espoused this approach since their inception. Secondly, the individual must create his/her own solution taking full benefit from the tools the technology enable. This means creating one's own spreadsheet, for example. It does not mean using a spreadsheet which was created by another. The business of IA as applied to mathematics education is to enable students to create their own methods of solution to important problems, not to be able to use someone else's method to solve a sample case.

Given this different perspective it is only to be expected that this approach is guided by a much different view of the learner than that espoused in the traditional AI model. In AI, as has been previously mentioned, successively accurate working models of an individuals cognitive processes are constructed. These serve as templates to construct intelligent systems capable of teacher replacement for use in instruction. This focus serves a laudable goal for many purposes such as distance learning, stand alone tutoring systems, and ILS programs, to mention but a few.

IA in education takes a fundamentally different approach. In IA, the roles of the machine and the user are reversed. Instead of having a system in which the user responds to the machine, you have a system where the user uses a set of provided software construction tools to actively construct more powerful personally meaningful representations of problem spaces, and tools to work within domains.

Examples

If we take an information-centered perspective, what tools and abilities are necessary to succeed in an information society? How can educational technology be used as a tool in acquiring these? The nature of the "tools" which are provided to students to "think-with" shape their performance and cognitive styles. For example, two-digit division may constitute a legitimate problem when paper and pencil are the only tools available for the student to use, but may no longer be a problem when calculators are available. When a computer is available for the students use, the situation shifts again. A legitimate problem with a computer might involve the identification and selection of what data to include in the problem, identification of the problem goals, and selection of appropriate procedures and control statements to obtain and verify the desired results.

Such use of the computer allows the individual to create a variety of techniques and representations to construct and share developed knowledge and expertise effectively. The computer assumes the role of an active listener that will attempt to do exactly what it is told, as opposed to a pre-programmed instructor requiring a specific type of answer. Furthermore, idiosyncratic working styles and representation techniques may be created and serve as tools for leveraging the user into a knowledge creation mode, as opposed to the knowledge replication mode fostered in AI ILS programs. In addition to providing the students with an opportunity to share their developed expertise, the computer in these settings becomes a tool which encourages the student to engage in sense-making and self-reflection.

If we fail to carefully identify exactly what our desired educational outcomes are, the computer can lead to unexpected problems. In particular, the representation modeled in the system may NOT be one which is advantageous in the broader picture; furthermore, the representation selected by the AI modelers may bear little or no resemblance to that actually used by the learner. This is a weakness in almost every AI program in education. Typically what is done is to model expert performance, which does not include all the dead ends and muck which the expert went through to develop it. The learner in such a system is presented with what represents the end level trace of an incredibly complex act of meaning construction. It is little wonder that so many students tune out of ILS programs.

To see one example of this trend, consider a graphing module used in an AI system described in Goldenberg (1988): "Software that graphs automatically from left to right sweeps over a domain in x without any student involvement and leaves the student active control only over the functions' parameters. In other words, the variable is not variable for the student but the constants are. Because the variable and constants switch roles in many graphic packages, the unthinking use of such software may obscure rather than clarify this difficult concept. ... there is also the possibility that a novice to graphs would dismiss graphs completely as How the computer behaves when you type x's into it."

Although well-intentioned, this proved to be a non-trivial intervention likely to have significant implications, not all of which are advantageous. The very features which contribute to a computer package suitable for a skilled user - speed, accuracy, flexibility, etc. - make it unsuitable for a beginning student attempting to construct an understanding of what is meant by a graph. The computer must be more than a black-box which always gives the right answer or provides the optimal path. The box itself must be transparent and its methods understandable to the student. In an IA system, the students' would have designed the graphing module for themselves (using admittedly a carefully guided construction of meaning) and have a deep understanding of all the assumptions made and the implications thereof.

Discussion

Typically AI programs take a product-centered approach toward instruction and adopt the view that "faster is better" as in "get the student to replicate the expert level of performance as modeled in the AI program as accurately and efficiently (ie, fast) as possible. Within this orientation, educational programs are designed in a fashion to take full advantage of the computer's speed in enabling a student to "produce" the end product as quickly as possible. In fact, such a perspective is clearly reflected in many of the general CAI models of feedback utilized in available educational software. In such programs, the computer provides immediate feedback to students responses to pre-determined questions from within a specified content domain. The tremendous speed of the computer makes it possible for the student to know within milli-seconds whether or not the question was addressed correctly. In general CAI models, this type of immediate feedback is preferred and planned for.

On-the-spot responses may be desirable for learning in content domains that are very restricted and require a high degree of memorization such as learning spelling lists and building vocabulary. However, the immediate feedback produced by implementing this model of instruction is not effective for developing higher order thinking skills. Although the student knows whether or not the answer provided was right or wrong nearly instantaneously, the basis for the decision does not belong to the student. Rather than the justification for the problem's solution being internal to the student, it has become external to the student and belongs to the machine. The computer, in this case, does not provide sufficient time for the student to think about the implications of the problem or to do self-confirmation - two of the more important skills in an information society. To put it bluntly, the computer has done away with the time necessary for the student to think and internalize.

If a student is to internalize and construct meanings from experiences, there must be time to reflect upon the nature of the experiences and how they connect with the students' existing knowledge base. When a student knows within a split-second whether or not a given answer is correct, there is no need for further reflection concerning one's own beliefs, intuitions, prior experiences, relation to other units of knowledge, and so forth. We do not want to reinforce the assumption that all that counts is the correct answer, and yet this viewpoint is being presented literally millions of times each day in numerous CAI programs.

Issues resulting from an inappropriate use of the computers speed of response are not the only items which should be considered in adoption of computers in an educational setting. Programmed learning as typically implemented in AI shells has the unfortunate characteristic of breaking down concepts into bits and pieces to facilitate presentation. From a product-centered viewpoint, fragmentation of curricular elements is viewed as a positive attribute as it contributes to a high rate of correct responses and enables the machine to ascertain right/wrong immediately and to make decisions regarding optimal path of presentation quickly and efficiently (Harnisch and Connell, 1991).

However from an IA perspective great care must be taken in selecting what knowledge units and connections to other knowledge units are presented. In an IA system, the user would construct their own knowledge units and representations, and establish the linkages with other (also student-constructed) tools, representations, and concepts. Despite their ability to model expert performance, AI models often fragment broad conceptual areas into a number of seemingly unrelated special cases to the novice mind. When this is done, we often succumb to the illusion that we are making progress when in actuality all we are doing is memorizing bits and pieces and forfeiting the greater power derived from an understanding of the coherence and relationships between ideas.

Conclusions

The range of problems which are being addressed by computer applications have steadily increased with its uses limited only by the imagination of those who would be users. Concurrently with this general technological growth, there has been an increasing view that the use of technology, in and of itself, will solve many of our problems. However, unless we ask the difficult questions concerning at what point technology enters into educational efforts and the effects upon desired educational values, we run a great risk of misapplication which could seriously damage the educational enterprise; on the other hand, when the goals, values and assumptions of education

- including a careful examination of the role of the teacher
- are carefully considered the adoption of technology may well live up to its promise as a powerful educational tool.

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Visual Descriptions in Layered Languages

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The effectiveness of computer environments in mathematics education is often directly related to the conformity of objects provided by a language to the educational task at hand. But the potential uses of computer technology application are extremely varied. Furthermore, different mathematical models may be mixed when describing complex problems and the objects used to investigate them. This paper will not discuss general problems of using complex objects in development of corresponding models, scientific languages, and representations. We will assume in the paper that the objects are already created and the problem consists in their computer description.

So, there exists a problem: what language paradigm should we use for description of complex many-sided systems? Solution of this problem influences all attempts to reduce natural descriptions to a computer form. In particular questions such as how to work with the software, etc. There are different approaches which have been used to solve this problem. The main one is based on plurality of classes of models that could be represented in some programming paradigms. For example, extremely wide variety of models may be represented in algorithmic paradigm (Wirth,1981). So, one approach might be to teach everyone to reduce descriptions in various applied areas to algorithms.

This is characteristic of classic programming approaches. For example, we can use a single language, say, C as general purpose tool to be adapted to each situation. It is very easy to teach a single language, but then we must study rules for transformation of any models' provided objects to forms we actually use in addressing problems. This can be pictured by imagining the processes necessary to create a program useful for reducing differential equations to a program in C. The algorithmic paradigm could be changed in the reasoning to functional or logical one with the same success.

An alternate approach would use a specialized languages' object set, and software, which would correspond to various paradigms (Floyd, 1979), (Gulliksen, Jonson, Lind, Nyargen & Sandblad, 1993). Then the users can choose the best match between paradigm, language, and software based upon what is most convenient for any given task at hand. This can result in great increases in efficiency. For example, it is faster to code a paper manually in TeX style, then to do it in C, but not so fast, as in WYSIWYG-based languages..

Further development in this direction includes ideas of integrated problem solving systems and a multiparadigm approach as advocated by Budd and Pandey, 1995 and Hailpern, 1986. In this case, the variety of different possible combinations makes it is very difficult to teach and to master different software. But it becomes very convenient to use software system developed for a specific area if one is already working in the field.

Microcontext Approach

The application of System Analysis theory and Object Oriented Design approaches to creating complex objects is becoming more commonplace. Such approaches are now widely used for document's organization (HyperCard and similar), and for linking of relatively big items in modern operating systems (as OLE in MS WINDOWS and others). In this paper we apply a similar idea to languages' and models' hierarchy Prokhorov, 1992-1995.

The essence of the approach might be viewed as:

1. Any information specification (except atomic ones) is regarded as a hierarchic structure, a superposition of more simple ones.
2. Each of the sublanguage-layers is oriented towards a much narrow class of operations, and its set of rules is much compact.
3. For every sublanguage-layer we have: (a) an independent internal idea of the sublanguage, and, (b) an independent form of external representation of the sub specifications (including media type).
4. A few universal actions are presented for each layer, such as (a) creating/viewing/editing, (b) interpreting or/ and translating/compiling, etc.
5. Independent (a) hardware, (b) software may correspond to each phase.

6. There are treaties supporting the multipurpose use of every language-layer, the multiplicity of couples of micro languages, for which the components mentioned in V can be used together.

So, the main idea of the microcontext approach is that we should not find or create "*the* best language." It is better to use a set of specific sub-languages, forming for a particular task a problem-defined hierarchical language. Software corresponding to each of micro-languages should support the descriptions at all stages of the description's life (preparation, interpreting, etc.), dynamically forming software environment for the composite language (as compound editor, compound interpreter, etc. Note, that from this viewpoint, even the simplest programming language (as Pascal, LISP, PROLOG, language of interaction with text processor, etc.) is a complex structure. It would not be considered as procedural, logic, or functional, . . . language, but a multiparadigm one.

This nested object approach is very effective for application in education. One can imagine the study of common languages consisting of dissecting common languages to single-paradigm atomic sublanguages. The basis of that part of curriculum may be a study of basic paradigm principles' set out of particular languages. Further, it is useful to search identical basic sublanguages in common languages to better understand a particular language's nature. Furthermore, it is fruitful to consider the set of basic language paradigms when hierarchical task's model or representation is developing.

Ideally one would have software supporting the layered approach with independent layers, so we could connect each with other in arbitrary combinations. Note, that this unifying idea may be applied to all levels of models hierarchy consideration, from low to top-level philosophy about complex problems (Figure 1).

Pythagoras Media

The main elements of such a microcontext layered technology are realized in the PYTHAGORAS media. This program has currently been developed in two versions, for MS DOS and WINDOWS. This media provides ease of use for the beginner plus extreme power for the more experienced user.

Characteristic features of PYTHAGORAS include:

- support of several programming paradigms on the top levels (algorithmic, functional, and syntactical ones),
- support of the microcontext multilanguage technology, that allows to use sublayers of the language, supported by another environments.
- inclination to graph descriptions with animation, speech, and sounds,
- wide use of a game component,
- high success of use the same software by both little kids and Academy researchers.

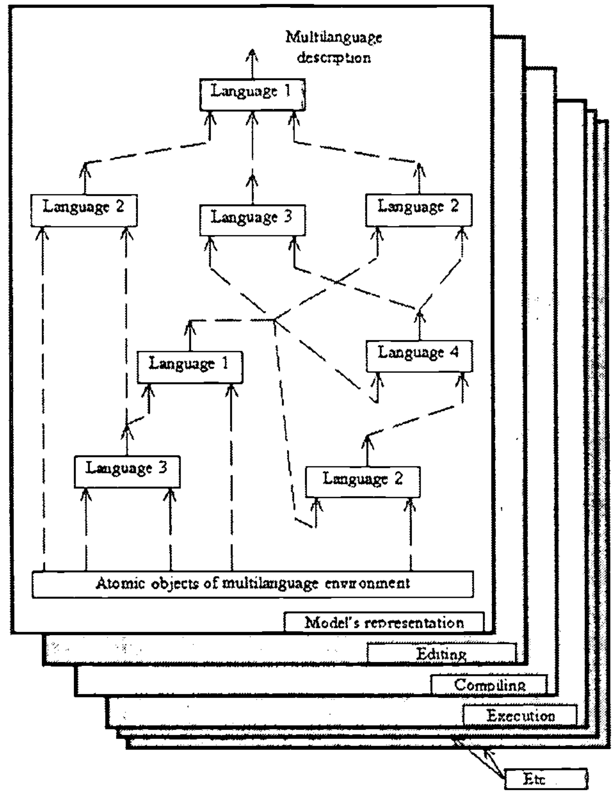

Figure 1. An example of a general chart of languages' relations.

Depending upon the available hardware, PYTHAGORAS supports several internal layers (algorithmic, formulae and syntactical languages, language for descriptions of data types, turtle graphics, etc.), and is open to attach arbitrary external software to form sublanguages. Note, that attached software, supporting a sublanguage, may operate on far computer, accessible through Internet or/and LAN.

Included in the supported graph languages are methods for structured descriptions of algorithms, data types, formulas and syntax in the media with both internal and user-defined objects denoted by icons. Some simple programs might be built without use of any text descriptions at all. So, a student could handle PYTHAGORAS based solely upon visual thinking (Stooder, Taylor & Macie, 1995), (Raeder, 1985).

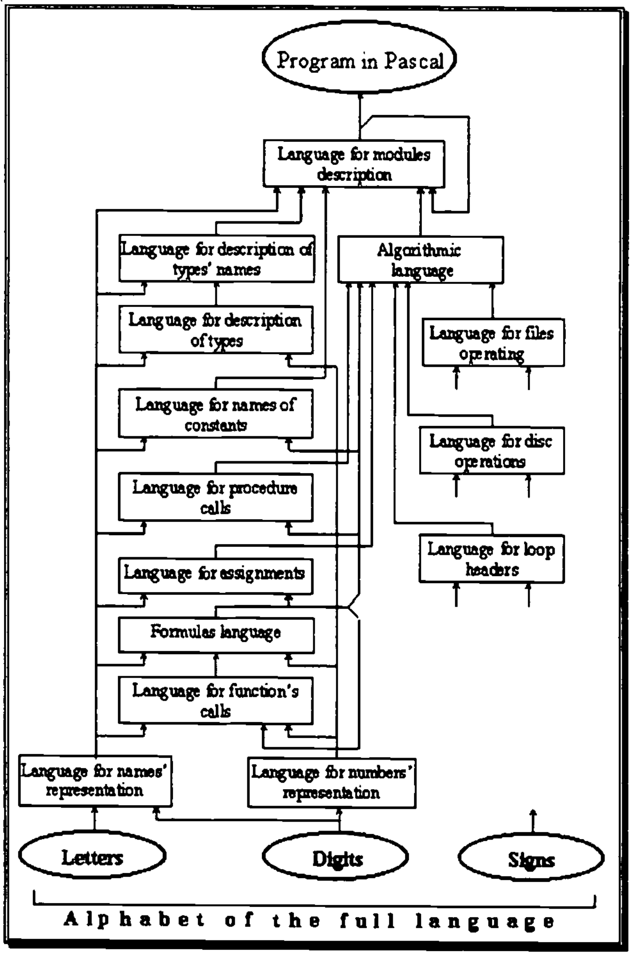

Figure 2. PYTHAGORAS showing top layers of multilanguage program with distant components (the icons with the char C denote minimized sub-modules in parallel C for a distant multiprocessor machine).

PYTHAGORAS orients student to use a top down approach to design (Reek, 1995) as their primary approach. Nevertheless, the bottom up approach is still possible: a student may use early developed modules (for example, procedures) for new modules' creating later, more powerful representations which could be modules created in another environment.

Applying the open microcontext technology in PYTHAGORAS allows the use of the algorithmic language of PYTHAGORAS as meta-language for any external languages. If we have properly defined the sublanguage, then we can use objects created in any sublanguage as common operators of the program. PYTHAGORAS will automatically starts the corresponding editor when we edit the operator, it will then start the corresponding compiler and initiate the corresponding interpreter during the execution phase.

So, the program appears to the user as a unified multilanguage program, not as separate modules. New sublanguages can be created by the assignment of software forming a subsystem of editor, compiler, and executor. Examples of subsystems would be the software supporting graphics or sounds, and subsystems to use external equipment such as multimedia or computer based laboratory apparatus. Application of this technology allows to work in most suitable environments for any special part of many-sided problem. In addition to this openness to attach external tools, PYTHAGORAS may be successfully used alone too, because of sufficiency of base components for first steps.

Algorithmic and Formulae Language Layers

Two kinds of operator sublanguages are currently available. The first one is the language supported by built-in compiler and interpreter. A student could easily use a graphic algorithmic language as top layer of PYTHAGORAS (Prokhorov, 1988), (Parker, 1995). The second currently available supported language produces a graphic version of C. Development of the software to support graph versions of C++ and JAVA is currently in progress.

The algorithmic layer of PYTHAGORAS supplies visualization with animation of the next objects and processes:

a. a chart of a program (scenario),
b. a process of the program's creating,
c. a process of the program's execution in a program's chart;
d. a process of environment's change during the program's execution, for example, results of a turtle's activity, as in LOGO (Papert, 1981).

When a program is running in the ordinary mode, the program will be executed as in common programming environments. If a program is running in a mode with executor's visualization in children metaphor, the turtle graphics' commands will be executed with moved turtle or pencil, and will be accompanied by corresponding sounds.

The Game Component in PYTHAGORAS

Gaming components increases students interest (Kölling, Koch & Rosenberg, 1995). PYTHAGORAS currently allows many enjoyable metaphors to be used for the algorithmic chart's representation. These include math graph, railroad, catacomb and others. A student can choose various metaphors of representation of the same program in different times, as he/she likes. For example, railroad metaphor is very fascinating for young children: in this metaphor, an algorithm is represented as aggregate of road-beds with railways switches, stations and so on (see figure). Creating a program is accomplished by using a set of tools, associated with the used metaphor. For example, a bulldozer represents the tool for deleting a chart's element. To force the game component for young students, we use animating cursors while moving on the desktop.

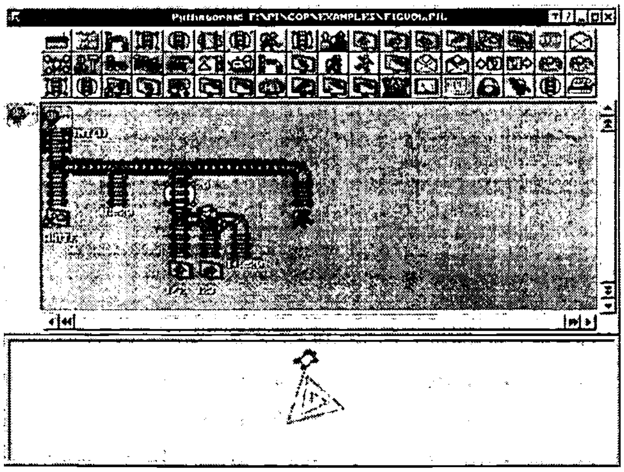

Figure 3. Game metaphor in PYTHAGORAS: execution of a program in animation mode.

On of the most fascinating aspects of running a created program chart is the animation mode. In this case, he/she will see the activity of a "program's supervisor" on the screen. For example, in the case of railway metaphor, a student can see an engine with moving toy, instead of formal pointer. When a program is running, the engine is guided by the tracks, that is chart of the program. The engine is stopped side by side "stations," corresponding to executable operators (that is, terminal nodes of the program's tree). The commander leaves the engine, and makes an order to the executor, for instance, a turtle. The order is accompanied by speech and flight of command's icon from the executor to the turtle. After the executor actualizes the command, the commander goes back into the engine, and the engine then moves further. The engine stops side by side railways switch and turntable too. In this case, the commander asks the executor about environment's state (for example, about color under the turtle), waits an answer (accompanied speech and flying icon), and makes a corresponding choice. In a case of sub-procedure's call, the chart window is switched to the sub-procedure; the commander moves on that chart, and then returns after the called sub-algorithm be finished.

So, generally the algorithmic layer of this educational use of PYTHAGORAS reflects the metaphor of the "writer"/"commander"/"executor" triplet. A student could see visual separation and interaction of the commander and executor. There are two animations on the computer's screen, during execution of a program in the PYTHAGORAS. These ones are: an animation of the program's execution (commander's activity), and transformations of the environment (executor's activity).

Experience of the Approach's Application in Education

The multi-metaphor layered approach was applied over five-six years in curricula in Ural State University (Computing Mathematics), Ural State Tech University (System Engineering, and Information Technologies), Regional Evening and Summer Schools for Talented Children, Ural Institute of Humanities, and others. The approach is used as the base of curriculums.

PYTHAGORAS was used to teach pre-school children. Kids of five or six years old enthusiastically mastered the media. The experience shows, that use of PYTHAGORAS for children really transforms boring "programming" into a very fascinating game; actually, children sense the media handling as kind of game. However, even young children understood basic ideas of algorithm programming at this earliest stage of interaction and created relatively complex programs during this "game."

A version of the media was used as the only environment at the National Team Olympiad in Computer Science. Mastering PYTHAGORAS was one of the main problems at that 12-hour Olympiad. Participants (four high-school students per team), had to develop the popular Russian game TETRIS in PYTHAGORAS, but no student was familiar with this environment before the competition. Participants had demonstrated a progress in utilization of the approach and media, including usage of sub-systems. A quarter of the teams had developed working versions of the game.

Concurrently, a version of the media is used for development of complicated multiparadigm multi-component complexes. As example we would refer to a system for airplane's flight modeling (including atmosphere, plain dynamics, control system, etc.) in multi-machine distributed computing environment on the base of PCs, local network, INTERNET, and powerful multiprocessor computing machine. Hence, students may to create distributed programs in PYTHAGORAS, using LAN and INTERNET resources.

So, the same software might be used successfully by different groups of users: pre-school children, scholars of all ages, university students, and Academy researchers.

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Videotaping Lessons: Enhancing Conceptual Change in Preservice Mathematics Teachers

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This study investigates students' beliefs about the teaching of mathematics as revealed in their review of the video tapes made of lessons they taught. The results indicate that video taping had an impact on preservice teachers' ability "to examine and revise their assumptions about the nature of mathematics, [and] how it should be taught?" (NCTM, 1991). As part of a larger study involving a cohort of elementary education preservice teachers, students in an elementary mathematics methods class were videotaped three times, in their first lesson, a middle lesson, and their last lesson. The first tape identified one student as using constructivist methodology in her work with elementary students. When interviewed during a review of the video tape she expressed concern that she was "not doing 'it' right." She felt that her lesson was a failure because the students were having a hard time learning the concept she was teaching. The researchers reviewing the video and the preservice teacher's interview about the video were surprised at her reaction to her instruction. They felt that she was using constructivist practices that had been taught in the mathematics methods courses. This study follows this preservice teacher through her three video sessions and talk-alouds to see if her beliefs about her practice change towards the *Standards* or if she begins to change her practice away from the *Standards*.

Theoretical Framework

Since the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics* (Standards) (1989) and *Professional Standards for Teaching Mathematics (Professional Standards)* (1991), preservice programs for teachers of mathematics have been reevaluated in terms of how well they meet the specified goals being proposed. The *Professional Standards for Teaching Mathematics* (1991, p.160) states as objectives that preservice programs for teachers of mathematics should:

a. examine and revise their assumptions about the nature of mathematics, how it should be taught, and how students learn mathematics;
b. observe and analyze a range of approaches to mathematics teaching and learning, focusing on the tasks, discourse, environment, and assessment;
c. work with a diverse range of students individually, in small groups and in large class settings with guidance from and collaboration with mathematics education professionals;
d. analyze and evaluate the appropriateness and effectiveness of their teaching; and
e. develop dispositions toward teaching mathematics. (p. 160)

Videotaping has been shown to help with these objectives. Over a decade ago McConnell and Fages (1980) found that the self-confidence of pre-service teachers increased after receiving videotaped feedback on their teaching. Anderson, Frager, and Boling (1982) found that students who viewed videotaped sessions of reading instruction demonstrated more effective teaching techniques than those who had used role playing to improve instruction. Volker, Gehler, Howlett, and Twetten (1986) used videotaping instructional modules to help their students evaluate the behaviors of classroom students. The review of videos has been shown to increase the depth of reflection and self-analysis using the ideas and questions of others (Lasley & Matczynski, 1995). Sweeder and Bednar (1995) saw videotaping as an aid in reducing student anxiety and promoting student achievement. This study seeks to analyze the use of videotaping lessons of preservice teachers and the value of having the preservice teachers review the tapes with their instructor to examine what they saw in their instruction. Does this process change the preservice teachers beliefs about the NCTM *Standards* and their instruction?

Method

At the onset of an elementary mathematics methods course, 18 cohort students completed a Likert-type instrument designed to measure beliefs towards mathematics, specifically towards *Standards*-based reform ideas, the Standards' Beliefs Instrument (SBI) (Zollman & Mason, 1992). All students were videotaped (Erickson, 1986) at least three times for their mathematics methods class. The lessons videotaped were initially with a small group of elementary students and then with a whole class of elementary students. Mathematics lessons were taped later when the preservice teachers were actually student teaching. All students were asked to talk-aloud (Kagan, 1992) about what they saw in the video. The talk-alouds were taped sessions in which the student observed the video-tape of their teaching and responded aloud to it, commenting on anything that they thought about as they were watching themselves teach. These talk-alouds were conducted as soon as possible following each videotaping. Additionally, the student was interviewed with an open-ended interview (Mishler, 1986) immediately after the methods course was completed and then toward the end of student teaching. These interviews contained questions specifically designed to elicit honest comments about factors identified as potentially influencing the acceptance and implementation of the NCTM *Standards*. The talk-alouds and interviews were tape recorded and transcribed. Analysis was based on comparisons between students across identified factors as well as patterns that appear as the research progressed (see Ball & McDiarmid, 1988 for a similar research design). At the end of the methods course, the students retook the SBI survey and the scores were compared to see if students' beliefs towards the *Standards* had changed.

Change in Beliefs

The SBI scores of the students in the cohort group are listed in Table 1. (The line in bold is of a student who will be discussed later.) In all but one case the scores dropped indicating that the students had improved beliefs about the NCTM Standards. (Lower scores are a positive response to the Standards.) The highest change in score was 12 points and the lowest positive change was 2 points. One student had a score that went up 6 points indicating a negative effect of the class. The student with this score had been the most resistant to the videotaping and other assignments in the course. The mean change was 6.2 points and a two-tailed t-test comparison of the pre- and post-test scores was significant.

Because videotaping was not the only aspect of the class, a major question of this study is what impact the videotaping had on the change in students beliefs. The talk-alouds and the final interviews gave some insight into the importance of the videotaping in the changed beliefs of the students.

During the talk-alouds students made several comments about their dislike of the videotaping. They mentioned being self-conscious during these lessons. They did not like having the video camera in the room as they taught. It made them worry about things other than the lesson they were teaching. One student said, "There was a problem with the tape. We were trying to figure how to get it taped over, and we couldn't tell if it was recording or not. The light wasn't on, that is usually on when it is recording. And yes, I do look odd. We'll try not to think about that." Another student worried about how the elementary students responded to the camera. She said, "I think the kids are talking so quietly today. Maybe it's because of the video stuff." At the end of one talk-aloud one student commented, "Well it's no fun watching yourself. You get caught up in watching your physical appearance and you are thinking 'Oh my gosh, I shouldn't do this and do that.' But, um, I guess I felt positive about it." Most of these types of comments were made at the beginning of the talk-alouds. After the preservice teachers and elementary students became accustomed to having the equipment there, they seemed to forget about it. Then the preservice teachers were able to focus on their instructional practices.

Table 1.
Student SBI Scores

Student	pre-test score	post-test score	change in score
1	35	23	12
2	35	32	3
3	33	25	8
4	32	28	4
5	31	21	10
6	31	19	12
7	31	29	2
8	31	22	9
9	31	37	-6
10	31	22	9
11	30	27	3
12	30	23	7
13	30	23	7
14	29	25	4
15	29	21	8
16	29	21	8
17	29	23	6
18	27	20	7
Mean	30.7	24.5	6.2

P(T<=t) 9.5E-06

The preservice teachers had many comments about the videotaping in their final interviews. Most students did not see value in the videotaping. One student commented to the interviewer that she didn't like the videotaping and having to watch herself on video. She didn't see any purpose in this at all. She felt it would have been more helpful to have an "expert" sit with her, so she could learn something from it. Or she would have appreciated more direction for critiquing herself. This student, in her first talk-aloud did not mention mathematics at all. She commented on the students, discipline, how she looked in front of the group, but nothing about the subject of the lesson. Her comment to the interviewer was that she didn't understand the purpose for the videotaping or the talk-alouds after them. She, along with the others in the course felt like guinea pigs—just running through mazes and seeing no purpose in what they were asked to do. One student did seem to understand that the videotaping was done not just for research purposes, but as part of her learning when she said, "Videotaping was not just part of the research. But that's part of the educational process, although the professor would use that for research later." This same student did not always enjoy the videotaping. She also said, "A lot of people resented doing [the video-taping] because it was like a video factory, video cameras everywhere. It disrupted the students because there were cameras in their classrooms."

The comments from the talk-alouds and interviews do not support a positive change in beliefs about the Standards coming from the practice of videotaping. However the researchers noticed that the practices of the preservice teachers supported *Standards*'- based instruction as the course progressed. A look at one student helps to explain how the videotaping and talk-alouds encouraged the preservice students to change their instructional practices.

Importance of Talk-Alouds in the Change in Beliefs

In viewing the first video tapes, the researchers determined that the instructional practices of the preservice teachers matched their belief in the *Standards*. This was not true of Ann. Ann was a student identified early as having average feelings about the *Standards* in the original SBI survey. Ann's SBI score of 31 was just at the average of the 18 students, expressing beliefs neither strongly for nor against *Standards*-based reform. Her final score was 21, a strong change of 10 points. The review of Ann's first video identify her as using the *Standards* in her instruction, and her talk-aloud identified her as one who thought she was "doing it wrong."

Ann's first taped lesson was one that she had prepared only 30 minutes before she presented. In the lesson Ann asked the students to discover the concept of equivalent fractions through manipulatives. On the video the students were comparing shaded parts of a circle. One circle was divided into two equal pieces with one piece shaded and the second circle is divided into four equal pieces with two pieces shaded. Ann asked the students which shaded part of the two circles is bigger. She asked one boy, "If both of these circles were pot pies which shaded part of one of the pies would you want?" When Ann was talking about this part of the tape she said, "I could have probably done a better job of explaining why two-fourths is the same as one-half. I didn't deal with the numbers very much, I just dealt with the size." Later she said, "Here they understood what they were saying, but I think that if I could have shown them that six-twelfths was a half of a whole bar, just like a half bar was a half of a whole bar, I think that would have been more effective in helping them understand equivalent."

The researchers who viewed Ann's initial tape in this study commented on how well the lesson met the NCTM *Standards*.During her talk-aloud Ann was concerned that she did not tell enough. However the researchers agreed that her lesson allowed the students to discover the concept. She seemed to know that the students understood the concept, but she was concerned that she did not explain the concept to the students.

As the semester continued, Ann taught another lesson and talked about it. The researchers looked at the video to determine if she had changed her instruction to telling. They also listened carefully to her talk-aloud to see if she had become more confident in the students' abilities to construct an understanding. The researchers and cohort leader spent much time discussing how to help this preservice teacher recognize the *Standards* in her instruction and value the methods that were so natural to her. In her second talk-aloud Ann talked about what she saw in her instruction, and she began to comment that the students did not need to be told everything. Ann said, "Mary wanted me to tell her the name of that shape, but I wanted to stress the point of the lesson which was that they look at the shape. At the end I wanted them to know the attributes of the shapes, not just the name, but why some shapes are the same, have the same name. I find that in teaching I have to make so many decisions in teaching about what to tell students and what not to tell" She expressed the concern that she could not listen to every group of students as they discussed the shapes. She knew that some students were working on task thinking and discovering the ideas of the lesson. She also worried about the social noise. At the end of the talk-aloud she said, "They saw a lot about the shapes. There was good participation." The preservice teacher began to trust her students' abilities to discover. The researchers felt that Ann was moving in the direction of changing her views of the *Standards*. Early in her lessons she taught by the *Standards* but did not trust what she was doing. Later Ann continued to let students work in groups to discover meaning and she valued the process. She trusted the ability of the students to discover. She trusted the process of the *Standards*.

Conclusions and Significance

Most students' videos showed a match between their instruction and their beliefs in the *Standards*. Ann's story was unique in the class because she was strong in her methods initially, but only average in her belief of their value. Her SBI score started in the middle of the class, neither strong nor weak, but in reviewing her lessons from the videos, she felt she should teach against the *Standards*. As she continued to view her videos, she expressed delight in the methods of the *Standards*, in the discovery that her students could make. As the researchers and cohort leader discussed the possible fac tors that helped the preservice teachers change their views of their practice, they began to believe that one key factor in the change was self evaluation. Telling Ann how to teach would not teach her what to do any more than her telling the elementary students about fractions would teach them about fractions. Conceptual understanding for the pre-service teacher occurred in the same way conceptual understanding occurs for her students, with hands-on, discovery learning. The combination of investigating both concepts of mathematics and concepts of instructional practice together may have aided the conceptual change of the pre-service teacher in both areas more than learning about just one or the other separately.

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Appendix
Standard's Beliefs Instrument

The items in this questionnaire refer to the teaching of mathematics. For each item, fill in the mark for the response that describes your opinion. Work quickly, but be sure to consider each item individually. Any item you do not understand, please leave blank.

Mark "A" if your answer is STRONGLY AGREE
Mark "B" if your answer is AGREE WITH RESERVATIONS
Mark "C" if your answer is DISAGREE WITH RESERVATIONS
Mark "D" if your answer is STRONGLY DISAGREE

____ 1. Problem solving should be a SEPARATE, DISTINCT part of the mathematics curriculum.
____ 2. Students should share their problem solving thoughts and approaches WITH OTHER STUDENTS.
____ 3. Mathematics can be thought of as a language that must be MEANINGFUL if students are to communicate and apply mathematics productively.
____ 4. A major goal of mathematics instruction is to help children develop the belief that THEY HAVE THE POWER to control their own success in mathematics.
____ 5. Children should be encouraged to justify their solutions, thinking, and conjectures in a SINGLE way.
____ 6. The study of mathematics should include opportunities to make connections of using mathematics in **OTHER CURRICULUM AREAS.**
____ 7. The mathematics curriculum consists of several discrete strains such as computation, geometry, and measurement which can be best taught in ISOLATION.
____ 8. In K-4 mathematics, INCREASED emphasis should be given to reading and writing number SYMBOLICALLY.
____ 9. In K-4 mathematics, INCREASED emphasis should be given to use of CLUE WORDS (key words) to determine which operation to use in problem solving.
____10. In K-4 mathematics, skill in computation should PRECEDE word problems.
____ 11. Learning mathematics is a process in which students ABSORB INFORMATION, storing it in easily retrievable fragments as a result of repeated practice and reinforcement.
____ 12. Mathematics SHOULD be thought of as a COLLECTION of concepts, skills and algorithms.
____ 13. A demonstration of good reasoning should be regarded EVEN MORE THAN students' ability to find correct answers.
____ 14. Appropriate calculators should be available to ALL STUDENTS at ALL TIMES.
____ 15. Learning mathematics must be an ACTIVE PROCESS.
____ 16. Children ENTER KINDERGARTEN with considerable mathematical experience, a partial understanding of many mathematical concepts, and some important mathematical skills.

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MATH-PLACE: The Impact of Technology and Alternative Assessment in Educational Reform

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Pamela Freeman
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The approaches for solving mathematical problems have changed with technological advances and there is a need for reform in teaching techniques, the curriculum, and student assessment procedures. The MATH-PLACE - Measuring, Analyzing, and Training Heuristically: Professional Learning Assessment, Computer, and Equity Education - project was funded at Mississippi State University through the Learning Training and Networking Teacher Design Center Program offered through the Institutions of Higher Learning. MATH-PLACE was designed to provide inservice teachers in grades K-4 and 5-8 with instructional strategies to address the integration of technology and alternative assessment methods in the mathematics classroom.

During the past decade, research results have confirmed that a new direction for mathematics education is needed - a direction that empowers students with critical-thinking skills to reason and to solve problems more efficiently and effectively. For example, researchers have reported that students learning mathematical concepts using computer applications such as spreadsheets (Dugdale, 1994) score higher on tests and are more interested in learning mathematics (Palmiter, 1991). In order to prepare students for the 21st century, teachers are experiencing changes in mathematics curriculum and instruction to include manipulatives, computer applications, and open-ended assessment techniques. Unfortunately, there are inservice teachers who have not been provided the opportunity to receive the proper training in educational reform methods and strategies for implementing the instructional techniques as described in the National Council of Teachers of Mathematics Curriculum and Professional Standards (NCTM, 1989; NCTM, 1991, NCTM, 1995) and Goals 2000 (1994). Thus, the basis for the project described in this paper was to provide inservice teachers with opportunities to improve their mathematics instruction in kindergarten through the eighth grade using manipulatives, technology, and alternative assessment strategies.

Just as students should be provided a problem-solving environment (NCTM, 1989), it is essential to provide inservice teachers a problem solving training environment for learning how to identify, explore, and solve problems using manipulatives and technology. As teachers begin to learn how to redefine the kinds of tasks students do in the classrooms and employ hands-on materials, calculators, and computer applications, adjustments in alternative assessment techniques must follow (Hembree & Dessart, 1992). Assessment (testing) as practiced today arose because very efficient methods were found for assessing large numbers of individuals at low cost (Mathematical Sciences Education Board, 1993). Rather than the traditional objective test (short-answer, multiple choice, or true-false test), teachers must be trained to develop and implement new alternative assessment models to reflect that students have learned to reason, create models, prove theorems, and argue points of view (Carl, 1995). According to the Mathematical Sciences Education Board (1993), assessments that allow for a broad focus on technical criteria and are appropriately rich in breadth and depth provide opportunities for students to demonstrate their deep mathematical understanding.

Objectives

Inservice teachers may be aware of the research results; however, they are still overwhelmed and have difficulty integrating new teaching techniques into the current curriculum while meeting required school goals and assessment requirements. Therefore, the objectives of this project were to:

1. Develop a teacher training and networking center for Mississippi school districts in order for teachers to improve their professional skills,
2. Provide intensive professional development for grades K-4 and grades 5-8 teachers on using and incorporating hands-on instructional manipulatives, computer and calculator applications, and alternative assessment methods in an integrated approach.

Inservice Teacher Training

MATH-PLACE was the beginning of a mathematics teacher training center and resource laboratory at Mississippi State University. In order to meet the objectives stated above, the center provides inservice training on the latest issues in mathematics education and serves as a resource laboratory for teachers to borrow manipulatives and portable computers for use in their classrooms. The center managers are two mathematics education professors and a graduate assistant at Mississippi State University. The usual checkout time period for manipulatives is one week while the computers can be borrowed for as long as three weeks. All of the resources in the center are inventoried using a spreadsheet and placed in the laboratory cabinets and shelves based on the commonalties for use in the classroom. Even though the teacher training workshops focus on inservice professional development, the laboratory can be used by preservice or inservice teachers. The preservice teachers use the resources during practicum methods courses and student teaching.

During the summer, a brochure describing the project and containing an application was sent with a cover letter to school principals within a ninety mile radius requesting their recommendations and endorsements for three of their teachers to attend the MATH-PLACE workshops. A total of 32 inservice teachers in grades K-4 and 16 inservice teachers in grades 5-8 participated in the project. The workshops were scheduled on the first Saturday of each month, alternating between the two groups of teachers. It was important to provide separate workshops for teachers in grades K-4 and 5-8 in order to effectively address the teachers' needs and provide the participants an opportunity to network with other colleagues from various school districts. If a teacher attended all three workshops for their appropriate grade level, they received a stipend, continuing education units, handouts of classroom activities and alternative assessment strategies involving manipulatives, calculators, and computer applications, and a manipulatives sample kit. The instructors for the workshops were teams consisting of university professors and inservice teachers. This was an important component that served as a "bridge" between the university and elementary schools. Even though it was beneficial to provide training to the teachers based on grades taught, the enrollment of teachers in grades 5-8 was lower than anticipated. In an effort to address this issue, future recruitment efforts for recruiting teachers of these grade levels could include one hour presentations or inservice professional development sessions at the schools to demonstrate the topics to be explored during the workshops.

Workshop Content

It was not possible to simply demonstrate new instructional tools and expect the teachers to be able to effectively integrate these into their instruction. The integration of hands-on manipulatives and technology in the classroom was necessary and, as a result, the proper training of teachers included modeled instruction using the instructional tools for teaching specific concepts that could be transferred into the teachers' *real* classroom of instruction. The use of hands-on instructional tools such as Cuisenaire rods, pattern blocks, and base ten blocks provided the teachers with new ideas of ways to provide students a problem solving environment in the mathematics classroom. The teaching strategies implemented during the workshops were focused in the areas of geometry and algebra because these topics are often neglected yet the applications are much more meaningful in the presence of technology.

Technology

The technology training consisted of computer-aided demonstrations on how to use selected computer applications, followed by the participants being actively involved in hands-on exploration using the various computer applications. The model used to train the teachers was a self-regulatory model that allowed the participants to work at their own pace. The technology training was based on the IDEA (Identify, Define, Explore, Assess) Model developed by Cardelle-Elawar (1993), which focused on elementary students having the opportunity to identify and define the problem, explore the software for solutions, and access the needed tools for solving the problem. This approach was selected as a model for training inservice teachers because the strategies reported in the research were successfully used in the elementary classroom. Therefore, it was feasible to use the same model for training inservice teachers in hope they would be more likely to transfer the methods into their own classroom instruction.

Computer-aided instruction and strategies for promoting a problem-solving environment using computer applications in the mathematics classroom were provided. It was not enough to demonstrate to the teachers how to turn on the computer and *use* an application or piece of software in an isolated activity without demonstrating how to incorporate the application into lessons that were designed to promote problem solving. It takes time to develop and become effective in learning not only new teaching strategies but also in modifying current teaching and alternative assessment strategies to meet local, state, and national goals. Therefore, the instructional component of the workshops consisted of "modeled" lesson plans using various spreadsheets, the World Wide Web, and educational software. In addition, the teachers learned how to use the spreadsheet as a gradebook and an instructional tool. Following the demonstrations, the teachers explored their options and completed selected activities using their choice of calculators and computer software.

Because technology has become a common component in the classroom, it was essential to provide the teachers with an evaluation process for selecting appropriate software for their instructional purposes. Based on prior experience, the workshop leaders selected educational software that had been rated favorable and non-favorably by preservice teachers based on the user-friendly capabilities. The purpose was to provide the inservice teachers the opportunity to compare and contrast the characteristics of educational software and report why they would or would not select the software for use in their classroom. Each teacher was provided a software evaluation form for rating the usefulness and user-friendly characteristics of the software.

Alternative Assessment Strategies

As closure to each training session, teachers were provided the necessary training in implementing more open-ended assessment techniques as recommended by the NCTM Standards. Initially, alternative assessment methods were discussed and participants identified the methods they felt would be most successful in their own classroom for meeting the new challenges involving the use of manipulatives and the ever-changing technology in the mathematics classroom. Then, each teacher completed various alternative assessments based on the instructional components presented during the workshop. A follow-up will be sent to the teachers during the 1997-1998 academic year to determine whether the teachers are implementing in the mathematics classroom the instructional and alternative assessment methods discussed during the workshops.

Although it is important to consider how differences in opportunity can affect students' success, it is equally important to be aware of how the integration of technology and assessment methods can affect students' opportunities to learn important mathematics. The current mathematics educational reform involving the integration of technology has resulted in different teaching and assessment strategies being ***randomly*** implemented in classrooms without a central focus on different grade levels. Thus, the uses of alternative assessment results of technology should be scrutinized for their impact on both students' opportunities to learn and schools' capacities to provide instruction consistent with the vision of mathematics education. The ever-changing developments in technology, cognitive psychology, and mathematical pedagogy will continue to create challenges for teachers as they attempt to modify their teaching techniques to include the use of different teaching tools and methods.

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Linear Algebra With MATLAB Package In Preservice Teacher Education

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The psychological theoretical foundation of this paper is the theory of stage-by-stage development of mental actions (SSDMA theory) elaborated by the Russian school of psychology (Leontyv, 1972; Galperin, 1979; Talizyna 1975, 1979). In the paper presented by M. Bouniaev (Bouniaev, 1996) at the 7-th International Conference of Society for Information Technology and Teacher Education the general ideas of applying fundamental ideas of the SSDMA theory to computer based instruction (CBI) were discussed. It was also shown by M. Connell and M. Bouniaev (Connell &Bouniaev, 1996) that recommendations for CBI based on the ideas of modern constructivism and SSDMA theory are very similar.

In this presentation we dwell on the applications of this general approach to the particular case of teaching linear algebra with MATLAB package to preservice teachers. Since a lot of linear algebra concepts can be tracked back to K-12 mathematics, it is important for preservice teachers to learn about different software packages along with psychological foundations of developing learning strategies that can be used for teaching such topics as systems of linear equations, matrices etc.

Unfortunately, the SSDMA theory, experimentally proven and universally accepted in Russia is practically unknown in the USA. So we have to explain at least very briefly some notions and ideas of the theory. The SSDMA theory determines methods of analysis of the instructional process and selection of appropriate strategies. According to it, a major goal of instruction is developing mental actions with objects of the studied field.

All actions can be referred to two categories: general logic actions and specific actions. Examples of such type of actions are qualification (quadratic forms qualification) or break up into classes (break up all matrices into two classes: singular matrices and nonsingular matrices), comparison (compare symmetric entries in the matrix), etc.

Specific actions are basically inherent to a given subject field. For example, in linear algebra they are: finding a solution of the system of linear equations, finding eigenvectors and eigenvalues, etc. We'll consider here in greater detail the action of finding eigenvalues and eigenvectors.

As a rule, the performed actions themselves consist of other, more primitive actions, which in their turn can be part of other actions. Actions that are part of a given whole, are called operations. For example, action of finding linear combinations of rows is an operation of the action of finding solution of a system of linear equations. That is, operations are also actions, hence the term "operation" implies only the hierarchical subordination among actions. Goal of an action and an action object are attributes of any action.

Analysis of component operations of any action shows that they perform different functions. Some part of performing an action is taken up by preliminary work, a plan or preparation for an action in a certain sense. This preparatory part is called orientation part of an action. The performance itself is called the executive part of an action. Analysis of actions and experiments carried out in this regard shows that there also exists a control part which takes place after the executive part is performed and the student compares the results achieved in the executive part of the action with the goals of the action and the draft plan of the execution planned in the orientation part.

In this presentation we consider as an example the development of action of finding eigenvalues and eigenvectors. It is natural that performance of any action depends on environment and tools allowed to be used. Our assumption is that students perform the action in MATLAB Notebook. MATLAB Notebook is a combination of MATLAB package and Microsoft Word wordprocessor. Working in the MATLAB Notebook environment students can use MATLAB commands as well as write and edit explanation on the same screen. They can save results of their work and use them for future studies. In the process of developing the action of finding eignevalues and eigenvectors we use not only MATLAB commands, but also M-files (Leon, Herman &Faulkenberry, 1966; Hill&Zitarelli,1966)

Since we are discussing not just a problem of action performance but first of all how to teach actions performance we have to rely on a textbook. We used the textbook of Steve Leon (Leon, 1994) . We also useed MATLAB syntax, for example the matrix [4 -2;1 1] is a matrix with the first row 4 -2 and the second row 1 1.

Actions Of Finding Eigenvalues And Eigenvectors In MATLAB Environment

In this section will discuss the structure of the action of finding eigenvalues. The object of this action is square matrix A, let us say A=[4 -2;1 1]. The goal of the action is to find all scalars m such that for some x Ax =mx (definition of eigenvalue) . Bellow we give the operational composition of the action of finding eigenvalues . We also give substantiations for all operations because we need them for the further discussion. We do not discriminate such suboperations as creating objects in working environment.

Scheme 1. Operational Composition Of The Action Of Finding Eigenvalues.

I. Orientation Part Of The Action - Plan Of The Action.

Operation 1. We substitute the problem of finding all scalars m such that for some x Ax =mx with problem of finding all values of m such that (A-mI) x =0 has a nontrivial solution. This operation has the following substantiation. The theorem (Leon, 1994) states that m is an eigenvalue of A if and only if (A-mI) x =0 has a nontrivial solution.

Operation 2. We find all values of m such that det (A-m*I)=0. Since the action of finding conditions under which Bx =0 (in this case B=A-mI) has a nontrivial solution was developed earlier, the following theorems (Leon,1994) are substantiation of this operation.

Theorem 1.4.3. Let A be a square matrix. The following are equivalent: a. A is nonsingular. b. Ax=0 has only trivial solution 0.

Theorem 2.2.2. A square matrix A is singular if and only if det(A)=0

Operation 3. Evaluation of det(A- mI) will give us polynomial ChP(A) - characteristic polynomial of A.

Operation 4. The solution set of characteristic equation ChP(A)=0 forms the set of all eigenvalues.

Operation 5. Creating object of the action in working environment. In our environment we type MATLAB command A=sym('[4 -2;1 1])

All other operations are developed according to the plan of action.

II. Executive Part Of The Action.

Operation I. Substitution of expression Ax =mx with expression (A -mI)x=0. The objects of this operation are: matrix A , matrix mI, matrix H=A-mI. We have to create this object using MATLAB commands.

Operation 2. Determining for what values of m Hx=0 has a nontrivial solution (this action was developed earlier). As well as in the previous operation the major part of this operation consists from creating objects of the operation in the working environment. Operation's objects are: matrix H, ChP - characteristic polynomial of matrix A, ChE - characteristic equation of matrix A. Performance of the executive part of this operation (substituted with MATLAB command "solve ChP") shows that 3 and 2 are eigenvalues of matrix A.

Teaching Linear Algebra In MATLAB Environment

Analysis of the linear algebra course and MATLAB package shows that a lot of actions to be developed in the process of instruction have their computerized representationes (or models) as MATLAB commands or M-files.

Teaching linear algebra based on SSDMA theory and using MATLAB package consists of developing at each stage of instruction a particular group of actions in the assumption that their operations are already developed at a sufficient enough level and therefore may be substituted by appropriate MATLAB commands (M-files).

Regarding the example of action of finding eigenvalues we can state that all the operations of the executive part of the action have already being developed at the previous stages of instruction. Actually the most important part of the action to be developed is the orientation part of the action including substantiation, and of course, the action itself as a whole. Developing the action as a whole we first should expose and develop it in the operation-by-operation mode.

The SSDMA theory gives prescriptions for subject content analysis, how to organize and structure the learning material, as well as the algorithm for developing the action itself. One of the important and hard parts of subject content analysis to do for CBI is organizing the hierarchy of actions to be developed: actions of lower level are operations for actions of higher level, and creating their computerized models.

Thus for developing the action of finding eigenspace for the given iegenvalue, the actions to be developed (an action of lower level in the action hierarchy) and have computerized models are the following.

1. Action of finding eigenvalues of given matrix. Computerized model in MATLAB - command "eig(A)".
2. Action of entering different matrices into MATLAB .
3. Actions of performing arithmetic operations with matrices in MATLAB.
4. Action of finding nullspace of a given matrix H. Computerized models in MATLAB - command "null(H)" or M-file "homsoln(H)".

In the assumption that all the operations listed above were developed at the previous stages of instruction, developing the action of finding eigenspace for a given eigenvalue consists mostly of developing the orientation part of the action (including substantiation). Let us illustrate it with an example of operational composition of the action of finding eigenspaces.

Scheme 2. Operational Composition Of The Action Of Finding Eigenspaces.

The action object is square matrix A (let us say A=[4 -2;1 1]). The goal of the action is to find all linear independent vectors x such that for given eigenvalue m Ax= mx .

I. Orientation Part Of The Action - Plan Of The Action

Operation 1. Find all eigenvalues. MATLAB command eig(A) can be used . Fix one eigenvalue m.
Operation 2. Find the basis for the solution set of system Ax=mx . Substantiation: definition of eigenspace corresponding to the given eigenvalue.
Operation 3. Substitute Ax=mx with (A -mI)x=0. Substantiation: system (A -mI)x=0 is equivalent to Ax=mx.
Operation 4. Since solution space of (A -mI)x=0 is equal to nullspace of matrix H=(A -mI) we find nullspace of H. Note that this operation was developed earlier and therefore may be substituted by MATLAB command "null" or "homsoln".
Operation 5. Creation object A= [4, -2;1 1].

II. Executive Part Of The Action.

Operation 1. Performance of MATLAB command eig(A) gives value m =3.
Operation 2. Substitution system Ax =mx (m=3) with system (A -mI)x=0 (m=3).
The operation's objects are: matrix A and matrix H=A-3*I. We create them in working environment by typing MATLAB commands I=eye(2) and H=A-3*I .
Operation 3. Finding nullspace of matrix H (M-files "null" or "homsoln" are used). As the result of performaning this operation we obtain vector $v=(2.1)^T$ that forms a basis of eigenspace corresponding to eigenvalue m=3.

Now we fix m=2 and repeat operations 2 and 3 with this value of m .

III. Control Part Of An Action.

Operation objects are matrix A, vector $v=(2.1)^T$, and number 3.
Operation 1. Evaluation of A*v (in MATLAB)
Operation 2. Evaluation of 3*v.
Operation 3. Comparison of A*v and 3*v.

Development Of Action At Different Stages Of Instruction

The SSDMA theory singles out 5 stages in the process of instruction.. Here we will briefly outline them.

First Stage Of Instruction

At the first stage the student gets necessary information about goals, objects and operational composition of the action to be developed. The orientation, executive and control parts of action are defined as well. SSDMA theory specifies four independent characteristics of any action used to judge the level of development of an action. One of them is the degree of completeness which indicates if all the operations that were to be performed have actually been completed, including the operations of the orientation part of action with substantiation. . This demonstrates the ability to perform any action in operation-by -operation form . Therefore in presenting the material to the students we must do it also in operation-by-operation form.

Let us consider further the example of developing the action of finding eigenvalues and eigenvectors. At the first stage of instruction it is important to connect abstract notions with the images and hand-on activity. For this purposes we can use ATLAST M-file "eigshow" (Leon, Herman &Faulkenberry, 1996). The program gives graphical demonstration of geometric eigenvalue/ eignevector relationship . Working with the program students can find eigenvalue and eigenvectors belonging to this eigenvalue before they have formal definitions.

Based on the graphical demonstration the instructor gives the formal definitions of eigenvalue, of eigenvector, of eigenspace corresponding to m, characteristic polynomials, characteristic equation.

Then the instructor provides students with the operational compositions of the actions of finding eigenvalues and eigenspaces (Scheme 1 and scheme 2). The first action to be developed in the operation-by-operation form is the action of finding eigenvalues. The second action to be developed is the action of finding eigenspaces. Since the action of finding eigenvalues is an operation of the action of finding eigenvectors , the action of finding eigenvalues can be substituted by MATLAB command eig(A).

Second Stage of Instruction

As we have already mentioned the SSDMA theory specifies four independent characteristics of any action used to determine the level of development of an action. We have already discussed the completeness of an action that is the ability to perform all operations in operational composition of action without skipping any operation.

Probably the most important characteristic of an action is the form of an action. An action can be in the materialized (material), speech or mental form. The materialized form of action is connected with manual activities (manipulation, hand-on activities, etc.). Objects of action (or their models) are presented in the material form, results of action should be real transformations of these objects or their models.

The second stage of developing an action deals with students performing actions in the material or materialized form. As we wrote students can use M-file "eigshow" in combination with formal calculations. In MATLAB Notebook environment they can also use a mouse for pasting the objects-blocks and transferring them to a different place on the screen. This enables students to perform transformation actions with models of objects of the studied actions.

Since it is important for instructional process at this stage that students discriminate all operations as well as objects those operations are aimed at, we give them for homework traditional exercises that can be found in any textbook but insist that actions be performed in the operation-by-operation mode.

Example Of Homework Problem. Find eigenvalues for each of the following matrices. Then find all eigenspaces . You can use the copy features of MATLAB Notebook.

Students can copy all the theorems and definitions that already exist in their own notebook. We give the students the hard copy of scheme 1 and scheme 2 and computerized schemes 1Home and 2Home. Since schemes 1Home and 2Home are interactive versions of scheme 1 and scheme 2, we give here an example of just one of them. We put three question marks to show that this is the students' working space where they are supposed to copy or to type the answers. In the parentheses we write comments whenever appropriate.

Scheme Home. Action Of Finding Eigenvalues Of A Given Matrix

Action object: ??? (let us say A=[4 -2;1 1]

Goal of action: ??? (to find all scalars m such that for some x Ax =mx)

Substantiation of action goal ??? (definition of eigenvalue, students are supposed to type it here for the first exercise and copy for others).

Orientation Part Of Action - Plan Of Action.

Operation 1. We substitute the problem of finding all scalars m such that for some x Ax =mx with the problem of finding all values of m such that (A-mI) x =0 has a nontrivial solution.

Substantiation: ??? (Students create their own MATLAB notebook in the process of developing any action and therefore usually they have all theorems that substantiate actions of the lower level in the action hierarchy. Students are supposed to copy all the theorems that substantiate the operation from their own notebook).

Operation 2. We find all values of m such that det (A-m*I)=0.

Substantiation:???

Operation 3. Evaluation of det(A- mI) will give us polynomial ChP(A) - characteristic polynomial of A.

Operation 4. All solutions of characteristic equation ChP(A)=0 form the set of all eigenvalues.

Operation 5. Create the object of action in working environment. ???

Executive Part Of Action

Operation 1. Substitute expression Ax =mx with expression (A -mI)x=0. What are the objects of this operation:???

Operation 2. Determining for what values of m Hx=0 has a nontrivial solution.??? What are the objects of this operation:??? (matrix H, ChP - characteristic polynomial of matrix A, ChE- characteristic equation of matrix A)

What MATLAB commands or M-files do you use: ??? (MATLAB command "solve ChP").

What conclusion did you make:???

Control part of the action can be substituted with M-file eigshow.

The Third Stage of Developing an Action

The third stage of developing an action is that of speech form, both in its oral and written variant. And the possibilities provided in this case by MATLAB Notebook are hard to underestimate. It not only enables students to express their thoughts in a written form but also connects them with models of the action constructed at previous stages of instruction. It should be noted that "show" or "proof" exercises of Leon's textbook provide good material to develop actions in the written (speech) form.

For the same lesson the following types of exercises that require written explanations can be assigned.

1. Show that the eigenvalues of a triangular matrix are the diagonal elements of the matrix.
2. Let A be a square matrix. Prove that A is singular if and only if 0 is eigenvalue of A. etc.

Students write the explanation , if appropriate they do some experiments. To substantiate proves they copy in appropriate places statements of the theorems and definitions they use.

Fourth And Fifth Stages Of Instruction

The fourth and fifth stages are very similar. At the fourth stage the action should be developed in the inner speech form. It must be developed in the operation-by-operation mode with all the operations performed separately. Thus it is essential in organizing instruction to provide the students with the opportunity to describe in a compressed form the operations performed. MATLAB commands and M-files may play this role of compressed expression of an action performance.

The fifth stage is development of an action in the mental form. The action at this stage becomes an inner mental act with only the product of this action explicitly evident and observable. Assimilation of the action at a given level of compression and generalization becomes a matter of top priority in developing the action at this stage.

At this stage of instruction students are supposed to make conjectures based on the experiments in MATLAB environment. There are some special matrices in the ATLAST Computer Exercises for Linear Algebra (Leon, Herman & Faulkenberry, 1996) that provide good material for these experiments. Computer can perform certain operations at the student's command. Therefore performance of this time consuming but necessary action can be taken over by a computer.

Another function a computer can be assigned is presentation of the same type of problems and control over their solutions (drill-and-practice) . It is important to remember that at this stage the action should be developed in the compressed form. And, finally, MATLAB Notebook provides new forms of recording students activities thus substantially increasing motivation at a given stage.

Conclusion

1. MATLAB Notebook is a very convenient (and important from the standpoint of SSDMA theory) tool to develop actions in both written and materialized forms. The result of each computer session is fixed in the Notebook as a meaningful text with MATLAB commands or M-files.
2. Basic ideas of the SSDMA theory can be implemented successfully in teaching linear algebra using the software package MATLAB and the related published materials such as Linear Algebra Labs with MATLAB"(Hill & Zitarelli, 1996) and ATLAST Computer Exercises for Linear Algebra (Leon, Herman & Faulkenberry, 1996).

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The Role of Technology in Lesson Planning: The Case of Preservice Teachers

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This paper describes preservice teachers' ideas of how technology can be used to help high school students develop an understanding of the mathematical concept under consideration. The subjects in the study were the five preservice teachers enrolled in the methods course, Teaching Mathematics with Technology. The analysis of the lesson plans developed by the subjects revealed the differences in preservice teachers' ideas of the role of technology in their lesson planning. Some teachers planned to use technology to enhance their lesson while others planned investigations in which students would use technology to explore mathematical ideas.

Introduction

The NCTM *Standards* (1989) maintains that the appropriate integration of technology will "transform the mathematics classroom into a laboratory...where students use technology to investigate, conjecture, and verify their findings...[and] the teacher encourages experimentation" (p. 128). In this context, teachers often become students as they struggle with understanding technology and its pedagogical implications (Norman, 1993). Indeed many universities address this need by offering preservice teachers methods courses in learning how to use technology to teach mathematics.

We teach such a course to preservice middle and high school mathematics and science teachers as part of their professional preparation. During the past several years, we have observed through their prepared lesson plans that preservice teachers have considerable difficulty in successfully integrating technology into instruction so that students are able to construct their own knowledge of the mathematical concept under consideration. Too often in their planned lessons and activities, these novice teachers did not fully utilize the additional power that technological tools offer the mathematics classroom, focusing instead on automated manipulations that served only to keep students occupied.

Klimick-Schoaff (1993) suggests a step-by-step procedure that may help teachers to develop lessons that effectively use software or calculators in the classroom. This procedure includes (i) analyzing technology to determine its attributes; (ii) finding corresponding problem-solving strategies and then deciding on the types of questions that can be answered through the use of the technology tool; and (iii) studying the syllabus to determine what topics might benefit from this approach. Based on our experience, it is Klimick-Schoaff's second step that has emerged as a common obstacle among preservice teachers. Therefore, this study focuses on preservice teachers' ideas and choices of problem-solving situations and investigative strategies, as well as their decisions on how technology can be used to help high school students construct their knowledge of mathematics.

Method

Subjects

Five preservice teachers who took the methods course, *Teaching Mathematics with Technology*, at a large southeastern university participated in this preliminary study. This methods course addresses three important areas of technological competence for preservice middle grades and high school mathematics teachers. 1) The use of technology to support and enhance professional productivity, information access and transfer, and collaboration and communications. 2) The use of technology to support and enhance student-centered learning by actively involving students in mathematical investigations and problem solving activities that promote mathematical reasoning and critical thinking. 3) The use of technology to promote conceptual understanding of content specific knowledge found in the middle grades and high school mathematics curricula. Computers and calculators are used with a variety of tools including the Internet, Geometer's Sketchpad (GSP), NuCalc, EXCEL, Claris Works, HyperStudio, and Calculator-Based Laboratories.

All of the preservice teachers in this methods course were within two semesters of their student teaching practicum. During the semester the participants were asked to write a lesson plan to teach a particular mathematical concept or the concept of their choice. Based on one of the objectives of the course, the expectation was that they would incorporate technology into a lesson plan of their choice. These lesson plans were collected and analyzed to determine the preservice teachers' ideas of the role of technology in their teaching. In particular, their ideas of using a spreadsheet, GSP, the Internet and the graphing calculator were analyzed in depth. Because of the space limitation we chose to report here only the analysis of the teachers' lesson plans using the GSP software.

Analysis and Results

It was our purpose to analyze the investigative activities developed by the preservice teachers as part of their lesson plans. Frobisher (1994) has classified general investigative processes into four categories. These four categories of investigative processes are Communication, Reasoning, Operational, and Recording. Frobisher (1994) described these categories as follows: *Communication processes* involve students in explaining, talking, agreeing, and questioning. *Reasoning processes* have students engaged in collecting, clarifying, analyzing, and understanding within their investigations. *Operational processes* included those of collecting, sorting, ordering, and changing. *Recording processes* were described as drawing, writing, listening, and graphing.

These four categories contribute to Frobisher's (1994) final category, *Mathematical processes*, that involves the students in guessing, pattern-searching, interpolating, extrapolating, predicting, conjecturing, testing, hypothesizing, generalizing, or proving.

We adapted Frobisher's (1994) five categories of investigative processes by adding some additional descriptors to code our data. A code of Communication Process was assigned to the part of a preservice teacher's lesson plan if it required the student's involvement in explaining, talking, agreeing, questioning, discussing, or writing. Reasoning Process was assigned if the lesson plan required the student's involvement in classifying, comparing, contrasting, analyzing, understanding, defining, or organizing. Operational Process was used when the lesson plan engaged the student in collecting, sorting, ordering, changing, dragging, transforming, constructing, or selecting. Recording Process was assigned when the student was required to engage in drawing graphs and figures, writing (numbers, words, symbols), listening to information, creating tables, measuring, observing, or labeling. Finally, Mathematical Process was assigned to a piece of data if the student was asked to engage in guessing, pattern-searching, interpolating, extrapolating, predicting, conjecturing, testing, hypothesizing, generalizing, or proving. Each sentence of the preservice teachers' lesson plans was analyzed for evidence of any of these five processes. From our definition of the categories, it is clear that more than one code could be assigned to the same sentence of the lesson plans.

After coding the data for each teacher, we summarized the number of times the students were asked to engage in each of the five processes. From that summary, two distinct groups of lesson plans emerged, casting technology in the roles of lesson enhancer or investigative tool. Qualitative analysis of the relationship among the investigative categories further clarified preservice teachers' ideas on the role of technology in designing investigative activities:

1. Preservice teachers plan to use technology to enhance the presentation of information in their lessons

The lesson plans in this category were characterized as teacher-centered plans, with technology used as a lesson enhancer. The data from these plans were categorized as requiring students to predominantly record information (listen, watch, and/or write) generated by the teacher and the computer. There were few operational processes included in the enhancer plans, and these operational processes were controlled by the teacher. Little or no communication processes were included in this type of plan, and the few reasoning processes that were included were judged to be disconnected from the recording and operational processes of the planned activity. An example of an enhancer lesson plan is shown in Figure 1, where technology is used as part of the teacher's lecture about circumference and area of a circle.

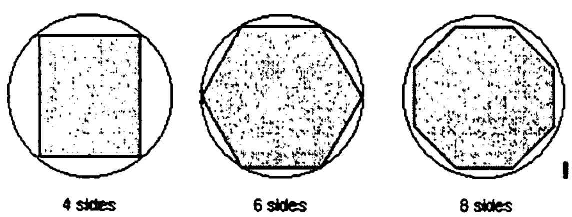
2. Preservice teachers plan investigations for their students to explore mathematical ideas

These lesson plans involved the students in a learning context that reflected their active involvement with the technology to pursue investigations related to learning mathematics. The students were engaged in more operational and recording processes than those plans in the enhancer category. To a lesser degree, the investigation plans involved students in communication processes, reasoning processes, and mathematical processes. Further analysis revealed two main subgroups that were distinct from each other based on the complexity of the lesson plan. Complexity was defined by the number of times the students were asked to engage in reasoning processes or mathematical processes. Complexity was further defined by the connections established within the lesson plans between the operational/recording processes and the reasoning/mathematical processes.

Simple investigations. Lesson plans in this subgroup mainly asked students to use technology to construct figures. Simple investigations involved students in making just one conclusion or observation from the constructions. Some of these simple investigations were somewhat trivial. Others required students to draw a conclusion that was somewhat disconnected from the preceding operational and/or recording processes. In this second case, we questioned whether students would be successful in drawing the desired conclusions. Stated another way, the planned use of reasoning or mathematical processes resulted in a lesson that was disconnected to the preceding operational and/or recording processes. Figure 2 is an example of a simple investigation in which students are asked to make only one conclusion from the operational and recording process of constructing a perpendicular bisector [operation - record - operation - record - operation - record - reason/mathematical].

Circumference and Area of a Circle

The first topic we are going to discuss is the circumference of a circle. What do you think of when you hear the word circumference in dealing with circles? For instance do you think of the interior or exterior of a circle? Most of you would probably say the exterior which is correct. What is the difference between the circumference of a circle and the perimeter of a polygon? Well yesterday we defined the perimeter of a polygon to be the sum of the lengths of its sides. It is rather obvious that a circle has infinite sides, so we are unable to call it a perimeter. To give you an example of this here are several polygons inscribed in a circle. You notice as the polygons have more sides it looks more and more like a circle.



As we said before circles have infinite sides. This limiting number of sides is defined to be the **circumference** of the circle.

The next topic we are going to discuss is the area of a circle. Now that we have concluded that the circumference deals with the exterior of a circle then area must deal with the interior of the circle. What do you think of when you hear the word area? What does it mean when someone tells you to stay in your own area? It means you have that entire section, but no more. Basically everything included in the boundaries that are set forth, What do you think is the difference between finding the area of the circle and the area of an inscribed polygon, The philosophy is very similar to the difference in perimeter and circumference. The areas of inscribed polygons get closer and closer to limiting number, and this limit is defined to be the area of the circle.

What would you expect to happen to the perimeter and the area as we increase the number of sides of the polygon? Remember what we talked about earlier. A circle has an infinite number of sides. For example using some trigonometry we found that a 4 sided polygon has a perimeter of 5.66r and an area of 2.00r^2. What do you suppose the perimeter and area would approach as we increase to a 20 sided polygon? We are going to approach the circumference and area for a circle which are approximately 6.28r and 3.14r^2. The exact values are given by the formulas below.

Circumference: 2*Pi*radius
Area of a circle: Pi*radius^2

Note: 3.14 or 22/7 are only approximations so, be careful when solving problems if the problem asks for an exact value.

Figure 1. An enhanced lesson plan.

Investigation: Point on a Perpendicular Bisector of a Segment

In this activity you will investigate the relationships of points on a perpendicular bisector of a segment to the endpoints of that segment.

Sketch
Step 1: Construct segment AB with its midpoint C.
Step 2: Construct line K perpendicular to AB through point C (this line is called the perpendicular bisector of AB).
Step 3: Construct two arbitrary points D and E on the perpendicular bisector K.

Investigate
Measure DA, DB, EA, and ED. Do you see a relationship? Drag the points to various places on like K. Are the relationships that you previously observed still maintained?

Conjecture
Write your conjectures below.

____
____
____
____

Present Your Findings
Discuss your results with your partner or group. To present your findings you could print a captioned sketch showing the points on the bisector to the segment and the measurements that illustrate your conjectures.
Explore More
Construct triangles by connecting DA and DB creating triangles DAC and DBC. Can you make any observations about the relationships between these two triangles? Move point D to various positions on the perpendicular bisector. How does this affect the relationships of the new triangles?

Figure 2. Simple investigative activity.

Complex investigations. Investigations were deemed complex when there were a number of different processes that were planned to engage the students. Figure 3 presents a complex investigation of polygons with respect to pattern finding and generalizing a formula for the sum of the measures of angles in a polygon. The plan required students to construct, measure, and make a conjecture several times in succession, beginning with a triangle. Plans that characterized more complex investigations required more reasoning and mathematical processes and these processes were sequenced to follow an episode of construction and recording. [i.e. operation - record - reason/mathematical; operation - record - reason/mathematics; etc.]

Discussion

Given the dual role of computers as a computational and instructional tool, it is important to understand how preservice mathematics teachers plan to use technology in their teaching. Some preservice teachers see the computer as a drawing or computational tool to enhance their lectures or class presentations. Others envision a classroom where technology is used for students to investigate mathematical ideas. However, this preliminary study finds that preservice teachers' ideas about investigations are qualitatively different. The simple investigations for students tended to emphasize constructions and measurements using the GSP, with few instances of communication, reasoning, or mathematical processes. Less common among preservice teachers' ideas of investigations was the notion that each construction and the related measure(s) were tied to an instance of reasoning and/or mathematical processes. Also, we conclude that communication processes are not seen as important in the plans in comparison with the other four processes.

Investigation: Polygon Angles

Construct a triangle, ABC, and measure each of the three angles. Drag various parts of the triangle and watch the measures of the three angles. Write down any observations you make. Use Calculate to confirm your conjectures.

Now repeat the same activity using a quadrilateral, a pentagon, a hexagon, a heptagon, and an octagon. Construct a table to organize your observations. You might want to include a column showing the number of sides of each polygon,

Triangle

Quadrilateral

Pentagon

Hexagon

Heptagon

Octagon

Each polygon listed above can be subdivided into non-overlapping triangles. Go back to your sketches and determine the number of non-overlapping triangles that would cover each polygon, Add this information to your table.
Can you determine a formula for the sum of the measures of the angles in a polygon using the number of triangles covering each?

Figure 3. Complex investigative activity.

The translation of this research to our practice is the next step in our preliminary study. More specifically, we plan to have the preservice teachers use these five processes to evaluate lesson plans written by other preservice teachers, as well as their own plans. We conjecture that these teachers' pedagogical investigations may prove to be another powerful learning experience on how to teach using technology.

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The Influence of Technology on Teachers' Ways of Knowing Mathematics

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During the early stages of an investigation of the integration of technology into teacher thinking using Shulman's teacher knowledge framework (Shulman, 1986), it became clear that the ways in which teachers know their subject are an important influence on their teaching approaches, that learning with technology is likely to produce a change in ways of knowing, and an understanding of this change can form a useful part of a teacher's pedagogical content knowledge.

The variation in ways of knowing amongst different individuals may be studied in relation to many factors. One set of factors concerns the individual's identity in terms of, for instance, gender and culture. Another set concerns the educational environment experienced in terms of school ethos, curriculum, pedagogy, resources, and relationships with other learners. Of particular interest at present is the study of variation in ways of knowing according to the extent and nature of technology use in learning. For many years now, teachers have been encouraged to use technology in their teaching for a variety of reasons, the main ones being to bring about improvements in learning traditional subjects, to reduce the number of qualified teachers needed, and to improve learners' skills in applying technology to worthwhile problems.

We shall explore the first of these reasons, and in particular, how improvements in learning mathematics may be brought about by exploiting technology's power to support more powerful and flexible ways of knowing mathematics. We shall also consider the implications for teachers' knowledge if they are going to be able to use these ideas in the classroom.

Ways of Knowing

Most epistemological positions in current research into the learning of mathematics allow for individuals to know the same piece of mathematics in different ways. What makes a group of people feel that they are talking about the "same" piece of mathematics is a relational structure which is common to the ways in which they individually represent the knowledge. They can communicate these relationships amongst the members of the group by means of a shared system of terminology and notation. This feeling of sharing and agreement is sufficiently strong amongst expert mathematicians that many believe that the piece of mathematics exists independently of their individual mental representations, their social interactions and the physical signs they use. However, all the research evidence concerning the difficulties which novices have in understanding mathematics indicates that they do not easily gain a feeling that they share the expert's knowledge of mathematical structure. In fact, for any particular concept or technique, learners exhibit different ways of knowing, not just different amounts of knowledge. Experts are likely to know a concept in multiple ways, and are able to switch their thinking to the most appropriate form of knowledge when solving problems. In particular, expert teachers of the subject are able to switch amongst the several possible ways of knowing which their students may posses, in order try to understand each student's thinking and work towards the objective of a shared understanding.

These different ways of knowing are characterised by the variation in conceptual relationships, the imagery, the analogies, the learned facts and the algorithms which each individual uses to make sense of the piece of mathematics, both in pure mathematical terms and in terms of its applications to problems in other domains. I suggest a number of categories of ways of knowing a mathematical process or relationship:

- static verbal (SVe): the knower can state a relationship in words
- static visual (SVi): the knower can visualise a relationship or recognise it in a visual image
- dynamic visual (DVi): the knower can represent the generality of a relationship or process through the visual perception of variation

- passive algorithmic (PA): the knower can follow a procedure for carrying out a process (this may involve conscious attention to the process, or the process may be carried out as an automatized routine)
- active algorithmic (AA): the knower can be construct a general procedure for carrying out a process
- inductive (I): the knower can recognise a relationship from a pattern of values
- deductive (D): the knower can deduce a relationship from the structure inherent in a situation

These categories have been identified by analysis of detailed published findings from the UK (Hart, 1982; Assessment of Performance Unit, 1984) and of my own observations in classrooms (Kennewell, 1996) and when working with student teachers. Only some of these will be applicable to any particular piece of mathematics, and the appropriate categories will depend on the nature of the mathematics involved. In order to illustrate these categories, the following topics have been chosen randomly from a typical curriculum for mathematics. The suggested ways of knowing are either drawn from the sources given above, or are derived from the theory and represent possibilities to be investigated.

Examples

Rational Numbers. These may be known as the division of a whole object into parts (DVi); as a subset of a set of objects (SVi); as the result of a division calculation (PA); as a pair of numbers with called numerator and denominator (SVe).

The Area of a Triangle. This may be known as the number of unit squares and parts of squares (SVi); as a rearrangement of two copies of the triangle to form a parallelogram or rectangle (DVi); as a formula to be applied (PA); or as a relationship which is necessarily true between the length of any side and the corresponding altitude (D). It may also be known by making many different triangles by cutting and arranging copies of a piece of paper with known area, and then calculating ½ x base x height for each one (I).

The Distributive Law in Simple Algebra $a(b+c)=ab+ac$. This may be known as an algebraic rule: removing brackets (PA), as a concrete rearrangement of manipulatives/dots/ shapes (DVi), or visual combination of them (SVi); as the fact that if one adds together two numbers, and then multiplies the result by a third number, the result is the same as if one had multiplied each of the two numbers separately by the third, and then added the two results together (SVe); as a pattern of results from many separate calculations (I); by writing a Logo program to systematically evaluate each expression and compare the result for different combinations of numbers (AA); or as properties of numbers and operations which can be deduced from definitions/axioms (D).

Pythagoras' Theorem/Rule. This may be known as a procedure, viz., to find the longest side of a right-angled triangle, square the lengths of the two other sides, add together, and square root the result (PA). A further, separate algorithm for finding one of the shorter sides may be known as well. Alternatively, it may be known as a relationship expressed verbally, such as: the square on the hypotenuse is equal to the sum of the squares on the other two sides (SVe). The same relationship may be known geometrically, by means of a dissection of the largest square to form shapes which can be rearranged to make the two smaller squares (SVi); or even as a dynamic image whereby the smaller squares undergo isometric transformations so as to form components pieces of the large square (DVi). It may be known inductively from many drawings and measurements produced within the class (I); and may even be known by a proof using Euclidean axioms and inferences (D). A few may know it as a special case of a more general principle concerning regular shapes drawn on the sides of a right-angled triangle (D).

Maximum and minimum values of a quadratic expression such as x^2-4x+3. Again, this may be known algorithmically, either as a procedure involving completion of the square of a linear term in x and then merely identifying the constant term (PA); as an application of differential calculus involving the equating of the derived function to 0 and then substituting the resulting value of x (PA); or as a situation which is susceptible to the weak method of trial and improvement (AA). Alternatively, it may be known graphically - the function is symmetrical about its minimum value, and so its minimum value is therefore obtained by substituting the value of x which is half way between those at which it cuts the x-axis (SVi).

Of course, the same individual may know such a piece of mathematics in multiple ways. Indeed, the development of mathematical expertise is characterised by an increasing richness of conceptual structure, rather than merely an increasing extent of knowledge.

Objects of Mathematical Thought

In addition to the ways listed above which all involve an articulated representation of the relationship or process, a piece of mathematics may be known as an object of mathematical thought (Sfard, 1991) or a "procept" (Tall, 1995). This is a encapsulated, holistic mental representation of a relationship or process which the knower may operate on as a single item within a more complex problem or structure, yet will still be able to articulate the process or relationship when appropriate. Thus a person who knows the particular processes and relationships listed above as objects of thought will be able, without working through algorithmic procedures, to:

- recognise that a rational number may be represented as a position on a number line;

- find the area of a complex shape by splitting it into separate triangles;
- interchange expressions of the form a(b+c) with their equivalent form;
- write an expression for the modulus of a vector;
- write down the value which makes an expression maximum or minimum.

This way of knowing has been named reification (Sfard, 1991), and is of great importance in developing more advanced concepts which subsume the relationship or process in question. For our five example topics, the more advanced concepts might be measurement of continuous quantities, finding the area of a circle, factorisation of algebraic expressions, vector algebra, and graph sketching, respectively.

Accordingly, reification is the aim of much teaching effort. However, attempts by teachers to convey knowledge of such mathematical objects directly lead to inappropriate ways of knowing which I would describe as premature reification. One example of this "fruit salad algebra" (Küchemann, 1978, p. 26) where learners are taught simplified expressions such as

$5a + 3b - 2a + b$ by thinking of a as an apple and b as a banana. It has been suggested by Küchemann and others that such ways of knowing do not form a good foundation for the desired progression in mathematics. It seems likely that the reification of a mathematical relationship results from integrating multiple experiences involving more than one way of knowing the relationship.

Influences of Technology on Ways of Knowing

Returning to the examples, the following are afforded when technology is used in studying the topic:

- Rational numbers can easily be changed from a division operation to fraction form and to decimal form, facilitating the perception of equivalence across the three representations which correspond to static verbal, passive algorithmic and reified.
- The area of a triangle may be calculated using dynamic geometry software. The triangle can then be manipulated so that the learner can explore the effect of moving the vertex parallel to the base, which gives better dynamic visualisation of the dependence of the area on the height. Mason (1995) describes this as knowing through muscular sensation, and this "mouse mathematics" may constitute a different way of knowing from one that involves cutting and arranging. The same idea may be extended to Pythagoras' Theorem. The active algorithmic approach can also be used for the application of Pythagoras' Theorem and trigonometry by challenging students to model the solution of right-angled triangles using a spreadsheet.
- The distributive law may be studied by inductive and active algorithmic methods using, for instance, a spreadsheet. The learner may be given first a number of different expressions and asked to explore which ones are equivalent using replication of the formula and testing with many values. Next they can be asked to suggest a rule for removing brackets, then to test their rule on an expression containing parentheses by typing in an equivalent expression without parentheses, and finally to check their results by replicating the expressions over many cells and evaluating them each for many different values. A computer algebra system (CAS) may be used for the first stage of this, of course, but may less valuable in learning as it does not demonstrate visually the equivalence of the expressions. Graph plotting software may be a better alternative for showing equivalence visually, although this is less dynamic than when the learner builds a table of values.

The method of trial and improvement for finding turning points of a function may be made much more efficient with technology at various levels from simple calculator through to CAS. The graphic calculator also provides a dynamic visual approach through graph tracing. In addition, its ability to plot a family of graphs obtained from the variation of one parameter, and even to cycle through them dynamically, may offer an effective path to reification of the relationship between a function and its turning points.

Technology thus affords a change from ways of knowing which are static verbal, static visual and passive algorithmic to those which are dynamic visual and active algorithmic. These new ways are potentially more powerful in solving problems and in providing a foundation for more advanced learning. They support structural rather than operational thinking (Sfard, 1991). However, technology also affords a change from deductive to inductive ways of knowing. Whilst this shift to weaker, more general methods increases access to important mathematical ideas, it constitutes a loss of power in solving particular types of problem. We must be aware of the danger of losing the deductive element which is the essence of advanced mathematics.

Indeed, we must ensure generally that learners do not miss out on traditional ways of knowing which they will need in addition to the new ways afforded by technology. Effective problem solving in a domain requires multiple ways of knowing. Teachers, therefore, need to set specific tasks for students which require switches in ways of knowing, to discuss the solutions with students in order to stimulate them to make switches for themselves.

It is not yet clear whether the technological means of carrying out algorithmic procedures (graphic calculators, CAS) provide an alternative to reification as a foundation for more advanced concepts, or whether the value of the technology is in supporting the process of reification by providing a powerful way of knowing the process. This is a key question for further research, because the answers we find will indicate how technology may be exploited most effectively in teaching and learning.

Implications for Teacher Education

If the suggested benefits for learners are going to be realised, it is not enough for students just to be presented with the activities suggested. Studies such as those detailed by Hoyles and Sutherland (1992) have shown that effective learning depends on careful structuring of challenges, intervention by teachers at particular points in a task, and reflection by students on their approach to the work.

For most teachers at present, activities involving technology have the status of curricular knowledge rather than pedagogical content knowledge, and Shulman's (1987, 1986) theories of knowledge transformation for teaching suggest that what is needed is for technology to be part of teachers' own subject knowledge. It will be hard for teachers to integrate technology into their teaching if they do not themselves know mathematics in the ways supported by the use of technology. The alternative is for applications of technology to be seen as optional extras which may be adopted in order to motivate students rather than to develop their understanding of mathematics.

Student teachers may or may not know various aspects of mathematics through technology. Those who do have the opportunity to develop their pedagogical content knowledge with technology integrated, but they will need encouragement from their mentors (we must accept that mentors of student teachers may not have integrated technology into their pedagogical thinking at present). Those student teachers who do not know mathematics in this way must quickly gain the experience themselves of learning (or re-learning) some aspect of the subject with technology. These learning experiences may be fragmentary, however. Just a small part of their mathematics may be known through technology, and there is a danger that student teachers will only be able to use technology in teaching those particular pieces of mathematics they have studied with the aid of technology. They need, therefore, to discuss their experiences, to attempt to generalise from them and to form principled knowledge. As teaching with technology thus becomes part of their general pedagogical knowledge, we should find that they can apply it to new situations.

Experienced teachers should also be able to change the way they know some of their mathematics. The greater their experience of teaching without technology, however, the more automatized will be their repertoire of traditional teaching activities, the more entrenched will be their beliefs about teaching, and the more difficult will be the process of change (Noss & Hoyles, 1993). Some work on mathematics itself using technology away from the classroom may be an important stimulus to this process which must be continued in the classroom. Teachers' early attempts at applying technology in the classroom will not be very effective; but their subject knowledge and pedagogical content knowledge will develop together as they try out the use of technology with students and reflect on their experiences. Encouragement and advice from colleagues and other agents of professional development will be important during this process.

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Technology in Constructivist Mathematics Classrooms

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Once the constructivist philosophy is adopted day to day life in the classroom is profoundly and significantly altered for both teacher and students. This goes far beyond such superficial aspects such as the physical arrangement of workspace within the classroom, or heavy use of 'manipulatives' — two features which are most often noted by casual observers. With the constructivist adoption comes changes in some very foundational views of what constitutes knowledge itself. Even such basic notions as what an acceptable student product or the nature of the mathematics which is constructed should be must be carefully reexamined. Enabling in-service and pre-service teachers to successfully use technology within such classrooms is a major challenge for the teacher educator. The results of this study identify some factors which have proven to be helpful in this effort.

The research was done in two classrooms from the same school in a rural school district over a one year period. Both classrooms were taught by different master constructivist teachers who had each previously participated in one year of inservice, support, co-teaching and collaborative curriculum design prior to this work. These two teachers agreed to implement technology within their classes in markedly different fashions to investigate potential roles technology might play in enhancing a constructivist approach. Although each of these classrooms would easily be classified as technology intensive, one mathematics classroom utilized the computer as a student tool for mathematics exploration - in line with the instructional philosophy of the class. The other classroom utilized the computer as a presentation tool - more in line with a behaviorist approach. In each of these two classrooms total time utilizing the machine remained relatively the same. Within these contexts, this paper will address the question: Given two classrooms from the same school, both of which are taught by master constructivist teachers, is there an added value which might be expected of technology when it's usage is aligned with the instructional philosophy?

It should be noted that by the end of the research period both classrooms easily surpassed both state and district goals and had shown a significant improvement from their baseline. More importantly, however, where technology usage was consciously aligned with the guiding constructivist philosophy there was a marked increase in students who both scored well and consistently, a significant increase in performance scores, and a significant time by treatment effect relative to the classroom where technology usage was at odds with the philosophy of the classroom.

The conditions leading to these findings were first, that the technology was "tightly linked" with the underlying instructional philosophy and approaches. Secondly, the technology in the constructivist orientation was used as a tool for student use in creating their own personally meaningful representations - not as a delivery system. And third, opportunities were presented for the students to create computer based tools for use in solving their problems.

Technology Through a Constructivist Lens

The technology in this project made use of an object oriented computer authoring language - in this case HyperCard and its' scripting language Hypertalk. The object oriented nature of this language allowed for a wide range of powerful tools - such as drawing and painting - to be available for student use, and yet still had relatively simple syntactic requirements conducive to creating expressions in algebraic terms. The computer was used in the technology aligned classroom as a bridge between the sketch and the abstraction.

In actual practice the students did not proceed to the computer until they had become immersed in the problem they were working on via physical materials. The students did their initial sketching on the computer until they had constructed a working representation of the problem space they had encountered. They then identified what the relevant information should be through creating appropriate input and output fields. The developing representation at this time had many features common to both sketches and mental pictures. The entry into the realm of abstraction began as they constructed their method of procedure and expressed this in algebraic terms through scripting the buttons. Such descriptions, however, do not capture the full flavor of the student's thinking. To get a better flavor for the operation of this method see Connell 1995; Connell and Bouniaev, 1996.

Methods

Subjects

Subjects consisted of a total of 52 students completing a year of instruction at a rural western elementary school. These students had been randomly assigned into one of two conditions. Of this total 25 students were assigned to the technology misaligned classroom (TMC) and 27 students were assigned to the technology aligned classroom (TAC) [The N's are end-of-year and account for attrition]. The teachers covered a common core of mathematics curriculum and instructional sequence, although each individual teachers' curricular emphasis varied in response to the needs and strengths of the students. This school serves a broad predominately Caucasian, lower-middle class population. Based upon district provided data this school was at, or above, district mean achievement scores in mathematics.

Measures

Parallel forms of the Morgan Mathematics Inventory were used to gather student pre and post data. This fifty item inventory was the result of an earlier extensive cooperative effort between the author and a district level evaluation team (Connell, 1991) and was structurally similar to standard assessments such as the California Achievement Test (CAT) or the Iowa Test of Basic Skills (ITBS). During this test construction process an extensive item analysis was performed to select the best items and establish the item to objective mapping used in this study. The items making up each form of the test were subsequently mapped onto each of the state mandated curriculum objectives of Numeric Operations, Ratio, Measurement, Pre-Algebra, Geometry, Graphs, and Estimation in mathematics. Validity controls were constrained to face and content validity as determined by the teachers and investigators taking part in the study. Reliability estimates using Cronbach's Alpha were calculated for both pretest (alpha=.85) and posttest (alpha=.81) versions of the test as taken by this group of students. A 25 item geometry pretest from the McGraw Hill Mathematics series was used as a covariate. This assessment was structurally identical to the pre and post measures in construction and administration procedures.

Procedures

This project had been in place for a year when this research was performed. During this year the student growth and progress observed by the participating teachers as a result of their informal observations led to a refinement and stronger adoption of the project ideals and goals as described in the introduction. By the time this research began the following teacher characteristics were observed: instruction was student centered and constructivist in nature; the instructor's role was that of question asker and problem poser; and problem solving, and persistence and resourcefulness on the part of the students were highly valued by the participating teachers.

The pre-test was given during the second week of September as a part of the instructors beginning of the year assessment of the students. Conditions in both classrooms were controlled with both instructors following a previously agreed upon standard administration format. An existent Geometry pre-test was administered during the first week of October to serve as a covariate. As had been the case for the pre-test conditions in both classrooms were controlled with both instructors following the same standard administration format.

The treatments for this study were the day to day instruction given by the instructors. Both teachers had been identified as exemplary by the district administration and were observed by the author to have reached a master level prior to the beginning of the intervention. Classroom instruction in both classes was constructivist as described in the introduction. Technology was present in both classrooms, but only used as an integral portion of the mathematics instruction in the technology aligned classroom. Student time on computer as reported by the teachers was the same for both groups over the course of the day with the technology misaligned condition's use primarily as a delivery system for pre-packaged instruction.

The post-test was given during the last week of May as a part of the instructors end of year assessment of the students. As was the case for both pre-test and covariate data collection sessions, conditions in both classrooms were controlled with both instructors following the same standard administration format

Design

There were two primary quantitative analysis which were performed for this study. The first is more traditional and uses standard ANCOVA techniques to ascertain which, if any, of the observed differences in student performance over the course of the year were significant. The second analysis will not be reported here due to space considerations, but used SP curve theory to find out just what lives in the variance observed in the ANCOVA (See Harnisch, 1995; Harnisch and Connell, 1991).

The data was analyzed using a pre-post repeated measures design utilizing a subset of geometry knowledge as a covariate. As parallel significant improvements were found in each of the mathematics sub-continent areas identified in the item to objective maps, the total mathematics scores will be used as the outcome measure for the results section to eliminate the need for nearly identical multiple parallel discussions.

Results

Due to space constraints this discussion will be limited to the results of the repeated measures ANCOVA. It should first be noted that both the Technology Misaligned Classroom (TMC) and the Technology Aligned Classroom condition (TAC) showed a significant improvement over the course of the year ($t(23) = 6.13, p < .0001$; and $t(25) = 13.24, p < .0001$ respectively). Although heartening, this finding must be tempered with the realization that this intervention took place over the course of an entire year. Had a significant difference not been found it would have been cause for great alarm on the part of the investigator, not to mention the local school authorities.

Although a quick examination of the data shows the TMC condition (60%) to be initially performing better than the TAC condition (54 %), this observed difference was not significant ($F = 1.03, p < .3151$). Fortunately for this study, the observed differences at the end of the intervention, in which the TAC condition (81%) is observed to be performing better than the TMC condition (71%) were significant ($F = 6.42, p < .0152$). The time by classroom interaction effect likewise proved to be significant ($F = 15.62, p < .0003$).

Discussion

It is important to properly situate this study within the broader context of the research program of which it is a part. By the time this study took place these teachers had a years worth of experience with the materials, methods, and in dealing with implementation issues. I would doubt that the significant differences technology made would have been possible without the prior assurance that both classrooms were utilizing a similar model of constructivism at a master level. The previous year had allowed sufficient time for the teachers to construct a united set of epistemic beliefs and for these beliefs to impact their practice to a significant degree. Mathematical Constructivism involves too many counterintuitive practices to expect a simple two week intervention or inservice to suffice to reach the level of mastery necessary for the commonalty of beliefs and practices across classrooms in this study to occur (Connell, Peck, Buxton, & Kilburn, 1994).

In examining the results of this study, some very interesting observations may be made. To begin with, it must be noted that the students in both classroom were successful in meeting both state and district goals relative to their mathematics instruction. This was true in each of the required content areas as indicated by the district. This is an important observation which transcends the t-test significance which was reported under results. A significant t, obtained without a commensurate success in meeting mandated content requirements, might work well for writing an article or paper but does little in providing an effective example for project dissemination. Within this context, i.e., the success of both groups in learning the required grade level mathematics, it is clear that both constructivist approaches to instruction utilized in this study were effective. Although this is not surprising to those who employ such methods, it does serve to document for the literature once more the often surprising power of this different approach toward instruction (Buxton & Connell, 1994). The entire process of putting the teacher in the role of question asker, and then letting questions and not answers guide the instruction is often counterintuitive to many practitioners.

Given the fact that both classrooms had adopted a common constructivist mathematical pedagogy and used the same or highly similar set of materials, the question really boils down to what impacts technology might make in such classrooms. Implicit in this study was the notion that the technology usage must be tightly linked with the instructional program. The technology was, therefore, used in a constructivist fashion. The introduction of the computer was not an afterthought. Rather, the technology had a well defined theoretical place in the curriculum which was made explicit to the participating teachers. This notion of having the usage of the technology be "tightly linked" to the underlying instructional theory is of key importance in efforts to apply these findings.

The fact that technology, used in such a tightly linked fashion, does indeed have an impact is clearly demonstrated by the significant differences in performance found over the course of the study. Despite an initial non-significant advantage held by the students in the TMC condition the use of technology enabled the TAC students to not only overcome this handicap, but to surpass the TMC group to a statistically significant extent. Furthermore, the significant time by classroom interaction suggests that the length of time in which technology is used in this fashion the greater the impact.

One possible interpretation of this finding might be that for technology use to be effective it must map onto the underlying instructional practices in the classroom. This interpretation is problematic in that it assumes that any particular method for learning is equivalent to any other and that all we need do is to match technology implementation to the instructional approach at hand. This is not the case in elementary mathematics. This study differs from this simple interpretation in that the approaches to which the technology use was aligned reflected the thinking presented in the NCTM Standards (1989) to the maximum extent possible based upon the experience and beliefs of the participating teachers. As these Standards identify, not every instructional approach is equal in terms of it's effects upon student beliefs, systems of justification, and developed problem solving processes. Doing a better job at meeting inferior goals can hardly be seen as a step forward.

Conclusion

This study, at one level, serves as another testimony that a constructivist approach to instruction can be highly effective in the area of elementary mathematics. If this was all it had to offer, however, it would be of little impact upon the field. There are numerous examples documenting the power, effectiveness, and difficulties associated with such approaches. At another, more significant level, it begins to address some very difficult issues surrounding how technology might play a supporting role in such implementations. As a result of this study the following suggestions seem in order:

1. The technology should be utilized in a "tightly linked" fashion and supportive of the underlying instructional approaches. Educational problems are not likely to be solved by merely throwing CPU's (central processing units) at them.
2. The technology should be used as a tool for student use in creating their own, personally meaningful, representations. The presence of the computer alone as a delivery system of static expert representations does not guarantee, and indeed may inhibit, the development of student "re-presentations".
3. Opportunities should be presented for the students to instruct the computer, using algebraic notation as dictated by the authoring system, general systems of solution to the problems they encounter. This enables the computer to serve as an active critic of the student's work and forces a presentation in a more standard format than otherwise took place.

When these suggestions are taken to heart by experienced teachers, as was done in this study, computer technology has the potential to be a powerful mediating influence in the ongoing student construction of mathematical meaning.

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Technology in the Mathematics Classroom: Action Research in Graduate Teacher Education

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There is a special excitement that comes with the opportunity to develop a new course which spurs reflection on basic beliefs for teaching and learning as well as particular goals for the specific course. This course was the result of such reflection, beginning with the planning stages and continuing to the closing evaluation. As the course progressed, we attempted to document the development of the course, and the impact of the course on the participants. These became the components of our action research project.

Colleges of education are faced with the task of preparing preservice students and inservice teachers to become effective users of technology. This task takes many forms, from separate distinct computer literacy courses to full integration of technology into all teacher education courses. Separate technology courses require a computer expert and focus on developing technical skills. A criticism of these courses is that they do not provide a good model for how technology can be used in a classroom. Additionally, these courses have been criticized for not providing opportunities for students to examine the place of technology in society and its effect on education (Davis, 1993).

Another approach for introducing technology is through integration of technology in existing methods courses. In another study, Copley (as cited in Davis, 1993) found a higher use of the computer with elementary preservice mathematics students who were allowed to explore mathematics and technology together than students who were in separate instructional technology courses. Nicaise and Barnes (1996) describe the process of integrating technology into an undergraduate secondary mathematics education class on teaching geometry. The purpose of the course was to prepare students to understand different instructional methodologies, tools, and textbooks and their application. The course was designed with technology as an important component in the creation of an information rich classroom based on constructivism. These instructors employed several instructional techniques. The first phase of the course consisted of learning theories, geometry curriculum for secondary schools, and technology demonstrations. There was hands-on training of geometry software and Internet tools, including e-mail and the World Wide Web (WWW). Students explored a variety of instructional software including *The Geometer's Sketchpad* (Jackiw, 1991). The learning activities for the course revolved around the authentic task of designing a theory-driven geometry curriculum. Students worked in groups to build a curriculum that integrated at least three subject areas. The students shared their curriculum by building a WWW site. Informal reports of the students note high satisfaction with the web development part of the course.

At Lesley College Graduate School of Education the computers-in-education faculty developed a program to integrate technology into teacher education. Such integration is not an easy task and requires rethinking of course content by teacher education faculty that may not have sufficient knowledge of technology. The computers-in-education faculty found that team teaching courses in which professors of subject area methods courses were paired with technology faculty or teaching assistants with strong technology backgrounds was extremely effective (Roberts & Ferris, 1994).

A specially focused course on the use of technology in a specific subject area is another way of introducing technology into teacher education. Many of these courses began as summer workshops for teachers. Steen and Taylor (1993) describe a working conference for teachers at Teachers College, Columbia. The conference consisted of two components: software evaluation and lesson creation. In the software evaluation component, the participants worked in groups to carefully evaluate mathematics software including a discussion of the kinds of lessons for which the software would be an effective teaching tool. In the other component the participants created original lessons using the software, including time for practice and discovery exercises for the participants. At the conclusion of the working conference the participants were able to select software for their school or institution and to develop lessons utilizing that software. Morris (1992) also describes a preservice course that developed from a summer workshop. Students participated in experiments designed to introduce software that allowed them to become familiar with principals behind mathematical concepts.

In the Computer Application and Manipulative Mathematics Program at the University of North Carolina at Charlotte, teachers learned to use computer software to develop ways to make the transition from concrete manipulatives to manipulation of symbols (Piel, Green, & Gretes, 1994). Informal interviews with the participants determined that they had decreased their use of textbooks and increased their use of manipulatives and technology. Using technology helped teachers rethink mathematics and consequently change their teaching methods.

Course Development

The idea for the course came from a need to prepare mathematics education students at the University of Tennessee, Knoxville to use technology in the classroom. Like other courses found in our literature review, this course sought to provide opportunities to explore the use of technology. Further, it sought to implement many of the ideas present in the literature.

The course was developed by a mathematics education professor and an educational technology graduate student (Roberts & Ferris, 1994). This was a successful match. Development began with a discussion about the goals of the course. We wanted to provide an opportunity for students to learn mathematics with technology. It was our idea that until teachers have had an opportunity to learn with technology they would not be able to teach with technology. We wanted our students to develop a vision of what a classroom with technology could be even though many of them will not immediately teach in such a classroom. We also wanted to provide a model for teaching with technology for our students (Nicaise & Barnes, 1996). Teaching with technology provides instructors and students the opportunities to explore different roles. During class presentations the instructor not presenting information interacted with the students in the class. During lab and exploration days we served as facilitators. We shared in the preparation of the lessons and labs. Our goal was that our model of collaboration and facilitation would help the students think about instructional techniques for their own classroom.

To further model the integration of technology, we decided to make the course paperless. We began by making the syllabus available on the world wide web. This offered unexpected opportunities. Each day we were able to clarify assignments and ideas by creating other pages linked to the syllabus. The students' work also became a part of the syllabus. The students were patient and willing to keep trying when technical difficulties occurred. Continuing with the paperless aspect of the course, students turned in their assignments via the local area network. Evaluation of student work was provided by way of a word processing file that was loaded on each student's computer. The students could then copy that file and remove it from the hard drive to ensure privacy. As the course progressed students developed electronic portfolios.

Conceptual Framework for Course Activities

The course was organized into five modules: (a) teacher and student use of the Internet; (b) productivity tools for instruction, databases and spreadsheets; (c) technology for teaching algebra; (d) technology for teaching geometry; and (e) management and evaluation of technology. Each consisted of three types of activities: developmental, experimental, and instructional. Developmental activities provided opportunities for participants to become familiar with specific technology resources. Experimental activities provided opportunities for students to expand their knowledge of mathematics through technology. The main objective for the participants was that they use the mathematics software to learn something new about mathematics. The students selected individual lab activities to explore mathematical concepts. Instructional activities provided opportunities for participants to apply what they had learned about the individual software packages to develop instructional materials. Students worked in pairs or individually to complete activities. We used class discussions of assigned readings to tackle issues like classroom management with computers and the effect of computers on teaching

Portfolio Development

A central feature of the course was the means of assessment. Students created an electronic portfolio consisting of activities that they had created within each module. They also created word processing files that explained what they learned or how they would use the materials they created. Students kept a personal copy of their portfolio on disk. About half way through the course the participants learned how to use Hyper Text Markup Language (HTML) to create WWW pages. They created their web portfolios using basic HTML tags and a simple text editor. They made screen shots of their explorations and lessons completed in the modules and converted these to a web acceptable format.

This aspect of the course offered both the instructors and the students opportunities for authentic problem solving. Posting the files to the WWW server required the development of consistent file naming schemes. Another technical problem the instructors faced was limited allotted file space for the student portfolios. Obtaining file space which would remain available for an extended length of time for a class was a new procedural issue for the university.

There were several design issues that the students and the instructors faced in WWW page development. Instructors had to design a method for linking the course syllabus to student work. Students faced several decisions about the design of their portfolio. For example, one student designed her portfolio as one long document in an outline format with internal links to sections. Another student choose to make her portfolio as text with hypertext links to examples of her works. Still another student made her portfolio several pages that linked to each other allowing one to choose items to view. As students gained skill in HTML development they added graphics and ideas from other sources on the WWW.

Results: Participant Reflections

The culmination of the research aspect of this project was the written evaluation from the participants. They expressed their perspectives on the ways in which technology acts as a change agent in their attitudes, skills, knowledge, and behaviors in the mathematics classroom. The anecdotal analysis of professional growth is seen in the following excerpts of student comments and corresponding examples of their use of technology from each module.

As indicated above, each module provided the students opportunities to learn new software, learn mathematics in a new way, and apply both to the design of lessons for their own students. In the Internet module one student represented her new knowledge of the Internet in an innovative concept map.

Another student used the computer to make creative worksheets. Although typically a productivity tool, her use of databases took a different look. As she learned about databases and spreadsheets, she applied that knowledge in ways useful to her since she did not have access to a computer in her classroom.

One student who saw herself as a "slow learner" in this class gained "many insights and a huge amount of information." She related her own computer anxiety to students' mathematics anxiety As she expressed, "readily available assistance and experience go a long way to alleviating both." Her use of spreadsheets to explore the Central Limit Theorem is an example of her willingness to use technology in innovative ways, beyond her previous view that these programs were "limited to clerical types of teacher chores like averaging grades."

An elementary school teacher felt that "the more knowledge and experience a teacher has with technology causes him/her to have positive attitude about, and feel comfortable working with, whatever is available. It helps to see the vast possibilities of how to incorporate these materials into the regular curriculum ... for the entire instructional process." Within the Algebra module, she portrays this positive attitude in innovative instructional ideas for her students by using the technology in conjunction with manipulatives to "guide students from concrete to abstract."

A high school teacher, worried about students losing essential skills by using the computer, found that "computers allow students to go straight to the heart of the problem instead of getting bogged down by the time consuming computational work." He used *The Geometer's Sketchpad* (Jackiw, 1991) to create pie charts by rotating angles to make the sections of the chart.

A variety of concerns were expressed during the discussions in the management and evaluation of technology module. Several students discussed opportunities to apply for grants for technology classrooms such as Tennessee's 21st century classroom: "I will not do that [discard application] the next time I am offered the chance to bring my students the technology they need to learn so that they will be successful in their future." Another student stated, "With all I've learned this summer about technology, I could feel confident in applying for a 21st century classroom next spring." Recognizing that access to technology in the classroom was an important issue, students expressed valid concerns regarding the equitable use and availability of computers one student wrote, "Not every school is equipped with them which hurts the students;" and "the gap between the education of the low economic areas and the middle to upper economic areas will widen even more."

At the conclusion of the course students reflected on changes in knowledge, skills, and attitudes. This allowed students to rethink their philosophy of instruction and assessment. "By using technology in a classroom, one's philosophy of instruction and assessment has to change....The assessment of students with computers has more to do with the process rather than content. I think students feel like they have more control about what they are learning..." Assessment alternatives are certainly available with computers, but not limited to the technology. "Two examples of how students can show their understanding of the material are (a) students writing paragraphs explaining what the numbers mean and (b) one student explaining the mathematical process involved to a fellow student."

The obvious area of growth was in participants' attitudes, skills, and knowledge regarding the use of technology in the mathematics classroom. In the words of one student,

> This class has changed the way I think about teaching. Having experience with the computer gives new ways to design lessons and activities, even without an available computer. Now, I will think to imitate many of the activities with paper and pencil instead of pouting that I do not have any computers in my room. Now, I'll consider what

happens when I rotate this shape or drag this corner. ...My philosophy of computer technology has changed, because I have had an opportunity to explore different software and the internet with guided help.

Participants expressed changed beliefs and behaviors about the class environment, teacher and students roles, and instructional strategies. They perceived the nature of mathematics and its possibilities with their students as more exploratory, interactive, and authentic. What they said and what they did reflected the idea that technology had the potential to change *what* mathematics is taught, and *how* mathematics is taught.

Discussion

One of our major goals was to create an innovative course that integrated mathematics and educational technology and embodied features found in the literature. Another goal was for students to learn some mathematics using software as well as to use software to create lessons for their students. Evaluation of the course based on student work, student reflections, and our informal analysis indicates that we met both of our goals to a large extent. Within the course design, we would readdress the assessment of student work, especially the use of the portfolio, using a best-work rather than all-inclusive portfolio of student work. We would also reconsider assessing multiple aspects, such as creativity, substance, form, and design. We also would develop a means to incorporate student progress as well as mastery of materials.

Examples of student work and reflections indicate that students were able to reconceptualize their own learning of mathematics. Moreover, the process of learning with the technology was important to the design of lessons for their own students. We would hope to strengthen these opportunities even more for students to learn the content in new ways through the use of technology.

It is our hope that, by sharing the process and product of our action research regarding our course, other teacher educators will also be encouraged to develop and implement means for integrating technology into the mathematics education curriculum. As we attempt to impact students' beliefs and behaviors, we too must reflect upon our own beliefs and behaviors, and respond accordingly. Designing innovative instruction in a collaborative effort makes partners of people as well as partners of disciplines.

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Technology in Mathematics Education: A Model for Revisioning Preservice Courses

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It is no longer a question of whether or not technology experiences need to be an integrated part of a preservice teacher education program. The question now focuses on identifying those processes which will best help us put those experiences in place. Teachers & Technology , the 1995 report from the Office of Technology Assessment, clearly identified several real concerns in the area of technology and the preparation of new teachers. Two of these findings that provided the impetus for this project were: 1) graduates of teacher preparation programs are entering the field with limited knowledge of how technology can be used in their own practice and 2) teacher education faculty are teaching about technology, not with technology. The ISTE Foundation Standards as presented in the Curriculum Guidelines for Accreditation of Educational Computing and Technology Programs (1992) also identify the skills new teachers should have when they complete their preservice program. Additionally despite the calls for including technology experiences as a part of preservice teacher education programs articulated by national and state organizations and groups such as the National Council of Teacher of Mathematics (1991), Interstate New Teacher Assessment and Support Consortium (1995), Simpson and Wallace (1996), Molina and Schielack (1996) the concerns noted above are found in the preparation of teachers of mathematics.

Faculty involved with preservice students should provide experiences that include real-world instructional problems where technology can be a solution in solving those problems (Rodriguez, 1996). Our previous collaborative work, Bloom and Handler (1993) has lead us to believe that collaboration among university faculty in planning a systematic integration of technology across the full preservice experience, as well as, in the revisioning of particular course offerings can be successful.

Project Goals

This project addressed two main goals. The first was to integrate meaningful technology experiences within the mathematics methods course. The second goal of this project was to develop a model that would assist faculty as they revision existing courses and explore ways to assist student attainment of the objectives of those courses through the use of information technologies.

The partnership for this project included a member of the Technology in Education Department and a member of the Mathematics Education Department. We acknowledge that our previous collaborations, as noted earlier, make us somewhat different than new partnerships that might attempt to use this model. In any collaboration the element of trust is key and we had already established that in our working relationship. Others might find the process developing more slowly as the working relationship is established.

In the National-Louis University undergraduate elementary education program preservice students are required to complete an introductory Computers in Education course prior to admission to methods courses or student teaching. A course that includes clinical experiences in classrooms is a prerequisite for the computer course. Through this sequence, the students are able, to some degree, to place the experiences of the Computers in Education course in a school-based context. The placement of the computer course in the program means that methods course faculty can expect students to have the basic computer skills necessary to accomplish the assigned technology based tasks. The computer course provides 'how to' knowledge and skills and some application, but the continued application and development of skills to meet the ISTE Foundation Standards takes place throughout the program.

Building the Model

As we approached building the model we examined the "Innovation-to-Practice" process model described by Yessayan(1992). The phases of the model include exploring the possibilities that exist, gathering information toward implementation, planning for incorporation into instruction (Yessayan referred to this as "innovate and experiment") and reflecting for modification.

Our first step in the process was to identify the course with which to explore and build the model. The Methods for Teaching Elementary School Mathematics course was chosen. It was to be offered two quarters in a row providing us opportunity to continue to build the steps of the model during the first quarter and move through the cycle again as we planned for and implemented the changes in the second quarter. While Bloom was a comfortable technology user and had integrated some technology experiences into his courses, he was not familiar with the range of software available to him and his students. Handler brought this expertise to the project. That was how we had envisioned the model developing. One partner would bring the technology know-how and awareness that the instructor of the course being revised had not yet perfected. This partner might be a department colleague who has gone through the process or it a colleague from another department who believes in the importance of the technology integration process. What the collaboration needs is at least one partner that has a personal comfort level with technology, uses technology in her/his own instruction, and is willing to be a mentor.

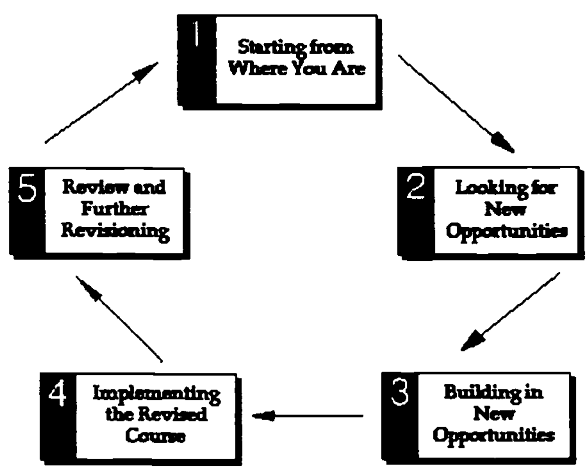

Figure 1. The model in its current form.

Implementing the Model

Starting from Where You Are

During the first quarter we began with the extant technology experiences. Bloom reevaluated technology experiences from previous course offerings and considered their effectiveness in terms of desired and actual student learnings. Previous student experiences had included a CAI software evaluation and the in-class use of the Geometer's Sketchpad (1995) and Data Insights (1990). In our planning process we considered what the student experiences would be and what kinds of modeling could be done by the instructor. We determined that we would build in several new experiences during the first quarter, assess their value and success, and use that information in our planning for the second quarter.

Our brainstorming at this point also focused on another vehicle to expand student understandings. In previous offerings of this course, students had been required to interview a mathematics teacher using questions that were linked to the mathematics topics in the course. The interview was revised to include questions that focused on the teacher's use of technology tools in his/her own instructional practice.

During the first quarter Handler observed Bloom's class as well and demonstrated several pieces of software. One of the pieces of software demonstrated was Math Blaster Mystery (1989) (MBM). Previous demonstrations of the software focused on the problem solving steps and the ability for teachers to create their own files of problems using the provided template. During this demonstration of the software, Bloom led a discussion on how specific course objectives could be met through the use of MBM. He showed the students how the answers chosen by children could help the teacher identify misconceptions held by those children. This approach to using the software was new and one that worked well in subsequent demonstrations and discussions of MBM.

Meetings throughout the first quarter focused on how to revision the course in terms of both instructor and student learning experiences that support the objectives. These changes were then reflected in the second quarter's course syllabus. We aimed to develop both new technology experiences for the students and ways the instructor could better model technology as his own instructional tool. With that two-pronged approach as our guide we prepared for the second offering of the course.

Looking for New Opportunities

During each quarter the first step was to brainstorm the opportunities. These included:

- student activities during class
- revising of the teacher technology interview
- technology-based assignments
- options for instructor modeling
- opportunity to learn new software and use for instruction.

We took into consideration the time needed to learn new software and included some pieces with which Bloom was familiar. As it was important for us to add one new experience for the instructor, he chose to learn how to use the slide show component of ClarisWorks (1995). We also created an assessment activity to determine how the students perceived this new focus on technology experiences.

Our plans had to be adjusted following the first meeting of the methods block faculty. As the four faculty members shared their plans for the quarter it became obvious that each was planning to provide students with technology-based learning experiences. We then reexamined and redesigned the mathematics methods course so students would be engaged in a variety of skill experiences with a minimum of overlap. The minimizing of overlap was a critical finding of that meeting for us. We would encourage others attempting to implement this model to check for such duplication of experiences.

Building in New Opportunities

Three specific opportunities were identified during which the instructor could model the use of technology as an instructional tool. The first was to model, on his own, the use of MBM and lead a discussion similar to what had been done during the first quarter. The second modeling experience included the use of Inspiration (1992) as a concept mapping tool in class using a computer and a LCD panel. The last opportunity was to work with Handler in order to learn how to use ClarisWorks and develop one slide show to be used for instruction.

The final format for the course included three technology related assignments. The first assignment focused on practitioners' current use of technology in their teaching of mathematics. Towards that end students were provided a protocol of interview questions. Each student interviewed a practitioner and the results of those interviews became the basis for an extended discussion of those responses. For the second assignment students could either construct an appropriate set of problems for MBM or create an annotated bibliography of technology-based resources available, including resources accessible via the Internet, for teaching elementary school mathematics. In the MBM assignment the students used the teacher utility component for creating problems. As they created the incorrect response selections for their problems, the preservice students had to indicate what error or misunderstanding in a student's mathematical thinking would be revealed as a result of the answer choices they had included. In the third assignment, students would create mathematics activities for children using Kid Pix(1994).

Implementing the Revised Course

A key component of the implementation process was to assess what we were doing as we looked at content and instruction of that content in a new way. We did not see ourselves as adding onto the course but rather approaching the content through new instructional strategies. The goal was to discover ways in which the technology could assist in introducing mathematics concepts and could also build pedagogical knowledge.

One problem we encountered was in relation to the students' technology knowledge and skills. We had assumed that all the students had completed the required introduction to computers course prior to enrolling in the mathematics methods course. We later determined that this assumption was in error. Faculty wishing to incorporate technology experiences into their courses would be well advised to assess the technology knowledge and skills of their students and be prepared to include time for teaching students about the technology itself.

In implementing the revised course Bloom redesigned the Kid Pix assignment to look at both math concepts and mathematics pedagogy. Students had to consider the accuracy of the mathematical model being portrayed, the quality of the interactivity created in the screens, field test the screens with students and summarize that field experience. They were also required to write a summary describing the process they used throughout the completion of the project, and, as means for further assisting students in linking this technology experience with the course objectives, include a reflective statement describing how this task helped them attain those objectives.

In implementing the ClarisWorks slide show Handler was able to take the notes and create a template and an opening screen. The partners then sat down together, one dictating the content with the other modeling how the program worked. Changing positions and roles, Handler aided Bloom as he created the next several screens. With this assistance he was able to complete the slide show on Interpreting and Analyzing Data: The Shape of the Data.

Review and Further Revisioning

In order to assess what had occurred over the two quarters, we tapped several data sources. We collected feedback from the students, sent a survey related to course technology use to the other methods faculty, and we each had personal reflections concerning the process. In order to determine how well the ISTE Foundation Standards were being addressed, we examined all of the technology experiences the students had completed within all four of the methods courses. All of these data will be used in future program review and development and in identifying areas for faculty professional growth experiences in the technology area.

Student Feedback. Student feedback provided important information about the assignments. We were initially surprised when none of the students had selected to create an annotated resources bibliography. In their feedback the students clearly indicated that they had chosen not to select this assignment option because the directions had not been clear enough. Their previous experiences with the lack of access to the labs also provided concern that the assignment would be too difficult to complete. For them using Math Blaster Mystery or Kid Pix was far more comfortable. They had previously seen these programs in their introductory computer and mathematics methods courses.

The students had very positive responses to the Math Blaster project and the development of the Kid Pix screens. Bloom had already modeled the programs and showed how the mathematical concepts had been woven into the lesson. Then the students had a chance to apply these ideas in meaningful projects that could be used with children. Student feedback included comments such as "The method of focusing on the problem solving process instead of all the focus being on the answers was new to me"(from an MBM project), "I felt that working the program (from an MBM project) enabled me to understand children's mathematical thinking more than I had in the past", "This field test showed me that technology allows children to work at their own pace" (from an KP project) and "I learned to think about what students need to think about when they are involved in an activity"(from an KP project).

One of the assignments was a revision of the classroom teacher interview. The interview focused not only on teacher's mathematics instruction, but also on the teachers' valuing of technology as a tool, ways in which that valuing was communicated to students, decisions about and decision making processes for using technology, and assessing and evaluating mathematics learning and how technology assisted new mathematics knowledge. During the post-interview discussion in class the students found that the practicing teachers interviewed typically did not use technology in their mathematics teaching. The few that did tended to either use CAI software or word processing in connection with their students' writing. Reflecting on these findings allowed the students to reexamine the types of technology experiences they had had in the course and the barriers to using technology in mathematics teaching and learning commonly faced by elementary school teachers. From this discussion and the students written summaries of their learning, the course instructor deemed that the goals for the assignment had been attained and that the teacher technology interview would be an assignment worthy of incorporating into the next offering of the course.

Faculty Surveys. We discovered that students had a variety of experiences but not all were of the same quality. In the science methods class they previewed laserdiscs and CDs that fit into the science curriculum. They also had an opportunity to go onto the World Wide Web and look for science resources. The social studies methods instructor had students evaluate software and list appropriate software in their Social Studies Unit project. As a part of their language arts methods the students helped children in classrooms develop word processing skills. Finally, all written assignments in the mathematics and language arts methods courses were to be word processed.

Collaborators Reflections on the Model

In examining the usefulness of this model in other settings, several questions arise. We will raise but a few of those. What if methods courses are not in the school of education? What if there is not instructional technology support? What if there is an integrated methods experience in a clinical site? These are a sampling of the questions that would need to be thoughtfully considered and planned for.

We learned that revisioning courses using this model is a process that takes time and commitment. If this process is important in the redevelopment of teacher education programs it must be supported administratively in some way. In our case, Handler was on sabbatical and so time was available however we had no other institutional support. We also learned the importance of preplanning equipment needs and arranging for access to the resources students would need for assignments, creating back-up plans in the event that the technology does not work, and, above all, we learned about the need to be flexible and trusting.

This project reaffirmed for us the pleasure of working in a collaborative relationship. It is important as faculty try this model that they build their partnerships carefully, taking time to talk about ideas, values, and beliefs. Don't plan on making big changes right away. Find out where you are and move carefully. As you and your partner(s) work together, think course specifically and programatically. Spread the word about what you are doing. Open communications with other faculty and encourage their efforts at integrating technology. Open communications with students and provide them a first-hand view of peer collaboration at work. We think it is worth the effort.

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Teacher Training in Computer-Aided Algebra Instruction

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The University of California at Berkeley and Vista Community College, also located in Berkeley, share many instructors. As a result, the two institutions work very closely with each other. In fact many of Vista College's evening classes are offered on the campus of UC Berkeley. Vista Community College offered computer-assisted elementary algebra and intermediate algebra in the spring of 97 for the first time. This pilot project had been in preparation for about a year as of the fall of 96. Peralta Community College District which Vista College belongs to held a number of workshops for prospective teachers during the fall semester of 96. This paper is about the design and the goal of these workshops.

Rationale for the Workshop

1. Most mathematicians use computers only to typeset their papers. They need to get used to using them in different ways. In particular, many are against using calculators to learn and teach mathematics. They need to be shown the differences between a calculator and a computer in the ability to aid students in their learning and in the role they play in mathematics instruction.
2. Needless to say, computer-aided instruction did not even exist when they were students. Therefore, even the concept of computer-assisted instruction is entirely new to most professors. They need to get initiated in various senses; both theoretical and practical.
3. Instruction using computers requires an entirely new set of teaching paradigms. Chalk-and-blackboard professors from the old school need to learn how to modify their teaching.
4. As the method is new to the students as well, the professors should stay at least several steps ahead of the students in terms of both the knowledge about the equipments and the awareness of new learning methodology.
5. By making it a district-wide workshop and appealing to the power of numbers, the chance to get any grant will be maximized. Furthermore, this arrangement enables us to form, even loosely, a district-wide task force of computer-literate mathematicians.

Design and Goals of the Workshop

The workshop contains the following elements.

Organizational Meeting — Introduction

In this mandatory meeting, professors from different schools are introduced to each other. Unlike at four-year colleges such as the UC System schools, at community colleges the resources one college can afford are quite limited. This is the case both with man power and other resources. Therefore, it is crucial that all five campuses along with UC Berkeley can band together to create a common resource pool which any faculty at any campus can take advantage of. The fact that so many professors are graduates of UC Berkeley makes the process of getting to know each other and forming camaraderie quite easy.

Getting Started with Interactivity

Basics of the operations of the pcs delivered to the schools along with the necessary preparation both equipment-wise and otherwise are discussed.

As mentioned in the Rationale section, computer assisted learning is quite new for most faculty members. In particular, it is important to understand the difference between a typical lecture and computer assisted instruction since even a typical lecture is interactive to some extent. The instructors should learn the newly defined interactivity in the context of computer-assisted instruction. Needless to say, as the name suggests, Computer Assisted Instruction is not done exclusively by a computer. Human guidance, intervention, and reinforcement are very important ingredients of any successful CAI. Proper timing and extent of intervention must be learned. In this unit, the instructors learn the rather theoretical aspects of CAI. Our experience with mathematicians, including myself, is that they cannot feel comfortable unless the theory behind what they are told and supposed to do is presented to them alongside practical instructions.

Syllabus Workshop

Course design issues and issues surrounding effective use of each software are addressed. This is important as each software is designed for a specific set of tasks.

This is a unit in CAI practicum. The instructors study actual syllabi for a course built around CAI. Several types of syllabi are presented for comparison. The core of this unit is the presentations by those who actually taught such courses out of the syllabi they are presenting and the ensuing brainstorming sessions with the professors who are being trained to use the systems. As some opinions and criticisms expressed by the participants were quite revealing and at times even eye-opening for the presenters. Both the presenters and the trainees gained much out of this session.

Site Visit

In some of our neighbor community college districts computers have already been used for mathematics instruction for a while. For example, Chabot College has been using technology in their instruction campus-wide. This visit keeps us from reinventing the wheel.

Seeing is believing. It is one thing to read about CAI, and it is quite another to actually try it oneself. But, seeing it in action in a real classroom is several notches above those in terms of the impact on the participants. For one thing, it makes a believer out of doubters. For another, they get to hear about their colleagues' experiences including the problems they faced. It was quite convincing and encouraging when they told us the attrition hit the all time low at their school since the introduction of CAI. Many instructors took this opportunity to become students themselves and try out the softwares. As they use their computer to teach humanities as well, many mathematicians were able to experience firsthand what it is like to learn a new material from a computer interactively. This also served well as sensitivity training as many experienced quite an array of unexpected problems including even failure to logout.

Monitoring Student Progress

As the whole point of computer-aided instruction is allowing the students to proceed at their own pace, each student will be doing a different exercise at any given moment. The issue of keeping track of the students' progress is discussed with an emphasis on time management and effective use of laboratory assistants.

The students are allowed to move to more advanced sessions only after a successful completion of all exercises and obtaining a passing score on the exit quiz. Needless to say, this relieves the instructor of grading and recording duties. However, at this point our system can only act as a bookkeeping tool, and detailed analysis of difficulties and individual patterns of mistakes still have to rely on human instructors. This is often compared with machine translation. Machine translation equipped with artificial intelligence is quite powerful and impressively fast when translating a standard document. But, they fail miserably with nonstandard documents. Current learning theory emphasizes different learning styles exhibited by different individuals. Individualized teaching is, at least at this point, only possible by human instructors. As the questions on the quizzes and the grading scheme are somewhat simplified to facilitate fast grading and fast feedback by the computer, frequent human intervention is crucial. Half of the instructor's job is to learn to analyze these quizzes in a new format, and the other half is to master the technique of complementing the CAI system. By complementing, we mean relegating all simple jobs to the computer and concentrating on the tasks that can only be done by humans. For example it is quite difficult for a computer to teach effectively how to approach word problems. On the other hand, computers are very good at giving computational problems with similar features such as equations with fractional coefficients.

Speaking of relegating jobs to others, an effective use of laboratory assistants is another area where the teachers need to be trained. At four-year colleges, most professors have experience with teaching assistants. But, community colleges, at least the ones in California, do not have teaching assistants. Furthermore, the functions performed by TAs are quite different from those of laboratory assistants. We have to remember that some mathematics professors have not had a laboratory of any kind even as students, and as such they have not even encountered a laboratory assistant in their life before. This is not unrelated to the fact that mathematics is basically a matter of individual efforts, and a common mistake first time teachers make is trying to do everything and trying to run the show all by themselves.

Introducing Students to CAI

The title says it all. This is as new for the students as for the professors. Some pointers as to what to teach the students and what pitfalls exist are provided.

Generally speaking, it is true that today's college students are far more versed in technology than a typical instructor. Nevertheless, game playing, emailing, and browsing are not the same as learning algebra. As community colleges are behind their four-year counterparts in using technology, most students have not had a chance to use any CAI system. It is particularly important that the students understand the reason for CAI. They need to know that the system allows the users to proceed at their own pace. But, they should also understand clearly that they do not pass the course unless they finish all the sessions by the end of the semester. Hence, self-discipline is a major factor whether it is a regular class or an instruction by computer.

Getting Up and Running

Instructors should know how to and from whom to get help. Also covered in this session are various troubleshooting techniques.

This intensive session is run right before the semester in an environment that simulates the actual classroom very closely. As each college in the district has its own computer facility, the workshops are run on the instructors' home campuses. By this time everything including support systems should be in place at each college.

Difficulties Students Face

During the course of the workshop, every participant is made aware of the following typical difficulties experienced by the students.

Lack of Individual Attention

The students who are more used to conventional lecture style teaching feel somewhat abandoned when they have to face the computer screen and interact with the machine by clicking and typing. They have to be told to take full advantage of the help available both from the laboratory assistants and the instructor himself.

Very low level of student-to-student interaction As each student proceed at his own pace, it is difficult for the students to discuss the problems they are working on with their classmates. This is why Vista College has a resident tutor for lower division mathematics classes. He organizes study sessions to promote group studying. Furthermore, the students are encouraged to post their questions to a computer bulletin board. This is precisely like the Usenet newsgroups except that it is just for Peralta students.

Limited Student-Teacher Interaction

Even though most students sit quietly in a typical classroom and do not ask too many questions, it seems to be comforting to know that the teacher is standing in front of them facing the students and is available to answer questions if one should decide to ask something. They should be told that they now have to take the initiative in their learning. The computer does not lecture to the students who just sit in front of it. Their computer lab is not a movie theater. They can not move forward unless they initiate the process. If they get used to treating the computer as a teacher, there is indeed much more interaction between the students and the teacher. However, for those who insist on learning it from a human teacher in a conventional classroom. That option is readily available. Most classes are still in the traditional format, and CAI is just an option for them.

Concluding Remarks

We have considered the content of the teacher workshop for computer assisted algebra instruction in the Peralta Community College District in Northern California. Even though this is a workshop for mathematics instructors, many features must apply to other subject areas as well. In particular, the difficulties the students face in learning from a computer is not limited to mathematics. After all, the reason for CAI is to let the students set their own pace and create their own learning style. If the conventional method suits the students, they should certainly be able to learn the material that way. It helps greatly to remember that CAI is not a cure-all, but is another alternative for those who do better if allowed to take the initiative in their learning and set their own pace. At the community college level, one of the major reasons for introducing CAI is to retain the students in the class. Therefore, if the student is not comfortable with CAI, there is no reason to force it upon them.

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Effects of Hand-Held Computers on the Teaching of Algebra

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The publication, "Algebra for Everyone" (Edwards, 1990), suggested that *all* high school students need to study algebra. Several mathematics educators supporting this idea have noted that traditional algebra is approached in a manner that is too abstract for most students (Chambers, 1994; Hawkins, 1993; Heid, 1995; National Council of Teachers of Mathematics Board, 1993; Seeley, 1993; Silver, 1995; Steen, 1992; Usiskin, 1995). A recurring message in each of these articles is that traditional algebra often is taught using a rigorous approach that involves rote computations, meaningless manipulations of symbols, and acquisition of a predefined set of procedures for solving a fixed set of contrived problems. In addition, the algebraic understandings cultivated in traditional algebra are generally far removed from those needed by both employment-bound and college-bound students in a technological world. The challenge of creating an "Algebra for Everyone"—one that can provide *all* students with tools that allow them to advance in both academic and employment settings—has caused mathematics educators to rethink the structure of algebra as well as the teaching of algebra.

Three major issues must be addressed for the implementation of an "Algebra for Everyone" to be successful. One issue centers on the obvious need for the rethinking of the topics and the structure of the algebra curriculum. The second issue involves the role of technology in a reformed algebra curriculum. The major influence of technology in mathematics education is its potential to shift the focus of instruction from an emphasis on manipulative skills and algorithms to an emphasis on development of concepts, relationships, structures, and problem-solving skills (Corbitt, 1985). This is right in line with the goals for the reformulation of the algebra curriculum. The third issue revolves around the need for effective staff development to prepare both preservice and inservice teachers to teach a reformed algebra curriculum that makes regular use of powerful technology. The proposed changes in curriculum and teaching practices are a substantial departure from conventional practice, and considerable evidence suggests that reforms of this type are difficult to implement and hard to sustain (Cuban, 1990; Cuban, 1992; Fullan & Stiegelbauer, 1991; Sarason, 1990). Reform efforts aimed at changing the way we approach mathematics teaching cannot possibly succeed without the assistance of teacher preparation and training programs.

Need for Algebra Curriculum Changes

One of the major themes that permeates mathematics in algebra and the courses that follow is the study of function. In spite of this, traditional algebra has been organized around the concept of equation and methods of solving equations. The concept of function has been "patched in" at the end of the algebra course without providing substantial meaning or purpose. The algebra curriculum has typically approached functions as a more advanced idea and has treated functions in abstract and general ways which serve to make simple ideas difficult (Stanley, Molina, Seeley, & Williams, 1996).

According to Stanley (1995), the emphasis on number systems and equations in the traditional high school algebra course made sense years ago when the course served as the first step in the preparation for a college-level course in "abstract algebra." But today the topics and organizational structure of high school algebra make less sense as the goals shift toward the laying of a foundation for general understanding of technical ideas in science and business, or as preparation for the eventual study of calculus. Stanley suggests that high school mathematics in general (and algebra in particular) should take on a flavor of *analysis* (where the study of functions is the central focus) and not of abstract algebra (where the study of number systems and equations is central).

Placing the concept of functions in the central role of algebra makes sense for several reasons: (a) the concept of function arises naturally out of the study of patterns and formulas of earlier grades; (b) variables represent quantities that change, and functions provide a way of stating simple and basic dependency relationships between these quantities; (c) equations are special cases of functions—rather than the emphasis of algebra being placed on the special case, it would focus on the overarching idea of function; (d) the flow of algebra would be more natural—questions often arise from the study of functions that lead to simplifying expressions, solving equations, and working with inequalities; (e) with hand-held technologies, graphs of functions are easily constructed and compared; and (f) connections between multiple representations of functions become more accessible with the computer assisted symbolic algebra (CAS) capabilities of the newest hand-held computers (Stanley, Molina, Seeley, & Williams, 1996).

Heid and Zhiek (1996) propose that algebra should be reformulated so that the curriculum (a) centers on algebraic concepts such as function and variable instead of on paper-and-pencil algebraic routines, (b) focuses on mathematical modeling rather than on classic word problems, (c) replaces symbolic manipulation with symbolic reasoning, and (d) encourages the use of multiple representations and strategies in algebraic problem solving instead of mastery and use of one representation or strategy at a time.

Impetus for Algebra Curriculum Changes Provided by Technology

The algebra curriculum needs to embrace a functions approach using experiences embedded in the context of realistic and interesting problems (Chambers, 1994; Fey & Heid, 1995; Heid, 1995; Silver, 1995; Stanley, 1995; Usiskin, 1995). Graphing technologies support the change to a function-centered algebra curriculum—the language of graphing technologies quite naturally depends on the concepts of variables and functions. In addition, the technology makes the use of real-life data and contextual problem-solving situations more attainable. Without technology, students are limited in problem-solving situations to solving problems which predominantly use algebraic techniques. Classroom time and student algebraic skills become issues when technology is not present; problems must be carefully written so that there are "nice" solutions. Because real data rarely behaves in a "nice" manner, contrived data has been used in the past. When technology is made available, real data can be collected and used because the technology can handle the "tacky" computations and the time-consuming and tedious manipulations. The student is allowed to focus on process and the construction of understanding which allows for meaningful interpretation of the outcomes.

Mayes (1993) has found that graphing technologies have (a) broadened the class of problems that can be presented to students because the polynomials need not be factorable or limited to small degrees, (b) allowed for both algebraic and graphing approaches, improving students' understanding by furnishing multiple representations of a problem, (c) afforded the opportunity for discovery-learning episodes by reducing the burden of computation, manipulation, and plotting so that students can focus on patterns and relations, and (d) allowed a focus on heuristics for solving more realistic applications by reducing the time spent on mundane manipulations and graphing.

Hand-held computers have recently become more advanced. For example, the new TI-92 hand-held computer provides a first glimpse of inexpensive powerful technology that will be available on a regular basis to all mathematics and science students (Demana & Waits, 1996). It has built-in software for computer assisted symbolic algebra (CAS), computer interactive geometry, 3-dimensional graphing, sequence graphing, a partial spreadsheet, as well as all the traditional features of graphing calculators. The TI-92 can be linked to a Calculator-Based Laboratory System (CBL) to collect experimental data electronically. The full range of probes available for computers are also available for CBLs. The affordability of such a powerful tool for mathematics and science investigations should certainly assist in redirecting the focus of the algebra curriculum.

The use of sophisticated technology such as the one described above encourages change not only in how mathematics is taught (instructional component) but also in what mathematics is taught (curriculum component) and the setting in which it is taught (contextual component). Technology can play a powerful role, both as a catalyst for change and as a resource to facilitate the transformation of teaching and learning (David, 1990). Together, reform and technology create a far more powerful force for change than either is alone.

Need for Professional Development Training for the Teaching of Algebra Using Technology

To make "Algebra For All" a reality means focusing on fewer topics organized around central ideas while preserving mathematical integrity and rigor through the depth of study rather than the breadth of study. As we formulate this approach to teaching algebra, we must use the information that we know about how students learn best and apply that knowledge to our teaching. Students need to be involved in active learning situations with new information being connected to the information they already possess. Algebra students need to be provided with opportunities to experiment and collect data, to analyze that data, and to draw reasonable conclusions based on the findings. Algebra needs to focus on "ways to solve a problem" rather than "the way to solve a problem" so as to equip students with multiple solution strategies. A major obstacle in creating such courses stems from the fact that teachers have never been taught how to teach in a way that engages students in a variety of interesting and important learning activities structured to develop the inherent critical thinking and problem-solving abilities of all students (Seeley, 1993).

To assist in the development of an understanding of how algebra might be addressed from a functions approach, a professional development algebra institute (Williams, 1996) was created for secondary mathematics educators in the state of Texas. This five-day institute was produced with funds from the Texas Statewide Systemic Initiative in Mathematics, Science, & Technology Education and the Texas Education Agency and consists of student activities, presentation transparencies, and teacher notes for three areas of first-year algebra: foundations of functions, linear functions, and quadratic functions. Initial training of trainers began last March—an effort which trained more than 100 mathematics coordinators/specialists and regional service center personnel. Those 100 trainers have provided multiple training sessions in their regions during the summer and again this fall. Training was also provided in May for university teacher educators thus allowing the materials to be incorporated into preservice secondary mathematics methods courses and/or graduate mathematics education courses. In the paragraphs that follow, an opening activity which involves the use of hand-held computers will be described to illustrate how teachers can be immersed in technology-enriched algebra experiments that demonstrate a different orientation for algebra with technology and function concepts taking increased "front stage" roles.

Example Activity

The Valentine's Day Idea Problem: The school's drill team has decided on a money-making project for February. They plan to take orders (and money) for roses in advance and deliver them to the designated students on Valentine's Day. The drill team has contacted several flower distributors and has narrowed the choice to two companies. They need to determine the more economical option.

Classroom Setup: Participants are divided into groups of four. Two people are positioned so that they cannot see the overhead projector. They represent members of the drill team who are to make the decision about which company to do business with. One person is instructed to ask cost questions from a small school perspective, and the second person from the perspective of a large school. The other two people are positioned so that they can easily read information that is projected onto the overhead screen. One of these persons is to represent the Roses-R-Red Flower Distribution Company and the other is to represent the Flower Power Distribution Company. It is their job to try and convince the drill team to buy from the company they represent. All four participants are provided TI-92 graphing calculators.

The Constraints: The following information is projected onto the overhead screen. Option 1: Roses-R-Red has offered to sell its roses for a fixed charge of $20 plus an additional charge of 75 cents per stem. Option 2: The Flower Power has offered to sell its roses for a fixed charge of $60 plus an additional charge of 50 cents per stem. Which is the more economical offer?

Outcomes of Activity

Initially, the Roses-R-Red representative concentrates on the fact that their fixed charge is only $20 compared to the competitor's fixed charge of $60. The Flower Power representative diverts the buyers attention to the fact that they sell each stem for 25 cents less. This situation provides for excellent discussion during the debriefing period. It draws attention to the fact that often students have a tendency to focus on certain parts of a problem situation while not attending to other parts. If allowed sufficient time to work on the problem, however, the context of the problem and the group discussion eventually lead students to address all the parts together.

Some buyers approach the problem by asking questions about the cost of a certain number of roses, and they build a table to keep track of the outcomes. For example, they might ask how much it would cost to buy 10 roses from Roses-R-Red and from Flower Power?, how much for 20 roses?, how much for 30 roses?, etc.

# Roses	Cost at Roses-R-Red	Cost at Flower Power
10	$20.75	$65.00
20	$35.00	$70.00
30	$42.50	$75.00
40	$50.00	$80.00

They note that the difference in cost is getting smaller as the number of roses purchased increases and generally continue to build the table to determine the point at which the difference is zero. They then understand that the most economical offer depends on how many roses are being purchased.

Other participants choose to write the functions that describe the two proposed deals and to graph them. The Roses-R-Red function is $y1 = .75x + 20$ and the Flower Power function is $y2 = .50x + 60$. By graphing the two functions and using the zoom and intersection features of powerful hand-held computers, the groups can very quickly determine that the cost difference becomes zero when 160 roses are purchased. Careful examination of the graphs with the trace feature of the technology indicates that Roses-R-Red is more economical when less than 160 roses are purchased, and Flower Power is more economical when more than 160 roses are purchased.

Several groups have entered the two functions into the function plotter menu but then used the table generator feature of the hand-held computers to investigate and compare the costs for the two companies. This provides for nice discussion about an approach that combines the first two approaches.

Some participants simply set the two functions equal to one another thus creating an equation with one variable. They can even use the CAS features of the TI-92 to solve the equation $.75x + 20 = .50x + 60$. This approach allows for excellent discussion on the roles of functions and equations in an algebra course. The approach exemplifies the point that equations are a special case of functions. The equation that is proposed is asking for the value of the common variable x for which the output of the two functions is equal. Once again the solution to the equation ($x = 160$) signals that there is no economic advantage when 160 roses are purchased. More work is required to determine what happens when less than or more than 160 roses are purchased.

Occasionally a group gathers several data points for each company, creates scatter plots on the calculator, determines a line-of-best-fit for each data set, and investigates the graphs to make their decision.

The real richness of the activity becomes obvious during the debriefing period when participants share their approaches to the problem. Teachers are allowed to experience for themselves that algebra problems can be solved in many different ways, that one approach is not best, that real understandings come from viewing multiple representations (tables of values, graphical representations, algebraic symbolic representations) of the problem and connecting the meanings of each of these representations. They also are allowed to see how equations naturally arise from functions and give purpose for finding the unknown quantity.

Closing Remarks

Mathematics teacher educators need to understand algebra very differently than we did a few years ago. Success in algebra in the past has been judged by mastery of a set of manipulative skills presented in isolation. In contrast, the algebra of today is expected to eliminate artificial and meaningless exercises and to de-emphasize symbolic manipulation while at the same time giving students opportunities for exploration and conjecturing and discovering. But not only must we understand algebra differently, we must be prepared to illuminate others. The algebra reform movement put into motion by the NCTM *Curriculum and Evaluation Standards for School Mathematics* (1989) will not succeed if teacher educators are not (a) prepared to rethink the algebra curriculum and ready to model instruction that allows for personal construction of meaning, (b) armed with technology and an understanding of how to allow the technology to assist learning—not control learning, and (c) prepared to provide quality preservice and inservice training for mathematics teachers.

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Math Central: A Web Site for Teachers and Pre-service Teachers

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In September of 1995 three faculty members at the University of Regina implemented an Internet service for mathematics teachers and students from kindergarten to grade twelve. Math Central <http://mathcentral.uregina.ca/> is intended as a meeting place for teachers of mathematics to share resources, as a service to teachers, students and parents who may need an answer to a mathematical question, and as a facility to allow teachers to carry on a dialogue amongst themselves. In this paper we outline why this service was begun, its basic structure, how it has been used by faculty and students in the Faculty of Education and how it has changed the structure of teaching and learning in Mathematics Education classes.

History and Background of the Project

The site, which is very much an educational project in the pedagogical sense, had its beginnings outside of the Faculty of Education. Our university, the University of Regina, is a moderately sized (approximately 11,000 full and part-time students) research oriented institution in Western Canada. The first author is from the Faculty of Education. The second and third authors have their training as research mathematicians and are members of the Department of Mathematics and Statistics in the Faculty of Science. The eight-year involvement of the third author with a Provincial Mathematics Advisory Committee and a three year involvement of all three authors with the local Public School Board's Mathematics and English Advisory Committee brought them directly into contact with teachers and students at all levels. In the case of the Provincial Mathematics Advisory Committee, the K-12 mathematics curriculum was being entirely rewritten with a problem solving approach, incorporating many of the themes from the NCTM Curriculum and Evaluation Standards (1989). Beyond the provincial level, a Western Canadian Protocol for Collaboration in Basic Education (1996), involving four provinces and two territories, was developing a Common Curriculum Framework for K-12 mathematics. The philosophy of the Provincial Education Department, Saskatchewan Education, is also reflected in this protocol. The Regina Public School Board Mathematics and English Advisory Committee was considering the interface between the secondary and post-secondary institutions and the problems students encounter at this juncture. This exposure not only emphasized the disparate views of research mathematicians with educators at all levels but exposed a gap in the maintenance of K-12 professionals and an complete breakdown or lack of communication between mathematicians on our campus with each of: K-12 students, student teachers in the Education Faculty, Faculty in Mathematics Education, and K-12 teachers. The introduction of new topics into the curriculum, the demand for interesting examples and applications, and the obvious lack of communication among K-12 teachers planted the seeds for the Math Central project. We envisioned a place where both students (at all levels) and teachers could share their questions and expertise, a site which would be theirs to develop, a site at which mathematicians from the Faculty of Science would act as a resource and as facilitators, and importantly, a site on which student teachers could develop and share resources while becoming literate in the ways of the web.

Relationship to the Curriculum

An important part of Math Central, other than the distinguishing feature that it was to be run by students, student teachers, and teachers, was that it actually support Provincial and Western Canadian philosophies of mathematics education. For example, the mathematics curricula (Saskatchewan Education, 1992, 1995, 1996) are centered around the philosophy of real-life problem solving, the active involvement of students, and the use of a variety of appropriate resources. The curriculum is designed to promote the following: the incorporation of problem solving in every strand of the mathematics program; the use of multiple resources; the application of mathematics to real life; the active involvement of students in their learning, including the extensive use of manipulatives; the application of estimation and mental arithmetic strategies; the use of calculators and computers as tools for learning and doing mathematics; the use of simulations, projects, and experiments as the basis of understanding the role of mathematics in the real world; and, an integrated approach to the teaching of mathematics.

Characteristics of the Site

The physical shape of the web site, as described below, was decided upon for a variety of reasons, many of them coming from our interaction with teachers in the field and from being on advisory committees. The problem of starting up a site without resources from teachers was somewhat delicate. It would not have been wise to have the site appear to be a university-driven site telling teachers what to do. A major facet of this site is the capability of teachers to share resources with teachers. Needing seed resources we adopted pseudonyms in some cases, while in others we directly addressed questions that we had encountered in our advisory capacities. Additional resources were obtained by inviting teachers into our advisory group for Math Central.

The Resource Room

The Resource Room is a facility to allow mathematics educators to store and retrieve resources. It is a place where teachers can share notes, ideas, lesson plans, or any other resource having to do with the teaching of mathematics. In the beginning, the Resource Room was seeded with resources written by those of us who started the project; now we are actively seeking submissions from teachers and student teachers. At the present time approximately 60% of the resources have been written by teachers or students and approximately 20% are in French. The resources are categorized by level, elementary, middle and secondary, and then by curriculum strand. A user is able to browse the database by level and strand and see title, author, and an abstract of the appropriate items. There is also a search mechanism that allows the user to search the database by keyword, author or title. The Resource Room also has mathematics glossaries, at the middle years level in English and at the elementary and middle years levels in French.

Quandaries and Queries

Quandaries and Queries is a question and answer service. Mathematical questions sent to us are automatically forwarded to a group of teachers and university faculty we call our Quandaries and Queries consultants. Input from the consultants is then formulated into a response which is returned to the person who asked the question. As in the Resource Room, the mathematical questions and answers are stored in a database that can be accessed by any user. This database is categorized by level and can also be searched by keyword, author or title.

Teacher Talk

Teacher Talk is an electronic mailing list for mathematics teachers. The intent of this service is to provide teachers with a place for an open discussion on mathematics education, with the topics as varied as the participants wish. Archives of the Teacher Talk discussions are maintained on the Math Central server and can be viewed by any user.

Bulletin Board

The Bulletin Board is Math Central's information board. It includes information about conferences, newsletters and periodicals, and the site itself.

Changing Nature of the Site

In our original concept of Math Central we expected that questions to Quandaries and Queries would be mathematical in nature and that questions concerning the teaching of mathematics would be discussed in Teacher Talk. The usage is of course determined by the users and the division between Quandaries and Queries and Teacher Talk has blurred. The site has thus taken on a life of its own through user-driven modification. Some examples of non-mathematical questions sent to Quandaries and Queries will illustrate this point. These questions are quoted verbatim from submissions to Quandaries and Queries, with identifying information removed.

1. I'm looking for information on math anxiety. Any resources that you know of on the Net? Thanks!
2. I am the mathematics consultant and we are about to begin work developing performance standards to accompany recently produced curriculum outcomes for the end of Grade 10. I am interested in identifying documents/sources which may have already been produced along this line. Thank you for your help.
3. I'm a graduate student from ***** searching for journal articles or research on linking math and children's literature in the primary setting. Could you direct me? I haven't had much luck on the WWW. Thanks!!!!!!!
4. My name is ***** and I am a student at *****. I have recently chosen to do a science project on whether or not a calculator causes people to lose their knowledge of basic math skills because of increased use, in other words, if we become dependent on them. I have had great difficulty finding any information related to my topic. If you have any related articles or studies on this topic, I would greatly appreciate your help.

These and similar questions have underlined the importance of having a list of consultants with a variety of expertise. Those of us who are academics can supply the expertise in mathematics and in pedagogy but the real experts on many aspects of education are the teachers in the classroom. If Math Central or similar sites are to be useful to teachers and students they must involve substantial cooperation among the various stakeholders.

Education Student Involvement

Since the conception of Math Central and its first appearance on the web in September of 1995, the site has employed education students to work on a variety of tasks such as transforming submissions from teachers or students into html format for posting in the Resource Room, demonstrating the site through workshops at the university and in schools, and compiling a cyberbibliography of math-related web sites. In addition to these paid appointments, mathematics education students contribute to the site by (1) submitting resources which they have personally developed, (2) asking questions in the Quandaries and Queries section, (3) subscribing to and participating in Teacher Talk, or (4) acting as consultants in answering questions that are submitted from the teachers or students.

Pre-service Course Involvement

The pre-service teacher involvement, particularly in the elementary (i.e., kindergarten through grade 5) and middle level (grades 6 through 9) mathematics education classes taught by the first author, has included the following:

1. One senior elementary and middle level mathematics education class was given an assignment which required them (1) to access and become familiar with Math Central, (2) to use Math Central's built-in links to explore other sites, and (3) to conduct a search for mathematics topics within Math Central and throughout the World Wide Web. In each case the students had to write a short description (and critical analysis) of the sites they visited, how the sites could be used, and by whom. These hundreds of sites were then collated, edited, and organized alphabetically (by our paid assistant) into our Cyberbibliography <http://mathcentral.uregina.ca/RR/cybiblio/cyberbib.html>. This was a massive project that began with some tears, much frustration as access was a problem for some students, a fair amount of one-on-one mentoring and peer support, and finally an acceptance that the Internet was here to stay and that this assignment was valuable for their professional growth as teachers. By the end of the assignment, and especially when students saw their work published on the web, they felt quite proud of their accomplishment; some became tutors for second year elementary pre-service teachers.
2. Another class assignment, this time for a second year, middle level class, involved the students, in groups of four, (1) locating and doing problems found on math web sites by use of a data projector and Internet connection in the math lab, (2) analyzing these problems for problem type, most efficient strategy, and curriculum integration, (3) creating a problem of a particular type, addressing a real problem situation, and becoming involved in the problem context, (4) giving their problem to other groups to solve, and (5) assessing the merit of their problem (self-assessment) and problems of their peers (peer-assessment). After about six class periods, the tested, evaluated and edited problems were ready for publishing on the Math Central web site (see "An Experiment in Problem Solving" <http://mathcentral.uregina.ca/RR/database/RR.09.95/maeers4.html>).

   For most of the students this was their first electronic publication, so the experience helped them to better understand the importance of the web as an effective tool for teaching and learning mathematics.

   Also, since the entire project was a class assignment, which carried course credits and grades, the students were strongly motivated to stick with the project and see it through to completion.
3. During the winter, 1997 semester, elementary and middle level pre-service teachers will become involved in Math Central through an assignment which will require them, in groups of four, to compile a resource bank to support different curriculum strands at different levels. For example, a group of four middle level pre-service teachers may decide to compile resources for data management and analysis, one of the middle level curriculum strands. They will begin with their curriculum guide to determine the extent of this strand at the middle level. Then they will visit Math Central to locate and explore any Math Central resources related to data management and analysis. From Math Central they may link to other sites and eventually they will produce an extensive resource list of web site information, text/print resources, non-print resources, computer programs, video and interactive CD-ROM resources, etc. Their assignment, when completed, will become part of a newsletter, which is distributed to all mathematics society members in the province, and it also will become part of the Math Central resource list for middle level data management and analysis.

Changes in Course Planning and Implementation

Dr. Maeers, in her course planning, is now incorporating into the assignment agenda opportunities for all students to (1) explore and become familiar with Math Central through an assignment (with credit attached to it) that requires of the students some contact with this site, and (2) contribute to the professional mathematics society of the province, either directly through the math newsletter, or through posting work on Math Central, whereby it can then be accessed by any interested party. From the exploratory beginnings to the final posting and publication, the students become keen Math Central and general Internet users/surfers. They also locate other resources, which they share with the class, and develop group projects involving Internet access. For example, one group used the Internet to investigate fractals, located fractal images, animated fractals, played fractal music, etc. They created a fractal slide show, using downloaded images and sound, and portions of a video, which was imported into the slide show. All of this played in the background during their verbal presentation. This presentation did not involve Math Central directly, but before they created their project they had spent many hours exploring Math Central and this exploration or playing phase enabled them to expand their horizons to more sophisticated Internet usage.

Course assignment agendas have changed to include opportunities for all students to access and explore features of Math Central and other web sites, and for students to become familiar with software appropriate for their chosen level of teaching. Actual class teaching has changed to include frequent opportunities (1) to demonstrate Math Central and other web sites to students, (2) to introduce and model how to effectively use appropriate mathematics software, and (3) to deliberate on the effective integration of web sites, the resources from web sites, and to incorporate software into mathematics instruction. It is critical that pre-service teachers are knowledgeable and comfortable with technology so they can select which tools or resources would be the most effective in the classroom environment they are planning for their students.

Conclusion

The creation and implementation of Math Central has precipitated the development and evolution of an extensive knowledge base of types of usage of this web site—who has used it, for what purpose, what percentage of elementary teachers, secondary teachers and so on. We know, for example, that the web site use began locally among the pre-service teachers at the university and has expanded to being used extensively by teachers at all levels around the province and by teachers from other parts of the country and around the world. We have linked our web site with provincial and national mathematics societies through the Bulletin Board, either by making a link directly to their web site or by posting information from other societies on Math Central, thus making available to interested parties relevant provincial and national up-to-date information. Math Central has thus become an environment where information from mathematics societies may be stored and retrieved. It has also become a user-friendly environment for teachers of our province, and indeed for any teacher, to locate resources to integrate into their classroom environment. Math Central has facilitated an autonomous learning environment for the students and for the pre-service mathematics educators; it has become a place where both students and professors can share ideas.

The Math Central web site has acted as a prototype web site for all subject areas in the Faculty of Education. It has provided mathematics education students with a real forum for participation and has enabled them to become proficient at general Internet research and at being mentors for students and teachers just beginning their Internet journey. The impact of having what the students call their very own web site has engendered real interest in learning (1) how to contribute to a web site, (2) how to learn from it, and (3) how to teach mathematics differently, and more effectively, by utilizing many different resources, and by knowing *which* resources to use.

Support and Funding

In a research-oriented faculty such as our Faculty of Science, an unusual concession was needed to develop Math Central. The Dean of Science, with the backing of the Vice-President Academic, agreed to allow work on the proposed site as a legitimate academic pursuit, an academic pursuit that would be evaluated at Faculty Review time, in Science, in lieu of research and publications in mathematical research journals. The Deans of Science, Education and Graduate Studies agreed to provide funds for the equipment. External funding was required to make the project viable. We sought funds to hire students to help design and implement the site and were successful in attracting funds from the SaskEd Multimedia Program and from Industry Canada, a supporter of SchoolNet, an educational initiative supported by a variety of organizations across Canada.

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MAKING CONNECTIONS

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The University Corporation for Atmospheric Research (UCAR) has developed a program, *Project SkyMath,* that integrates science, mathematics, and technology in a middle school (grades 5-8) mathematics module, *Making Mathematical Connections: Using the Science and Language of Patterns to Explore Temperature*, based on the content standards of the National Council of Teachers of Mathematics (NCTM).

When discussing connections, the NCTM Standards often refer to making connections within mathematics itself or to applying previously-learned mathematical concepts to new mathematical situations. But there are many other "educational" connections that enhance the learning process. The SkyMath module provides a mechanism for connecting key mathematical ideas to a real-world scientific context. It connects classroom activities with technology by introducing sophisticated technological tools as needed during the course of the development of the mathematical ideas. The SkyMath activities move students into the realm of purposeful projects calling for reflection and communication; these serve as a good transition tool to assist those teachers who have only taught in the more traditional manner to connect to constructivist pedagogy. We have found that when used in a classroom, it has encouraged in-school teacher collaboration (between the science, mathematics, and technology teachers), connecting science, mathematics, and technology teachers.

The most interesting connections for UCAR are those between middle school teachers and university faculty. UCAR universities (62 research-intensive universities having Ph.D. granting programs in the Atmospheric Sciences) are beginning a program to introduce the SkyMath module into their undergraduate courses that serve future middle school teachers. Earth Science Departments are interested in diversifying their offerings and have expressed interest in focusing one section on future K12 teachers. The introduction of the SkyMath module to future teachers fits well into such a section and provides the future teachers with content that could be taken directly to the classroom.

The university scientists are also building connections to their education departments and are learning the teaching styles of the new pedagogy, implementing them in their undergraduate courses, and are offering their scientific expertise as a backup to the SkyMath module. Faculty and undergraduate students are serving as resources to the local middle schools in a collaborative effort to support mathematics teachers in the implementation of the SkyMath module. In one university, the SkyMath module has been introduced in the school of education's math methods course as an example of the use of technology in a middle school math classroom. Undergraduates responded very positively to this opportunity to get familiar with a module they could use directly in their classrooms.

Following a similar pattern, the Universities affiliated with NASA's Minority University-Space Interdisciplinary Network (MU-SPIN) are connecting with local middle schools and encouraging them to introduce SkyMath into their curriculum. Seven minority universities have taken on the responsibility for building and maintaining Internet connectivity to minority institutions and predominantly minority-attended elementary and secondary schools in their areas. The SkyMath module provides math-content for the schools coming on-line.

A more general connection illustrated by SkyMath is that of connecting classrooms and teachers to the Internet. The SkyMath module is freely available for downloading from the SkyMath HomePage:

http://www.unidata.ucar.edu/staff/blynds/Skymath.html

The module is intended to be self-supporting for any middle school math teacher who has Internet connectivity — In addition to fifteen classroom activities, the module contains tutorials on accessing weather data, built in student assessments, "teacher stories" from teachers sharing their experiences with the module, reproducible masters that can be printed and copied for student activities, and an Internet SkyMath Mailing List for teachers to share experiences and information and to link up with a partner classroom.

SkyMath seeks connections with professional Societies like SITE in the hopes that the membership will assist us in communicating this opportunity for teachers to make mathematical connections.

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It is always a pleasure to read articles about multimedia and hypermedia. Developments in this area of Instructional Technology are evolving so rapidly that, between the time these articles were written and their presentation at the SITE conference, new programs and applications will have enriched our understanding and documented our progress. This section describes a wide variety of multimedia and hypermedia projects which are rapidly expanding the ways we understand, manage and disseminate the information that contributes to both our teaching and learning. The authors of these articles demonstrate a commitment to using new media in two main ways. Several authors discuss the role of the teacher and developer in using and implementing hypermedia. Other authors discuss the development of multimedia products that can be used in educational settings.

The Role of the Teacher and Developer

Bartasis and Palumbo explore the role of instructional guidance to aid the development of search strategies in a commercially produced, situated, hypermedia environment. Their article provides valuable information for teachers interested in using similar technology-mediated environments as part of developing writing process skills in their students. Several factors such as the inclusion of graphics in the writing product and the related process of reflection about relevancy appear to enhance both the visual experience and cognitive efforts.

Lee presents the findings of a survey designed to identify the motivational factors and learning methods that influence users learning to use hypermedia authoring applications. Results indicate that a constructivist approach with hands-on experience and learning-by-doing activities were viewed as valuable and useful.

The Development of Multimedia Products

Mitchell and Smalley describe the development of multimedia lesson plans by preservice teachers at the University of Central Florida. These lessons plans are created with a multimedia authoring tool and incorporate text, graphics and video components. Other strategies designed to utilize multimedia for a variety of purposes with different audiences are explored in this article.

Proost and Elen discuss the development of DigIT, a hypermedia information system about the use, development, and evaluation of courseware. Teachers are able to obtain a systematic overview of types of courseware and concrete examples as well as answers to specific questions. In addition, DigIT may be used as part of a training program for future teachers by providing a digitized source of textual information as well as a working example of a hypertext database.

Herrington, Sparrow, Herrington, and Oliver provide a description of interactive, self-paced and instructor-supported learning modules which provide preservice teachers with a more complete range of mathematics teaching and assessment strategies. These modules consists of a multimedia CD-ROM and a manual which provides a list of optimum implementation conditions. Preliminary evaluation indicates that the motivation to learn from the experiences described in the modules has resulted in student teachers developing self-directed strategies that have resulted in quality learning.

Hwu, Tzseng, and Pan discuss the planning and development of a hypermedia application designed to teach Spanish phonics. Their article describes the various phases of the development of the prototype and suggests that it is feasible to develop this type of application to enhance traditional teaching methodology.

In a close-up of a multimedia design team, Heath, Butts, Reed, Troutman and Varagoor, a group of graduate students from the Instructional Technology Program at the University of Houston, discuss their experiences in developing a product. Each student contributes a unique perspective of the design process and the role of collaboration, communication and cooperation in the success of both the team and the development of the product.

Ouyand and Holst present the development of an multimedia-based, instructional module designed to teach research writing. In this paper the authors present a description of the six phases of the writing module, discuss its potential effectiveness of teaching and provide teachers with suggestions for implementation which includes software. Both developer and user perspectives of the process are provided.

Stammen describes a two-year project designed to teach college professors and K-12 teachers how to use multimedia to enhance their classroom curricula. The project also involves pilot-testing the modules and related materials in four schools and at two universities. Information about the procedures and strategies utilized, as well as the systematic process involved is shared in this paper.

Strang and Schoeny discuss a software tool that allows teachers to prepare hypermedia lessons in virtually any content area. The three program modules, the authoring module, the instruction/testing module, and the feedback module, are described as well as field trials designed to assess the instructional phase's ease of use and student navigation.

The articles in this section provide a critical insight into current developments and future applications of new media. They offer a practical and useful resource for educators who want more information about this evolving area.

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TEACHING AND LEARNING INFORMATION SEARCH STRATEGIES IN A SITUATED HYPERMEDIA ENVIRONMENT

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Information-based technologies have quickly become an integral part of American society (Cerf, 1996). Rapid technological changes in American society are affecting changes not only in the way we do business, but in the way we educate our students, and in the expectations of educational outcomes (U.S. Department of Education, 1991). Although we cannot precisely predict what form education will take in the coming years, we can begin to identify skills that will be needed in order to function in technology-mediated environments. Through a synthesis of knowledge of how people learn and how people use technology, educational researchers may be able to make recommendations regarding the relationship between technology and the learner that could result in the design of more effective and efficient learning environments.

Technology implementation is a problem that affects educators at all levels, sometimes in a most daunting way (Budin, 1991). Facilitating technology implementation in classrooms does not require teachers to become programming experts, or commit to expensive dedicated learning systems, or become savvy Internet surfers. It does mean that teachers need access to information and acquisition of skills that will aid them in adding technology mediated instruction to the palette of tools they currently use. Classroom implementation of technology needs to be addressed in a realistic, usable manner so that educators at all levels of computer competency can begin to push the envelope of experience technology offers and use its capabilities to provide challenging learning environments that can be used to develop higher order thinking skills and prepare our students to take their places in a technology rich society. As technology continues to change and improve, the development of quick and easy, yet effective, methods of implementation becomes more urgent.

Over the last decade new computer hardware and software development has increased at an extremely rapid pace. Hypermedia, multimedia, access to the Internet especially the World Wide Web, computer-mediated communication, development of groupware and other types of collaborative software, are opening the doors to new types of learning environments and new perspectives on the use of the computer (and related technologies) in education. In the midst of these new technologies, a new perspective on the role of computer in the classroom is emerging. This perspective involves using existing applications as "cognitive tools for engaging and enhancing thinking in learners" (Jonassen, 1996). Using this perspective, the challenge before educators and learning specialists is a critical examination of existing technology, and a determination of its possible use as a cognitive tool in the promotion of meaningful learning.

Hypermedia Environments

The successful implementation of any new tool in the classroom - whether it is a book, a manipulative, computer software or a particular perspective on learning - depends on the teacher's awareness of the tool's strengths and weaknesses, as well as its utility. In order for meaningful learning with technology to flourish, teachers need to understand the strengths and weaknesses of technology mediated learning environments. The focus here is on hypermedia (Nielson, 1990) environments, as they are loosely structured and provide the opportunity for students and teachers to access and construct information in a variety of meaningful ways.

Research in effective uses of hypermedia identifies several possible problems for the user, including learner control and navigation issues. Learner control refers to a student's ability to make content selection choices, to sequence objectives, and to control the pace of the learning (Merrill, 1980). At issue over the years in hypermedia research has been the determination of the appropriate amount of learner control. In a meta-analysis of 50 learner control studies involving computer assisted instruction, Goforth (1994) found many conflicting and/or inconclusive results, but also determined through the analysis that it is important that the learner have some control rather than none, that learner control is an effective strategy and that adaptive advice is a central element of it.

The nonsequential nature of hypermedia systems can create information interaction problems for the user. Most information interchanges that we experience are linear. Interacting with information in a hypermedia structure requires the user to fight a history of traditional presentation of information in a linear, sequential manner (Conklin, 1987). Research regarding navigation in hypermedia environments has shown that several problems can impede the search for information. The ability to choose any path through the information can limit the user's ability to understand his/her location in hyper-space (Dede, 1992). Some hypermedia researchers have attempted to overcome this problem by providing navigation aids, such as maps or indices, or constraints on paths that users can follow (Gay, Trumbull, & Mazur, 1991). Another navigation related problem lies in developing a means to ensure that the user will interact with all the information the designer intends, guarding against simple omission (Shin, Schallert, & Savenye, 1994) or purposeful exclusion (Harmon & Dinsmore, 1993).

In spite of the potential problems presented, hypermedia seems to have much to offer learners. It can provide an environment that engages the learner through interactivity, allowing the construction of knowledge in a meaningful way. It provides an environment that can enhance the learners' ability to accurately access information, to capture it, to interact with it, and to manage it (Nelson & Palumbo, 1992).

When the environment in which information is presented is loosely structured, the role of instruction in technology mediated learning becomes a critical interplay of student interaction with the learning environment, the emergence of strategies through experience, and expert advice. The process that takes place when using a hypermedia system allows for review, revision, and improvement by an accomplished user. "When structured into learning environments that motivate guided inquiry, hypermedia has the potential to develop more user metacognition than linear media." (Dede, 1992, p. 56)

Instructional Guidance and Information Construction

In an attempt to address some of the concerns teachers may have with technology implementation, a study was conducted to explore methods of connecting teachers and students and technology in an easy, yet meaningful way. More specifically, it explored the role of instructional guidance to aid the development of search strategies in a commercially produced, situated, hypermedia environment.

Methods

Students

This study involved 32 fifth grade language arts students in a third-fifth grade elementary school located in a working class suburb of a major southwestern city. All students were grouped in above average ability groups and were taught by the same language arts teacher. Technology use in the school was limited to computer lab tutorials and computerized library card catalogs. All students have had some experience with basic navigation in hypermedia environments.

Software

The software used in this study is a commercially produced title, *The Nile: Passage to Egypt* (Discovery Communications, Inc., 1995). It is a multimedia/ hypermedia environment that is rich with still photos, videos, narration, and text about life along the Nile. The user navigates an Egyptian boat down the Nile and can choose direction, areas, and depth of investigation. Clicking on an area of interest allows the user to obtain audio explanation at a broad level, or audio, visual and text at a greater level of detail. Information can also be retrieved directly from the database, if desired. *The Nile* also has a journal in which users can record the information that they find - text, audio, and visual - as well as their own words. *The Nile* includes 30 minutes of video, 351 photographs, 3.5 hours of narrated articles on 300 topics. The user also has access to 17 thematically based guided tours which include video, text, and narration, as well as a glossary of terms.

Task

All students were given the same task, which attempted to capitalize on the situated environment (Brown, Collins, & Duguid, 1989; Choi & Hannafin, 1995) provided by *The Nile*. Students were asked to imagine that they were famous explorers who were commissioned by a national magazine to take a trip down the Nile and write an article about an aspect of life there. They were encouraged to use include information in whatever form they found interesting and that would make a good story for the magazine.

Procedure

Approximately one week prior to the study, students were asked to create a research report on the life of an animal of their choice, with a similar goal of producing a magazine article. They were required to use at least two text-based sources.

Students were randomly placed in one of three groups, reflecting the amount of instructional guidance they would receive. The free exploration group received no guidance on searching for information or organizing their ideas for their article. The guided search group received instruction on basic strategies that might help organize their search. This instruction took place prior to the task assignment only. Instruction included general strategy ideas, as well as related uses of tools in *The Nile*. Some examples include using the navigation map to determine an area to explore, or index (data base) to determine a topic to explore;

determining a topic sentence (or search question) to guide the search; using information in the media player to help determine subtopics; keeping on track; separating useful information from less important details. These concepts were also summarized on a card that the students were invited to use for reference. Students in the directed search group were given detailed, step-by-step instruction on organizing their searches, and using The *Nile* tools. This instruction took place prior to task assignment only. The students in this group were also provided with a summary reference card.

The students participated in five, forty minute sessions to produce their manuscript. A brief introduction to the tools used in the program preceded the first session. The first two sessions provided time for free exploration within the software environment. The students who were in either the guided or directed search groups received pertinent instruction prior to their third session. Students used the last three sessions to create their multimedia-based articles.

Analysis

Upon completion of the study, both the written reports on animals and the multimedia writing products were scored holistically by a group of three language arts teachers. The writing sample was scored using a holistic rating scale (Myers, 1980), with special attention to content related elements: organization of writing, accomplishment of task, depth of topic development, and number of topics included. Ratings were given on a scale of 1-4 for both types of products, using a rubric based on the general scoring rubric developed for the Integrated Assessment System, Language Arts Performance Assessment (The Psychological Corporation, 1990). The scoring was accomplished by a panel of three raters, with an initial random scoring activity to establish interrater reliability (Lohr, Ross, & Morrison, 1995). Agreement among raters was 89%. It was decided that two raters would score the samples initially, and discrepancies would be mediated by the third rater. Special attention was paid to scoring the digital writing samples, due to their multimedia content. The text component would be scored using the identical rubric for the preliminary (text-based) samples. Allowance for graphic elements was made by the use of a relevant graphic elements/total number of graphic elements ratio.

After all the writing samples were scored, a two-factor (Treatment by Testing Occasion) ANOVA with repeated measures on one factor (Testing Occasion) with writing sample as the dependent measure were performed.

Results

The 2-factor (Treatment x Testing Occasion) ANOVA with repeated measures on one factor (Testing Occasion) with writing sample as the dependent measure did not show a significant treatment main effect F (2,29)=.132, p =.8768. There was a significant Treatment x Testing Occasion interaction F (2,1)=4.653, p =.0394.

Table 1.
ANOVA Table

Variable	*df*	Sum of square	Mean square	*F*	*p*
Treatment group	2	.301	.151	.132	.8768
Subject (group)	29	33.058	1.140		
Testing occasion	1	2.641	2.641	4.653	.0394
Testing occasion by treatment	2	.401	.201	.353	.7053
Testing occasion by subject	29	16.458	.568		

The Treatment x Testing Occasion interaction is plotted in Figure 1 below.

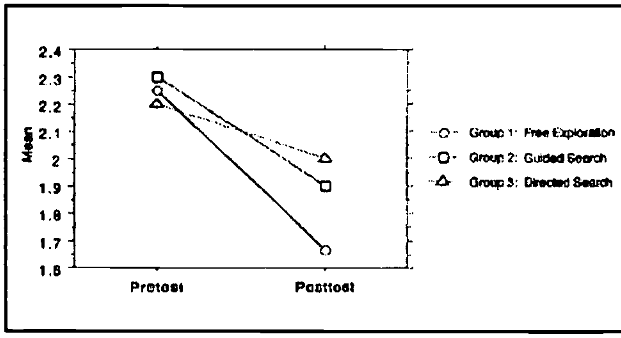

Figure 1. Treatment by Testing Occasion.

Mean scores for the technology based (post treatment) writing samples were lower than the text-based (pre treatment) writing samples for all three treatments (free exploration/control, guided search, directed search). The greatest decrease from pre to post score mean occurred in the free exploration group, the smallest decrease occurred in the directed search group.

As a part of the scoring activity for the digital writing samples, a tally was kept of number of relevant graphic elements /total number of graphic elements for each student's journal. A relevant graphic element was either a still photo or a video that was directly related to the text, either by topic or by specific mention in the text. The mean percentage of relevant/total graphics ratio is listed in Table 3 below.

Table 2.
Mean, SD of Dependent Measures by Treatment Group

	Text-based writing		Digital writing	
	Mean	SD	Mean	SD
Sample	2.25	.84	1.84	.95
Group 1: free exploration	2.25	.87	1.67	.78
Group 2: guided search	2.30	.95	1.90	.88
Group 3: directed search	2.22	.79	2.00	1.25

Table 3.
Mean of Relevant Graphics/Total Graphics Ratio by Group

Statistic	Sample	Group 1: free exploration	Group 2: guided search	Group 3: directed search
Number	32	12	10	10
Range	0-100%	0-100%	0-100%	0-100%
Mean	44.03%	43.80%	60.67%	27.70%

This study found that the use of an information-rich situated environment for information gathering has an effect on students' writing products. However, the effect, as measured by comparing text-based research and writing products to multimedia/hypermedia based was a negative one. Holistic scores on the multimedia writing product were generally lower than those for the preliminary, text-oriented writing product. The difference between means of pre-treatment (text-based) and post-treatment (multimedia-based) writing scores was less for those groups that experienced instructional guidance prior to carrying out the task.

Discussion

A situated hypermedia/multimedia environment can be a very powerful tool. While this study did not provide hard evidence regarding the relationship between instruction, search strategies, and organizing information, examination of other uncontrolled variables provides valuable information for teachers interested in using similar technology-mediated environments to develop information search strategies as part of writing process skills. The use of commercially produced titles may be timely and easy to implement, but teachers must have an awareness of variables that can possibly distract the learner from the primary task.

The ability of the students in this study to create a digital version of a research report within a hypermedia environment was severely hampered by varying levels of keyboarding and/or word processing skills. In hypermedia, cognitive overhead (Conklin, 1987) refers to the extra cognitive effort required to make decisions about which links to follow and which to abandon. This extra effort can distract the user from the primary task. Many participants in this study had the burden of dealing with an overhead of another kind - learning prerequisite technology-based skills while learning to use new software.

The findings of this study illustrate the increasing complexity of the task of searching for information in hypermedia environments that are enriched with pictures, movies, and sound. The multimedia, while providing a rich source of information, may have distracted students from their tasks. It also may have exacerbated the organization of information problems already demonstrated in hypermedia environments. Organizing information for a research-type report was a relatively new task for the fifth grade students. Providing a large amount of information in a relatively unstructured format was a challenge. Enhancing the information with rich graphic elements provided another level to the organizational challenge. These problems point to the need for students' guidance in methods of limiting their explorations.

Conclusion

Learning environments like The *Nile* provide a flexible tool that offers teachers and learners the ability to explore new levels of knowledge representation and construction. In the process, learners can develop new cognitive strategies and metacognitive skills. In this study, an act as simple as including a picture or video in the writing product called for students' reflection on the graphic element's relevancy as well as the criteria for its inclusion in the final report. Just as multimedia enhances our visual and auditory experiences, it can enhance cognitive efforts. In this study, multimedia-based writing skills required and broadened text-based skills.

Situated hypermedia learning environments encourage engagement of the students. They can be easily implemented in the classroom. Inexpensive, readily available software can be used in new ways. Well-planned activities can capitalize on student development of new information interaction skills. Clearly, there is more for a teacher to consider when using multimedia/hypermedia environments as cognitive tools. The possibility of a much richer process and product as a result of these efforts exists as well.

Finally, teachers need to be aware of the impact of the use of technology on the roles of student and teacher as well as on evaluation of new types of student work.

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DigIT: A Hypermedia Information System for Teacher Education

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The educational system is increasingly challenged by the rapid pace of technological innovations. It is often assume that these technologies can solve problems in traditional education and provide opportunities for new forms of teaching and learning (Smith, 1995). This has given rise to numerous arguments in favour of integrating technologies in teacher education programs. However, disappointing results are often the result of a highly pro-active and technology-driven approach. Media-comparison studies have shown that learning processes are influenced more by the content and the instructional design than by the technology (Clark, 1983). Therefore, more attention should be paid to design aspects, and less to technological aspects.

This does not mean that technologies can not make any contribution to education. Although no learning benefits are found for media (Clark & Sugrue, 1990), the use of technologies in education may increase the efficiency of learning and instructional processes. Moreover, explorative learning environments create opportunities for discovery learning that would be difficult to realise without computers (Leutner, 1993). The use of computers in education, however, is often inappropriate or even absent. One of the reasons is the lack of knowledge and numerous misconceptions of teachers about instructional design and the potential of computers for education.

In order to contribute to solving this problem and enlarge training opportunities, a hypermedia information system (DigIT) was developed at the University of Leuven about the use, development and evaluation of courseware. This information system supports teachers in making a sensible use of courseware in their teaching and enables them to gain experience with the use of digitalized information systems. Technology is used to educate teachers about the use of technology for student education. First, DigIT itself and the underlying design options are discussed. Next, suggestions are offered for the use of DigIT as one component of teacher education initiatives at various levels (pre-service, induction, in-service).

DigIT as Part of an Electronic Performance Support System

DigIT is an information system about the use, development, and evaluation of courseware. As such, DigIT can be conceived as one component of an Electronic Performance Support System (EPSS) (Elen, Hendrikx, & Proost, 1996). EPSS are digitalized, information-based instruments that may help people to execute (part of) their job and/or to develop relevant knowledge and skills. Generally an EPSS consists of a combination of three components (Gery, 1991): a database, training opportunities and tools. These are shown in Figure 1.

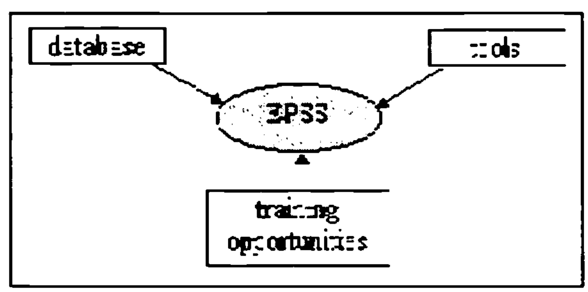

Figure 1. Components of an EPSS.

The database contains task-relevant and well-structured information accessible from multiple perspectives. Training opportunities in an EPSS generally deal with working with the system (e.g. digIT) as well as supporting users to construct a comprehensive and integrated understanding of the tasks supported by the system (e.g. evaluating courseware). EPSS also contribute to improved performance by providing tools that may apply in executing (part of) the task. Such tools may be situated on a dimension from simple to intelligent. Simple tools are to be conceived as an extension of the user. They help him/her to perform better by allowing the user to do something that would be more difficult or even impossible without the tool. A typical example would be a word-processor or, more specifically, tools to create transparencies. At the other end of the dimension are intelligent tools. They execute a number of core cognitive tasks which normally would be executed by the users. With respect to teaching, such intelligent tools have already been developed for supporting for instance curriculum development (Nieveen, van den Akker, & Plomp, 1994), design decisions (Elen & Stevens, 1993), and courseware development (Van Marcke, in press). Usually, such tools do not aim at replacing decision-making by the user, but at increasing its quality or efficiency.

Design of DigIT

Underlying every instructional design effort is a theory about learning and instruction. This theory influences the way instructional design and learning is conceptualised as well as what (learner-related and instruction-related design) parameters are taken into account (Elen, 1995). The development of DigIT is based on a mild constructivist viewpoint. Within this conception, "it is acknowledged that learners' activities are of greater importance for learning results than the activities of instructional agents, but it is equally ascertained that instructional agents may influence the learning activities of the learners" (Elen, 1995, p.81). Support is directed towards enhancing knowledge and skills of learners to process information independently (Lowyck & Elen, 1992).

First, a brief outline is provided of characteristics of meaningful learning within a cognitive conception. Next, learner-related and instruction-related parameters and their relation to the design of DigIT are discussed.

Cognitive Conception of Learning

A cognitive conception of learning highlights the active, constructive, cumulative, self-regulated and goal-oriented nature of learning (Shuell, 1988, 1992). The 'active' nature of learning implies that knowledge is the result of an energetic process in which the learner has to engage (Bereiter & Scardamalia, 1989). This activity is a 'constructive' one by means of which meaning is attributed to information. New information is selectively perceived and interpreted in a more or less unique manner, based on the learner's prior knowledge (Osborne & Wittrock, 1983). This refers to the 'cumulative' nature of learning. Successful learning implies relating new information to and integrating it in previously acquired knowledge. This, in turn, implies that successful learning results in alterations to both incoming information and prior knowledge of the learner (De Corte, 1989; Wittrock, 1981). This process of successful learning is 'self-regulated'. This means that the learner executes appropriate cognitive activities and prepares his or her own learning as well as continuously monitors these learning processes and evaluates learning results. Self-regulation is most likely to be successful when the learner is aware of the goal towards which one is working and possesses expectations that are appropriate for attaining the desired outcome (Shuell, 1988).

Learner-Related Parameters

Whether or not teachers will be able to engage in meaningful learning as characterised above, depends on mainly three factors: prior knowledge, cognitive skills, and metacognitive skills. Novice teachers differ from expert teachers with regard to these three characteristics.

Prior knowledge is the knowledge one has about a certain content domain. With regard to DigIT, prior knowledge pertains to knowledge about different types of courseware and tools that support the teacher in student education, instructional design issues and criteria for the evaluation of courseware.

Cognitive skills are mainly information processing skills. In order to learn, one needs to execute cognitive operations (e.g. structuring, relating, memorising, applying, etc.) on the incoming information. Experts differ from novices in both quality and quantity of cognitive skills.

Experts differ from novices also in their ability to adapt their cognitive activities to the learning task (Snow & Lohman, 1984). This ability to adequately apply and monitor cognitive activities, is a metacognitive skill. Metacognitive skills (e.g. goal setting, monitoring the learning process, evaluating learning results, etc.) enable the learner to regulate one's own learning processes.

Instruction-Related Design Parmeters

These individual differences between teachers do not need to be accepted as "given facts." Support can be offered to enable meaningful learning of all types of teachers. Instruction-related parameters should be manipulated in order to guarantee successful learning of novice and expert teachers.

Within a cognitive viewpoint, mainly two instructional-related design parameters can be identified, namely content and support. Main educational functions are offering meaningful content to the learner and supporting the information-processing in order to reach the learning goals.

Support can be presented implicitly (mainly by means of the structure of the information) or explicitly. Support can also differ in its object and amount. Support can be directed toward all conditions for and/or impediments for learning. The most important difficulties in learning pertain to prior knowledge, cognitive activities and metacognitive activities. These learner-related parameters also determine the amount of support that should be offered. Vermunt (1989) distinguishes between support being absent, capitalising on the skills already acquired by the learner, and cognitive processing taken over by instruction.

Educational Functions

Since the information in DigIT should be useful to teachers, the information elements were selected on the basis of interviews with teachers. Attention was paid both to the object of the information (programmed instruction, simulations, instructional design, etc.) and the form of the information (facts, rules, principles, etc.). The interviews revealed interest in seven types of questions about each topic: (a) what is it; (b) when/where does it apply/can it be used; (c) how can it be used/applied; (d) what are relevant quality criteria; (e) which major issues have been raised about it; (f) what does an example looks like; and (g) where can additional information be found. Support in DigIT is offered both implicitly in the structure of the information and explicitly mainly by added navigational aids.

The information in DigIT is structured in a hypertext-format. Successful navigation through this information demands prior knowledge as well as cognitive and metacognitive activities. The user must have a clear goal and must be able to select relevant information in order to reach that goal. This implies that one must be able to distinguish between main issues and details, to process information independently, and to be able to locate the information in the database. For experts, with advanced prior knowledge and cognitive as well as metacognitive skills, the non-linear structure of the information offers immediate access to relevant information. In linear information-systems, experts often get frustrated since they have to read all the information only to find the piece of information that is relevant to them. Besides, Newmark (1989) states that the non-linear aspect of hypermedia is strength because “learning doesn’t happen in the real world in a pre-organised, linear fashion” (p. 56). Jonassen (1988) considers the learner’s unique knowledge structure to mesh well with hypermedia materials. The user is able to select material based on criteria such as personal relevance, interest, curiosity, experience, information needs and task demands.

These advantages are valid for expert users. For novices, the non-linear organisation of the information can pose several problems. The main problem is that they might get lost in hyperspace. They do not know where they are, how they got there and where they want to go. In order to avoid this complete disorientation, navigational support, either implicit or explicit, is offered in DigIT by several ways.

Implicit support is offered by structuring the information in DigIT as a matrix with a list of hierarchically organised topics on one axis and seven questions on the other (see Figure 2). Unlike a web-like structure, the matrix limits the navigation possibilities by the number of links between the different cells.

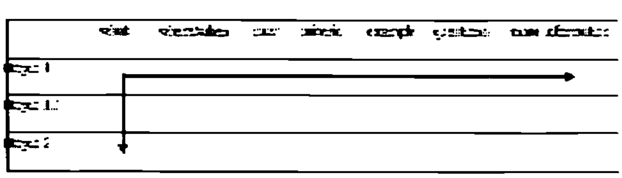

Figure 2. Structure of the Database Underlying DigIT.

Explicit support is offered in several ways and varies in amount. First, the information can be accessed in three different ways. Each entrance represents a different amount of support and is directed towards users with different knowledge and skills. Novices usually do not have a clear goal and are not able to select relevant information. They may rather want to get a systematic overview of the information, without the danger of being overwhelmed by too much information. For these users, an *overview entrance* is available. By using this functionality, the user enters the matrix directly and can navigate both horizontally and vertically, one step at a time. Other navigation possibilities are excluded for preventing the user of getting lost in hyperspace. Experts users, on the other hand, do not need this support, since their prior knowledge enables them to ask specific questions. The main problem these users are faced with is to locate and access the information searched for in the database. This problem is solved by an *index entrance*. The index gives an alphabetic list of all the topics covered by the system. Just clicking on it will provide immediate access to the requested information. Between novices and experts are users with no profound knowledge of the use, development and evaluation of courseware. They do have questions but may get overwhelmed by a high information load. Some pre-structuring is indicated. For these users a *third entrance* has been created which allows to retrieve all information elements relevant to a particular *question.*

Disorientation can also be avoided by increasing the transparency of the structure of the database. This will help the user in locating the information in the database. Within DigIT, transparency is guaranteed by always providing an indication of the context of a particular screen. This is done by dividing the screen into three parts: one part indicates the structure of the information, the second part indicates the current location within this structure and the third part shows the information itself. This is indicated in Figure 3.

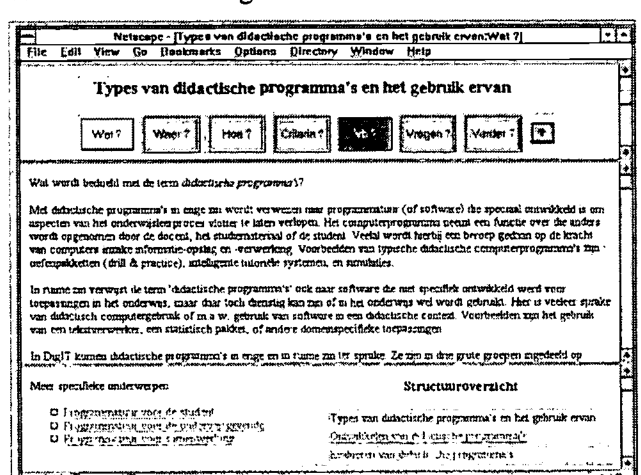

Figure 3. Screen Print of DigIT.

The limited domain knowledge of novices will restrict the comprehensibility of the (domain-related) information in the system. Therefore, a lexicon, accessible from each cell, was added which contains a simple clarification of technical terms (such as operant conditioning).

The amount of support is left to the control of the user. Support opportunities are offered but it is left to the user to make use of it or not. Besides, whether or not and the way learner will use the support available to them, is dependent on the way the support is perceived.

Possible Applications of DigIT in Teacher Education

DigIT and EPSS can prove useful in several ways in teacher education. They can be useful for actual teachers, already working in an educational institution as well as for future teachers, during pre-service and induction periods. The main differences between the two groups is that the second group can more easily be reached by explicit, face-to-face training efforts.

In the first group, teachers who are interested in using courseware for education, may use DigIT as a simple information system. These teachers can obtain a systematic overview of types of courseware and concrete examples as well as answers to specific questions. Although this information can already create learning opportunities, more intensive training will often be necessary to enhance the knowledge and information processing and self-regulation skills of these teachers. These training opportunities might be provided in a more elaborated EPSS that also contains tools that teachers may apply in executing (part of) their tasks.

The use of EPSS offers advantages that are especially relevant for lifelong learning of actual teachers. First of all, EPSS allow for continuous and just-in-time learning as they are transportable in time and place and hence can be used by the teacher whenever needed. EPSS also provide training opportunities that can be adapted to the specific learning needs of the learner and can be made available whenever needed. Besides, EPSS offer a suitable context for situated learning since the information can be used in direct relationship with a concrete task. Since the information is available on computer, which can be networked with other computers all over the world, EPSS also support co-operation as they allow for information exchange and communication between different users as well as access to relevant information and experts from all over the world.

Within the context of training programs for future teachers, DigIT can be used in a more structured way for mainly three different purposes. First, it can be used as a digitalized text for the course. This means that DigIT will be used as the main information source for the course. Moreover, DigIT offers an important extension of a written course in the sense that it implies structured access to related information all over the world. Second, DigIT can be used to educate future teachers information processing and self-regulation skills for successfully navigating hypertext-databases and independently selecting and processing relevant information. Third, DigIT can prepare future teachers for evolutions towards the widespread use of Electronic Performance Support Systems in the workplace.

Conclusion

Teachers will increasingly be challenged by using technologies in education. Due to the rapid speed of technological evolutions, important learning efforts will have to be invested by teachers to keep up with these changes. This implies that teachers will have to be able and motivated to select relevant information out of a huge amount of information and to process this information independently. Since educational programs can not keep up with this pace of technological evolutions, educational support should be directed towards "learning teachers to learn". This means providing the necessary information processing and metacognitive skills to learn independently. One way to provide this support is by means of an EPSS.

The DigIT-project reported here is part of a larger one that aims at consolidating know-how on teaching-related matters and at developing tools and courseware with high relevancy for teachers. The development of DigIT is a first step towards the construction of an Electronic Performance Support System which supports teachers in their educational assignment.

First indications about the value of DigIT for education of teachers will be revealed when the system gets implemented and used by a large group of teachers. Evaluation efforts should direct conditions under which systems such as DigIT and more broadly EPSS may contribute to the learning of teachers. Especially relevant would be research that investigates how user, system and context variables interact and affect the use of such a system. In general, however, the use of such systems depends on two factors: the quality of the system, and the perception of the functionality of that system by the user. The quality of the system is determined by the quality of the information as well as the quality of the support that is offered for processing the information. Decisions with regard to object and amount of support, therefore, should be based on individual characteristics of the user. Perceptions of the functionality of the system also influence whether or not the system will be used. Therefore, when presenting the system to teachers, careful attention should be paid to explaining the functionality of the system for improving the quality of teaching. Hence, introducing teachers to use DigIT may help them to overcome fear and resistance towards integrating technology in their courses.

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The Evolution of a Multimedia Development Team

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Anthropologists believe that a major advancement in evolution occurred when early cavemen formed teams to hunt and farm. Our ancestors learned that they could accomplish more together as teams. They could take on different roles, depending on their interests and skills, and could witness group accomplishments and successes. In addition, pooled ideas of a group were generally superior to the ideas of the individual.Over the years, with improved labor laws and new management and production theories, the concept of the individual in the work place has changed. Organizations have found that promoting individual skills is not enough. How individuals work and relate to each other is equally important. Therefore, as organizational and business problems become more complex, organizations have begun to regard teams as an effective way to increase production, performance and job satisfaction, and handle varied types of work.

Teams are also serving useful purposes in K-12 and higher education. Practical applications include staff and professional development, curriculum development, program design, cooperative teaching, educational reform, family interventions, and in-service and pre-service training. Team projects are also a useful classroom technique. This approach forces the individual student to become an active learner and serves as an introduction to project teams and self-directed work groups found in many business processes.

A cross-functional team is a special kind of team and is usually formed to complete a single complex project, or a series of related projects. Members of cross-functional teams bring a variety of individual skills and expertise to the project, hence the name cross-functional. Large multimedia projects are carried out through the use of cross-functional teams. Common multimedia team members' roles are: designer, programmer, audio-video specialist, content writer, and project leader.

In Spring 1996, the Instructional Technology Program in the Department of Curriculum and Instruction, College of Education, University of Houston, offered a graduate level course titled *Development of Instructional Packages*. This was a new course and the instructor had previous experience working on multimedia project teams. She divided the class into four, five-member multimedia teams and assigned team members roles that are commonly found in multimedia teams: (1) content writer (2) audio/video specialist, (3) multimedia programmer/author, (4) visual designer, and (5) project manager. Each team was responsible for working with a "client" in the College of Education, developing a multimedia project according to that client's specifications, and completing the project by the end of the semester. The purpose of this approach was to provide introductory, yet realistic, experience in developing multimedia packages.

The following account provides a close-up of the working relationship of one of the multimedia project teams in this class. Team members tell about their experiences and contributions to the overall success of the project; how they came together in understanding their strengths and weakness in order to make effective, practical, and creative decisions; and how they think these experiences might be applicable to in-service and pre-service teacher education.

In the Beginning

No doubt, team work can bring together the best skills and efforts of its individual members. However, "synergy" is difficult to achieve — especially in project work assigned to graduate students. This is certainly true at the University of Houston which is a "commuter campus." For the most part, students drive from the outlying suburbs and communities to attend classes. At the graduate level, most students work full time in addition to attending classes. As a result, team or group projects are very difficult to carry out and most students generally don't like this type of assignment. Pam, our graphics designer, expresses how most of the class probably felt at the beginning of the semester: "I was not looking forward to this class. I'd just completed a grueling semester and the thought of working on a group project did not exactly appeal to me. I usually shy away from group work (especially when dealing with technology) primarily because of my need to experience and be familiar with every aspect of a project. I think I work better by doing all of the work myself. Also, I have worked in groups before where personalities clashed or where there was an imbalance of effort and contribution among members. Nevertheless, working individually in this class was not an option." Gita, our audio/video specialist, was looking forward to taking the course and working with the instructor, but she too expressed reservations about doing team projects. Our team leader, Marilyn; our writer, Larry; and our programmer, Tom; all had previous experience working on teams in their work, but each knew that class project teams could be entirely different from work project teams.

Our instructor, Dr. Sara McNeil, made the team assignments during the third or fourth session and tried to balance the teams by assigning students based on their individual experience. Each of us silently worried about what team we would be on and the role we would be assigned. We all knew that we couldn't choose our job. Larry, our content writer says: "I thought — no big deal. Based on my previous experience, I would be either project manager or programmer. But I soon found out this was not to be. My previous work experience had also included a lot of technical and proposal writing, but that only partially prepared me. I was now responsible for both the text for the graphic displays and the audio script for the voice-overs. " Gita, remembers, "The only apprehension that I had was that I had to measure up to the high standards of our group." With the exception of Larry, all of the members of the team knew each other from other classes. Marilyn, our project leader, remembers thinking, "Being project leader is going to be a lot of work!"

Our group was assigned to create a multimedia package for a "client," one of the science education professors in the College of Education. The topic was evolution — earth history — which gave us ample opportunity to explore a variety of graphics, photos, video and audio. Everyone was excited about our topic. As Pam says: "This was a welcome change from the usual practice of creating a project for the sole purpose of receiving a grade. Yes, we would be graded, but we were also fulfilling an educational need to design a multimedia project which would be used in a class."

One of our first group efforts was to meet with our client to ask questions and to clarify the scope of the project. Once we did this, we began the conceptual design process where we discussed the direction we wanted to take with the project. This proved to be more difficult than we had anticipated ... as we would soon find out.

Marilyn comments, "I remember all of us being polite to each other at first. However, we had a lot of creative work to accomplish and 'polite' wasn't exactly what I had in mind from this team. But as soon as we got to know each other, our meetings became more open and lively. Also, when I was a project manager at my work, I had to make so many decisions! I wanted our class project team to make decisions together. So, I made a conscientious effort to get everyone involved. Fortunately, everyone wanted to contribute and stepped up to the task and participated whole-heartedly."

Gita adds, "I found these discussions, sometimes heated ones, to be thought provoking and interesting. Ideas were put forth, discussed and then tested for consensus. We tossed a lot of ideas back and forth while we were trying to visualize how this product should look and what was needed to make it a reality."

Pam recalls, "While we did not immediately "mesh", our mutual respect for the opinions and ideas of our teammates made this process very productive. We had to 'start from scratch' a few times, but those times were well justified — and were TEAM decisions. It took us about two weeks before we settled on a direction. And we did not make a major change after that point."

Larry felt that the team was successful making headway because of early decisions regarding decision-making. "As a team we decided to establish some ground rules, especially to operate on the grounds of consensus. When our team used consensus to reach decisions, it was not done by majority rule. Instead, each member of the team decided that even if they did not particularly like a decision, they could live with it. This resulted in every member of the team having bought in and been part of the decision. They could not put up the excuse that they objected, but were overruled by the majority. Each member of the team spoke from their area of responsibility and made their arguments. Even if a member of the team had much experience in another area, they did not represent that area in team discussions. To curtail circular or endless discussions on ideas we insisted that just to say that you did not like an idea was not enough. There had to be a technical reason the idea would not work, or an alternative must be suggested. This eliminated the 'I don't like it but have nothing better to offer' type of fruitless discussion. We also recognized that everyone could not always be at all of the meetings. Various things could arise and prevent someone from attending just as occurs in the real world. To deal with this we agreed that if the team had already met and come to a consensus on ideas, then the team's decisions must not be allowed to unravel because someone was not there and missed all the discussion. Previous decisions would hold unless a technical reason surfaced that required the decision to be revisited.

After these ground rules were put in place we quickly came to a consensus and decisions were made. Occasionally a technical issue arose that required a change, but that was discussed in the team and a consensus agreement reached on any necessary change."

Marilyn, a natural 'worrier,' had some concerns. "I was worried about how large the project had become and was concerned about our ability to successfully bring all of our ideas to life — by the end of the semester. We had so much to do and some of us were doing new things — I wanted everyone to be sure to ask for help if they needed it. I didn't want 'false pride' to get in the way."

Tom, our programmer, was able to assist the team in determining what was technologically possible — given the limitations of the software and his coding ability (He was new in his role, too)! Needless to say, putting all of the pieces together became a challenge — a fun challenge.

"When we began to try to work as a team, I was amazed at how dedicated each member was to the success of the project and the team. My initial expectation was that each person would draw upon their own expertise and try to do others' job. This never happened; we each had enough work on our plates to keep us busy," recalls Larry.

Everyone contributed to collecting bits and pieces, QuickTime movies, sounds, still images, and graphics from the WWW and every other available source. Digitizing and editing audio, movies, and images became skills that Gita and Pam artfully mastered. Larry developed a detailed script early on which turned out to be the "master plan" that kept us focused throughout the project. We developed a series of tentative frame sketches which became the basis of the prototype. We then worked from Larry's script to compile a list of all the necessary elements and which stage of development we would need them. We also made a priority list: "nice to have" versus "must have." We had our set-backs — visual concepts that didn't work, technology failures, disappearing files, and inadequate time for alpha and beta testing. Even though we couldn't add hours to the week or days to the semester, we were able to find technical assistance from technology staff and department instructors.

The final project was assembled and programmed in MacroMedia Authorware. Tom, our programmer, had only "casual" knowledge of Authorware. However, he learned how to make our program do what we wanted. Tom recalls, "I guess I was a little frustrated. I didn't have sufficient time to complete the coding to allow for an alpha and a beta test as had been originally planned. I did the debugging for the final presentation during the final class of the semester. Fortunately, we didn't find any major bugs and we finished the project on time."

Our excitement grew as we started to get closer to the finished project. Marilyn recalls, "When I saw the prototype with the placeholders, I thought, well ... it's OK. However, the next time I saw it ... it had graphics, video, and some sounds. I was amazed ... totally amazed to see how everything was coming together! I was so impressed!"

As Gita recalls, "The reward (for all of our hard work) came when we, as a group, enjoyed watching our final project grow before our eyes."

At the End

During the course of the semester, there were clear indications that each team was functioning differently — some successfully and some not successfully. As the semester came to a close, we found that we were the only team in the class that was not experiencing major difficulties. Our project was on schedule, our team had no major conflicts, and our client liked the work we were doing. All of the teams had similar challenges, deadlines, and expectations. However, the teams were performing quite differently in terms of project productivity and interpersonal relationships. What caused these differences? Was it because of the difference of individual skills, members' personalities, team leadership, or the situation at hand? Or, was it just pure chance? What was our secret?

Our team wishes it could answer that question because working on a successful project team is a truly gratifying experience. Social-psychologists, as well as managers and team leaders, are also interested in knowing how to put together effective teams. Why do some teams work and others don't? Is it a matter of luck and timing? Or, are there other key elements to consider? All of these questions are beyond the scope of this paper but we think it is probably a combination of all of the above mentioned things.

Pam offers an explanation,"... working in a cooperative group allowed me to create *great* things! Perhaps it was the support and encouragement that we gave each other." Gita explains, "Our group was a team of talented individuals... who understood their own strengths and weaknesses, and as a result, they were able to come together as a whole." Marilyn adds, "Everyone was totally focused ... we all wanted to make it work." Larry sums it up in saying, "Each and every person carried their weight and did not depend on someone else to do their job. We functioned as a team and not a collection of individuals. Our group rose to the highest definition of a team."

While we can only speak from our team's experience, we think that this class activity has provided a unique and positive opportunity to experience and receive the benefits of working with others. As a group, we were able to create something that was beyond the ability of any one of us to accomplish individually. A "traditional" class, complete with textbook and weekly assignments, would not have produced the same type of learning experience. Having an interesting project to work on with dedicated team members, is only a part of what contributes to the success of using project teams in the classroom. A sensitive and encouraging teacher is the remaining piece. Because of her experience working on project teams, our instructor, Sara

McNeil, was able to successfully guide us through the semester. She anticipated and understood the constraints and problems we might have, and planned the semester accordingly.

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INVESTIGATING MATHEMATICS EDUCATION USING MULTIMEDIA

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In 1830, Warren Colburn gave this advice to teachers wishing to teach children arithmetic: "It is necessary rather to furnish occasions for them to exercise their own skill in performing examples, than to give them rules. They should be allowed to pursue their own method first, and then they should be made to observe and explain it, and if it was not the best, some improvement should be suggested ... Examples of any kind upon abstract numbers, are of very little use, until the learner has discovered the principle from practical examples" (Colburn, 1830/1970, p. 15-16).

In 1991, the National Council of Teachers of Mathematics (NCTM) suggested that mathematics teachers be proficient in such things as:

- selecting mathematical tasks to engage students' interests and intellect;
- providing opportunities to deepen their understanding of the mathematics being studied and its applications;
- orchestrating classroom discourse in ways that promote the investigation and growth of mathematical ideas;
- seeking, and helping students seek, connections to previous and developing knowledge (p. 1).

Surprisingly, these visions of mathematics teaching, although over 160 years apart, display very similar sentiments which emphasize the need for student-centered approaches to learning mathematics. In the majority of schools across the world the reality is quite different. In classrooms, students are seated individually, they are required to listen passively and to observe the teacher demonstrating rules and then they spend extensive time practicing these rules. It is apparent that views about teaching mathematics are resistant to change and require restating generation after generation. The answer may lie in the methods through which new teachers become aware of and develop their pedagogical knowledge, skills and attitudes.

For many teachers of mathematics, knowledge about teaching develops from observing and imitating the way their teachers taught the subject (Ball, 1994; Lampert & Ball, 1990). Knowledge of teaching gained from tertiary institutions plays a secondary role. Here knowledge is often transmitted in the form of abstract theories generally unrelated to the contingencies of real classrooms. Where real experiences in classrooms are encountered through, for example, a teaching practicum, preservice teachers are often faced with the admonitions from their more experienced colleagues to put aside their book-learned theories and adopt traditional approaches more in line with their own school experiences. Being able to observe teachers and students working in situations that reflect the views expressed by Colburn and NCTM was, for some, a lucky encounter. However, with the use of current technologies a wide range of experiences can become a part of all student teachers' developing knowledge of ways in which mathematics can be taught and learned with understanding.

Multimedia appears to be an environment that supports aspects of observation, discussion and collaborative activity developing teachers' knowledge. The use of a technology which provides unrestricted access to large amounts of video, graphical, audio and textual material appears to be one way of exposing students to a learning environment. In this environment, students can experience aspects of classroom teaching various perspectives, and view a multitude of important ideas and representations of knowledge.

The purpose of this paper is to provide a description of interactive, self-paced and instructor-supported learning modules that can provide preservice teachers with a more complete range of mathematics teaching and assessment strategies. These modules would provide:

- an understanding of the purpose of each strategy;
- an awareness of the particular strengths and weaknesses of each;
- instances of where each could be usefully employed, and
- an inclination and willingness to employ these strategies in their own classrooms.

The design of the multimedia project was based on a theoretical framework of learning whose focus was on developing knowledge that was transferable to real situations. This framework of situated learning has the potential to provide the forms of learning outcomes demanded of teacher education programs.

Situated Cognition

Until the invention of schools, nearly all formal knowledge and skill was transferred through apprenticeships (Collins, 1988). Agricultural skills, trades, medicine, law and the arts were all taught by the master who handed on the required skills to the apprentice (Collins, Brown, & Newman, 1989). In the mid-to-late nineteen eighties, teachers and researchers in education began to investigate the notion of apprenticeships and to try to distinguish those characteristics which were critical to its success. Their aim was to begin the process of developing a theoretical perspective for successful learning based on the apprenticeship model, that cognitive science had, to date, not been able to explain.

Brown, Collins and Duguid (1989) were the first to use the ideas to produce a proposal for a model of instruction that has implications for classroom practice. In their model of situated cognition (or situated learning), Brown et al. (1989) argue that meaningful learning will only take place if it is embedded in the social and physical context within which it will be used. Collins (1988) defines situated learning as "the notion of learning knowledge and skills in contexts that reflect the way the knowledge will be useful in real life" (p. 2). The situated learning model is constantly evolving and recent contributions of various theorists and researchers, including the original authors of the model, have expanded and refined the notion to a much more comprehensive and far-reaching framework for classroom application. Many of these authors and theorists believe that useable knowledge is best gained in learning environments which feature the following characteristics (Herrington & Oliver, 1995):

- Authentic context that allows for the natural complexity of the real world
- Authentic activities
- Access to expert performances and the modeling of processes
- Multiple roles and perspectives
- Collaboration to support the cooperative construction of knowledge
- Coaching and scaffolding which provides the skills, strategies and links that the students are initially unable to provide to complete the task
- Reflection to enable abstractions to be formed
- Articulation to enable tacit knowledge to be made explicit
- Integrated assessment of learning within the tasks

Situated learning, as defined in these characteristics, has implications not only for classroom practice but also for the design of interactive multimedia. Not all these elements can be discretely included in a software program, but they can be provided for in a learning environment by considering the ways in which the program will be implemented and evaluated. These characteristics have been incorporated into a learning environment designed to provide a situated learning context in which students can investigate teaching and assessment strategies in mathematics education.

Elements of the Multimedia Learning Environment

Drawing upon the characteristics of a situated learning environment and the requirements of the content area of mathematics, each program was designed to comprise two elements.

(1) A CD-ROM on the issues of teaching or assessment strategies in mathematics education, each incorporating:

- Video clips of teachers using various techniques within their classrooms, with original sound;
- Video clips of teachers reflecting and discussing the strengths and weaknesses of the approach;
- Video clips of children discussing their feelings and thoughts;
- Interviews with experts in the field providing theoretical perspectives;
- Reflections by preservice teachers on the approach;
- Text descriptions of each approach;
- Teacher and student work samples;
- A problem-based notebook providing a variety of tasks within which to examine the resource.

(2) A manual for users and facilitators on how to implement the resource, which would also provide advice on the situated learning elements which were not included in the resource itself (such as collaboration and articulation).

Twenty three categories of assessment and twenty eight teaching strategies were selected as relevant to K-12 mathematics classrooms. This was done by conducting a review of the literature on teaching and assessment and from the reading of current issues in the field. Assistance was provided by two visiting scholars, one with experience in multimedia development in mathematics education, the other knowledgeable in the area of assessment in mathematics. Figure 1 shows the interface of the assessment multimedia program and its constitutive elements.

Videos

By clicking on the video cassette objects under the television screen, preservice teachers can view a short video sequence of either the scene in the classroom where the teacher demonstrates the use of the technique (*Scenario*), the teacher's comments on the use of the technique (*Teacher*), or a student's comment (*Student*).

Filing Cabinet Resources

Descriptions

By clicking on the top filing cabinet drawer, students can read a description of the strategy which includes advice on how to implement the strategy effectively in the classroom.

Samples

By clicking on the second drawer students can examine samples of school children's work or teachers' records. These samples were collected from the schools at the time of filming the segments and then digitized and imported into the program.

Reflections

The third drawer of the filing cabinet contains advice given by a preservice teacher on his or her experience of using the strategy on professional practice in schools.

Interview

Clicking on the bottom drawer of the filing cabinet gives students access to an expert commentary on the use of the strategy. Apart from providing valuable advice on methods of implementing the strategies in the classroom, the expert's comment is important because it allow students to compare their own level of thinking on the issue with the expert's. This is critical to the kind of reflection students might engage in as they use the program.

Notebook

Clicking the notebook on the table allows students to use the electronic notepad and also gives them access to the authentic activities of the program. The first tab, *Notes*, enables students to write their own reflections and ideas as they explore the various elements provided, and also to cut and paste text from three of the resources provided in the filing cabinet drawers: the description of the strategy, the preservice teachers' advice and the expert's comment. At the end of a work session, students can save copies of their notes to their own disks, then format them using their regular word-processing program.

The *Investigations* tab takes students to a series of authentic activities which replicate the kind of task a school teacher might be faced with in real life. The tasks are presented to the student realistically, such as in a memo or letter, rather than simply a list of possible activities, and they include genuine constraints such as deadlines and time allowances. Activities assume that students will be working in pairs or small groups, and require them to examine the resource over an extended period of time, and from a variety of perspectives.

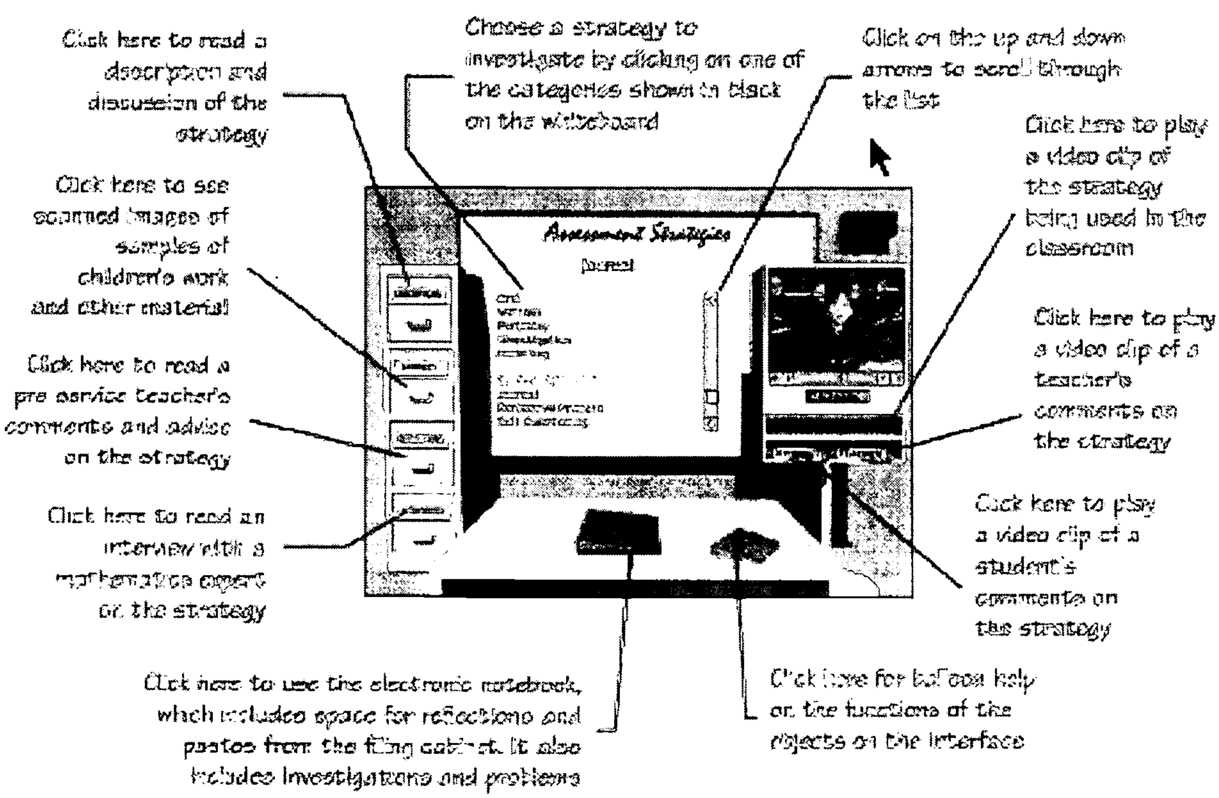

Figure 1. The Program Interface Showing Constitutive Elements.

Clicking on the *Problem Solving* tab gives students access to short problems which are more narrowly focused and require less time to solve. Such problems do not necessarily conform to the situated learning model proposed for the program, but were included to allow lecturers a broader range of approaches and to add versatility to the resource as a marketable item. The problems could be attempted in a single work session rather than the extended period of time recommended for the investigations.

The Manual

The manual provides educators and students with a list of optimum implementation conditions which are all based on the situated learning model used for the development of the program, and acknowledges the position that not all the critical elements of this model can be incorporated into the program itself. Some of necessity must be provided by the educator, and some by the students themselves. This list of optimum conditions is given below:

- The resource is best examined in depth, from a number of different perspectives.
- The resource is best used over a sustained period of 2-3 weeks rather than for a single session.
- The resource is best used by students working in pairs or small groups around each computer, rather than individually.
- The resource is best used when the lecturer is initially present during use to provide 'scaffolding' and support.
- The resource is best used when the lecturer demonstrates the resource by thinking-aloud as an investigation is modeled. Students then choose an investigation from those provided, or their own choice.

The manual also provides educators and students with a description of the theoretical framework on which the program was based, summaries of each of the strategies, and ways in which educators can assess students' use of the resource.

Requirements To Use the Programs

The large amount of multimedia used in the programs necessitated the use of CD-ROM technology as a storage and delivery medium. The resource was developed using Macromind Director, an application well suited to developments of this nature, which also enables cross-platform delivery. The resource has been developed with a mid-range delivery platform in mind. Then programs run on most multimedia compatible computer systems, such as a dual speed CD-ROM with 12Mb RAM, either Windows or Macintosh.

Implementation

Two similar but slightly different methods have been employed to trial the materials with teacher education students. The program on assessment strategies was used with classes of preservice secondary and primary mathematics teachers. In this situation, the lecturer was present and organized all the students to use the computer laboratory at the same time. The other method of no lecturer present (the lecturer-free method) and student nomination of time was used with Graduate Diploma primary and third year Bachelor's of Education students. In this case the lecturer was available on demand after the initial briefing of the workings of the resource and the requirements of the course had been explained.

In both cases students were asked to work in small collaborative groups of three or four members. They were required to select or were given one of the investigations from the program to consider. The activity needed the students to assume the identities of new teachers to a school or the mathematics coordinating committee of a school. They were then given the task to prepare a report on assessment or teaching procedures to be relayed to the rest of the staff (in reality the rest of their class) in a verbal presentation and also in a written form.

Evaluation

Initial evaluation of the resource was done by observation of the classes using the program, by interview with two students who were videotaped during their investigation of the activity and by assessment of the learning shown in the presentation and written report. The interview investigated students' perceptions of the elements of situated learning which had been incorporated into the design of the materials, the design aspects of the interface, the style of working and the quality of their learning.

The response to the interface was positive with students being able to conceptualize the layout of various resources and contents very quickly. They appreciated the classroom context and there was no hint that they felt patronized by the use of pictures in the interface design. One student commented:

> It was set up in a fun way, like it was a classroom. You had a video sitting there, you didn't just have the word 'video' and it didn't have the word 'filing cabinet' there. It was all there with pictures and you could relate to it.

Students generally found the interface and navigation system were logical in their layout and very easy to use, even for those students who were 'not very good with computers'. The non-linear nature of the system also found favor with the students as they were able to access the information in the order of their own choosing. Generally students did not recognize they were learning in a complex environment—each package contains over sixty video clips and over eighty documents—as they referred to the simplicity of the program. Of all the features only the television screen for the video clips was disliked as it was deemed by some students to be too small.

The students valued most the context and real-life relevance of the material they were using. Frequently, they drew contrasts between the authentic context presented in the program and the decontextualised approach often used in their teacher education course.

> Instead of just showing us the theory, it also showed the scenario inside the classroom so we can do that when we go on prac. It gave practical examples which I think the course is lacking a lot of.

There were, however, minor irritations for some of the students with certain personalities on the video clips for example a student commented negatively on the teaching style of one teacher while another noted the variation in the quality of teacher and child interview responses.

The approach established with the program involved, for many, a change in role and expectation both for themselves and the lecturer. For the student, it involved collaboration and thinking, often in a context of uncertainty. Responsibility for when to learn and what to learn was placed with the group of students. Hogan (1996) noted the crucial nature of this change of emphasis as she reflected on her role as lecturer:

> I was struck by the irony that I did an enormous amount of reading and thinking about education in order to prepare my lectures, plan effective workshops and select readings and texts for my students, while the students did relatively little. I was the most active learner in my classes - because I had total responsibility for what was learned and how it was presented for consumption. (p. 79)

The extra flexibility offered in this approach meant that students not only had to decide what the task was, but also decide the steps that would enable them to complete the task. The freedom was a positive feature for some as they could organize their many commitments, domestic, social as well as academic, and find better or more convenient times to work but for others the temptation to procrastinate often resulted in rushed and ill-prepared work.

As was noted earlier, two models of teacher role were used. Both roles attempted to activate the principles of situated learning namely supporting, coaching, clarifying and scaffolding the development of learning. Generally assistance was procedural on both content and software. While the 'lecturer-free' method allowed flexibility of time and was established to interact with the student group as the need arose, this was not always possible due to other commitments or the late evening use of the materials. Often, however, scaffolding or clarifying was done by another member of the group.

Collaborative aspects of the material were seen as crucial to higher quality learning of the main issues related to assessment and teaching. In a minority of cases students allocated aspects of the task to individuals who accessed them on their own and then brought this information back to the group for the presentation. This generally resulted in a qualitatively lower standard of presentation where each aspect of assessment or teaching was briefly sketched by the person who researched it. No overall or deeper knowledge of the issue was established; no argument was presented. The majority, however, worked together to clarify the issue or problem and to develop their response through joint planning and collaboration. In these cases the learning was richer and at a deep level. Students saw the value of collaboration as it aided their understanding both as a result of having someone explain aspects to them or, in the reverse of the case, having to justify or clarify their idea. A student noted:

> When we were doing our notes, it would be like 'What does that mean?' and you would have to explain exactly what you meant. You'd have to explain and explaining always clarifies no matter what you're doing.

Students articulated their understanding of assessment or teaching strategies in two ways: the formal reporting to the staff meeting and in their discussions with their partners as they used the program. One student noted that the capacity of the audience (the staff/class) to respond and question the findings of the report meant that the presenter could not merely copy large amounts of text and present that as a report. The possibility exists in this situation that further explanation will be necessary and understanding of the material is therefore essential. This is a very different form of learning for many students who are experienced at learning and repeating the notes of their lecturer. This depth of understanding established through cooperative work on the issue resulted in many students becoming highly knowledgeable in the areas of teaching and assessment.

The multimedia programs described in this paper, provide a different approach to learning, one that recognizes the importance of making connections to real-life situations, in this case real classroom experiences. The motivation to learn from these experiences has resulted in student teachers developing self-directed strategies that have resulted in quality learning. Ongoing research will determine whether such learning nurtures and promotes the kind of classroom practice envisioned by Colburn and NCTM.

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The Planning and Development of Spanish Phonetic Lessons with Hypermedia

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Having a basic knowledge of phonetics is indispensable to any person who works with language. Teachers of languages, especially, needs both the theoretical and practical knowledge of phonetics to diagnose students' pronunciation errors, and to devise means to help them correct errors. Students of languages also need the same knowledge to self-monitor their own pronunciation. In order to improve Spanish phonetic instruction, the authors examined the major difficulties that students frequently encountered in the traditional classroom.

To gain a thorough knowledge of phonetics, one should rely upon not only reading literature and studies, but, more importantly, actual practice through capturing the differences between various sounds by listening and manipulating articulators in the vocal tract. Unfortunately, traditional teaching methodology fails to facilitate an effective learning environment that engages students in needed practice. Students taking Spanish phonetics are rarely taught how to contrast sounds through listening or consciously controlling their articulators. Phonetic class focuses mostly on the discussion of the sound system rather than on gaining a practical knowledge and experience about it. Students are often left alone to imagine how a phonetic symbol being described sounds like. They do it either by deducting notes from the lectures or explanations in the textbook, or by associating it with a sound that they are familiar with. Audio cassettes are a major device used in the classroom to demonstrate sounds, and they are made available to students outside the classroom. However, the cassette player, with limited capacity, can lead to a frustrating and time-consuming experience when one tries to locate a specific item by rewinding cassettes back and forth many times. Moreover, it creates an unpleasant interruption to the learning flow. In reality, the demonstration of sounds using a cassette player is usually employed immediately at the end of a lecture. It usually covers a long list of items and several exercises for various purposes. This strategy generally does not produce a good result. As an alternative approach, inviting native speakers for live demonstration has also been adopted by instructors. However, bringing informants to the classroom is not always feasible because locating them and scheduling their visits are not easy tasks. Besides, they are not accessible to students any longer after the class.

In reality, practical and effective tools that meet various students' needs are desired to attain a very important objective of Spanish phonetic course. That objective is to help students improve their pronunciation through self-monitoring and recognizing common problems demonstrated by American-English speakers. Faced with the obstacles depicted above, the authors evaluated various types of available resources including computer programs as well as traditional audio-visual aids, which are still widely used in the classroom. After a careful examination of all these resources, the authors concluded that current computer hypermedia technologies (with elements of text, audio, video, and animation) should be our choice in an effort to help students acquire needed phonetic skills.

Personal computers have been around for over one and a half decades, and have made great impact on teaching and learning in the K-12 classroom. New computers are faster, more powerful, and easier to use than ever. Thousands of software titles have become available to enrich the content instruction with exciting activities. However, in an effort to find needed electronic resources to enhance the Spanish phonetic instruction, the authors were surprised by the shortage of the existing titles. The authors then concluded that an in-house hypermedia-based Spanish phonetic application should be developed and the first step is to develop a prototype.

Search for a Suitable Authoring Tool

Presently, many powerful, and yet easy-to-use programs are available on the market. They have provided a great potential for teachers to develop in-house applications that can contain many exciting elements such as text, graphics, animation, audio, video clips, and hypertext. The authors have evaluated various graphics, authoring, and presentation packages, such as HyperStudio, Powerbuilder, Visual Basic, PowerPoint, Macromedia Authorware, and Macromedia Director. In order to meet the needs of our project, many factors, such as the program's power, flexibility, and compatibility and the hardware and software requirements, have to be considered. Finally, Macromedia Authorware was chosen to be the main control of the program and Macromedia Director was chosen for its maximized control over the exact synchronization of sound and animated graphics. In addition, CorelDraw was employed to create graphics that generate animated effects.

Objectives of the Application

To accomplish our curriculum objectives and to match varied needs of a dynamic student population, the objectives of the program are defined. The application is to contain features that address the following needs:

- To encourage students to explore and experiment with their own articulators at the stage of trial and error in a private setting.
- To assist students to visualize the movement of articulators.
- To provide samples of dialectal pronunciation in various phonological contexts.
- To provide a tireless native speaker to repeat items with a click of the mouse button.
- To offer an easy record and play-back device to allow users to compare their own pronunciation with the model's pronunciation.
- To provide a self-paced tool to cater for students with different levels of attainment.
- To provide an easily accessed tool for the overview of the correlation between sounds and their spelling symbols.
- To offer pronunciation models and practices to correct common pronunciation errors made by English speakers.
- To provide an assessment to show learners their progress in learning.
- To support learning with a wide range of information resources.

Description of the Hypermedia Prototype Application

In this prototype, phoneme /s/ is selected to demonstrate the design of the prototype of this project. The corresponding orthography rules are chosen to be the first lessons because they are the basis of Spanish phonetics. Before starting the lessons on a phoneme, students, whether native or non-native speakers, need to have an understanding of the relationship of spelling to the spoken language. Contrary to English, this relationship is almost entirely regular in Spanish.

The objectives of the articulation lessons are to provide a concise explanation of articulation for every allophone of a phoneme, and to help students visualize the physical process of articulation through animation. The animation is to describe and simulate the movement of articulators and is synchronized with narration and sound. It aims to help students who have difficulty visualizing articulation process through ordinary textual explanations.

For each variation of the pronunciation of the phoneme /s/, there is a corresponding lesson on listening practice. The lesson serves to substitute traditional audio tapes to provide samples of dialectal pronunciation in various phonological contexts. Students can replay a recording by clicking the play button to play the entire list or by clicking directly the word or phrase they want to hear. In addition, this lesson offers an easy recording and play-back device to allow users to compare their own pronunciation with the model's pronunciation.

The lessons on pronunciation aim at pointing out pronunciation errors commonly made by American students, and providing correct model pronunciations. The lessons also offers an easy recording and play-back device to allow users to compare their pronunciation with the model's pronunciation.

The Quiz gives students an opportunity to check their comprehension of the material covered in the whole course under one phoneme. It consists of three sub-tests. The first test serves as a pre-test evaluating intellectual comprehension of the subject, of which the questions are either textual or concern the movement of articulators demonstrated by animation. The second test is a listening test on sound distinction at the word level. The third test evaluates the sound distinction ability at the sentence level. Both tests allow users to hear the words or sentences being tested as many times as they wish.

Program Structure

To satisfy students' individual needs, the program offers six different paths under one phoneme. Each path has a course title reflecting its function: Complete Course, Orthography Rules, Articulation, Listening, Pronunciation Practice, and Quiz. Each course can be accessed individually. Therefore, for students who only want to go over the listening exercises on one phoneme, they do not have to go through every lesson in the program.

The Complete Course is a path which allow students to access all the materials covered under one phoneme. It targets at users who wish to preview, review, or reinforce the learning of Spanish phonetics in an individualized way. Although the course follows a predefined path, users have the freedom to move from any point in the system to any other whenever they wish. Thus the path is predetermined from the instructor's perspective on how lessons can be best learned.

Navigation

The program, from top to bottom, contains two menu screens. When a user enters the program, the first menu s/he encounters is the main menu, where s/he selects a phoneme. Subsequently a sub-menu screen appears, which contains a list of six radio buttons corresponding to the six paths (or courses). As soon as the user clicks on one of the path units from the list, a detailed sub-menu containing a list of the corresponding lesson screens will appear at the right side of the current screen. The user can either click on the start button to start the lesson screens contained within the selected path (or course) in a linear way or the user can click directly on the lesson screen that s/he is interested in from the detailed sub-menu. This makes each lesson screen within a path accessible individually. This means that if a user chooses to abort the program in the middle of a course, s/he can restart right from the point where s/he left off.

Other Features

Narration

Narration is provided in the program whenever applicable since it takes less effort to listen than to read text. However, it is used in congruence with visual display to facilitate processing of information (Hoogeveen, 1995).

Animated Texts Synchronized with Narration

As mentioned in the previous paragraph, one of the hypermedia features included in this program is the synchronization of animated texts and narration to simulate a live lecture. This feature is used when simple texts are needed to exemplify the points in the lecture.

Animated Graphics

Graphics showing the side-view of the vocal tract have been widely used by phonetic books for instructional purposes. In this program, graphics of such nature are adopted and further enhanced. We use animated arrows as well as animated colored shapes on articulators to clarify and emphasize points in the lecture. In addition, movement of articulators within the vocal tract demonstrated by animated graphics along with concurrent pronunciation are used to simulate the process of articulation.

Hypertext

The transcripts of narration are organized into hypertexts. When users click on a linked-text, a pop-up glossary explaining the terminology will appear.

Pilot Study

The prototype program was tested with four students taking Spanish phonetics during the fall semester of 1996. All of them volunteered to participate in the pilot study. Each one used the program for approximately one hour and answered a questionnaire based on her/his experience with using the program.

In terms of their overall reaction to the program, all of them are strongly in favor of a hypermedia-assisted approach for the learning of Spanish phonetics. They believe that a hypermedia-assisted approach (lecture, textbook, and hypermedia program) is more efficient than the other approach (lecture, textbook, and audio cassette) because it takes less time to master the material. Their reaction on the efficient aspect of a hypermedia program corresponds in some way to several studies that compare classroom lecture and multimedia instruction (Najjar, 1996). The finding is that learning appeared to take less time when multimedia instruction was used. In our case, one possible explanation for students' reaction is that pronunciation samples delivered via computer-based hypermedia is easier to use and thus more efficient. As one student emphasized in the questionnaire, it is extremely important to learn a concept and hear the actual pronunciation right away. This is easily achieved through a hypermedia computer program. Another student said that with the computer program s/he could now control how much time s/he needed in order to repeat a pronunciation and sounds presented through computer were clearer. In addition, one student wrote that s/he did not understand a terminology of sound (predorsal /s/) before using the computer software and traditional method took more time because there was more reading and thought processing to do than with computer. This student's explanation was that with the computer program s/he could see (animation) and heard it (sound). One student also indicated that most of the people did not read the text book before attending a lecture, because it was dull and hard to read a lengthy text, implying that a computer-based hypermedia program was more interesting. Furthermore, one student mentioned that by using a moving object on the map it clearly indicated the location where a certain dialect was used. In sum, their comments and overwhelming support for the program suggest that this program has provided the components that match their needs. By fulfilling the aims we set up earlier, this prototype has accomplished the goal in enhancing the teaching and learning of Spanish phonetics.

Implications and Suggestions

Students' overwhelming appreciation of this prototype are revealed through written comments such as "it was fun to give feedback on a program that I'm sure will be helpful to students in the future" and "I liked it very much". Through both their written comments and the conversation that the designer had with them, it is evident that they appreciate and welcome the application developed by their teacher. This suggests that teachers should be introduced of the tools to develop their own applications to meet their classroom needs. Another advantage of developing such in-house application is that through the process of designing, it forces the instructional designer to better organize and structure the learning material. It has also made the designer reevaluate the instructional objective and rethink the instructional strategy both in the classroom and with the computer.

One important factor that determines the selection of the authoring tools is the user interface design, which is usually under the constraint of the software capacity. Hence, before selecting tools, the designer should have considered how the interface will look like and what features it contains. It is also important to enumerate the features that the application is to provide before searching for a suitable tool. A right tool can save numerous hours on redesigning the program and hard programming. For example, initially, the design of this project was to use a tree-like interface, as the Microsoft Explorer, to provide easy access to each lesson screen and to show an updated indication of the lessons being accessed. This type of interface structure is more exhaustive and the user does not need to make any provisional jumps in order to decide which further step to take. Unfortunately, Authorware does not provide an easy way of implementation. The authors therefore have to compromise with the selected tool and redesign the interface in order to maintain the navigation efficiency.

Teachers who are interested in designing an in-house application also need as much exposure to different educational and entertainment hypermedia softwares as possible. The more exposure and knowledge mean the more creative and effective the design will be. As many of our students have experience with many different hypermedia softwares, a dull design will be hard to meet their expectation on quality. In addition, programmers usually do not have the same knowledge background on the subject as the designer. Therefore, the application relies heavily on the designer's vision on how to take advantage of the technology to achieve the instructional goals.

Pilot study is an indispensable task. Through the pilot study, the designer will find out immediately if the design has met the established goals. Additionally, students can give many useful feedbacks on what features they like most, what additional features they want to have, or which parts of the program are confusing to them. Before conducting the study, it is important to direct students to focus on the meaningful aspects of the program instead of looking at errors that can easily be corrected (such as typos). Nevertheless, within the domain of feasibility and practicality, the prototype program for students should contain as less errors as possible because certain errors tend to distract some people's attention from the focus of the evaluation.

Summary

Spanish phonetics class plays an important role in helping students acquire needed knowledge and skills in differentiating sounds and in correcting pronunciation errors. The new computer hypermedia technology has made it possible for educators to develop appropriate application programs that fulfill students' needs as well as correct the inadequacy of traditional teaching methodology. This paper has discussed the various phases in planning and developing a hypermedia-assisted application to enhance the traditional teaching methodology. The development of this project suggests that it is feasible to develop an in-house hypermedia application and educators should be encouraged to develop their own applications.

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TEACHERS AND TRAINERS' MOTIVATION AND LEARNING STYLES ON CREATING HYPERMEDIA

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Hypermedia, a non-linear, non-sequential type of authoring package, has become a very popular technological medium among school teachers and corporate trainers. This is because hypermedia allows the teaching and training professionals to create dynamic textual, graphical, audio, or visual information to enhance the effectiveness of the instructional or training content. Among the popular hypermedia authoring packages include HyperCard in Macintosh computers, ToolBook, and LinkWay for PC Windows, and Authorware for both Macintosh and PC Windows (Brader & Dwyer, 1994).

The purpose of this paper is to present the findings of a survey study for revealing the level of academic confidence and motivations (perceived value and usefulness of learning to create hypermedia), as well as learning style preferences of the graduate students, mostly in-service teachers and corporate trainers, while learning to create hypermedia. It is hoped that the results of the study can be insightful to instructors of hypermedia to identify the motivational factors and learning methods that influence working teachers and trainers as they learn to create hypermedia.

The Participants

The participants of this study were twenty-two graduate students, mainly in-service teachers and corporate trainers, from the course titled "The Design, Development, and Evaluation of Computer-Based instruction" (CBI course) offered by the Program of Instructional Systems at the Great Valley Graduate Center of the Pennsylvania State University. Among these students, there were ten students in the CBI course of the Fall I section and twelve students in the Fall II section, both in the 1996 Fall Semester. In the Fall I course, the students were required to create a hypermedia lesson by using ToolBook for Windows, while the students in the Fall II course were using Authorware for Windows to create hypermedia lessons. There were nine male and 1 thirteen female students in these two courses, and their working experience ranged from three to twenty-five years.

The Survey Questions

The questions in the survey were grouped into three major categories: academic confidence and computer experience, value/usefulness of learning to create hypermedia, and learning methods. There were open ended questions and statements to be ranked, and the rankings for the statements ranged from strongly agree, agree, neither agree or disagree, disagree, to strongly disagree.

In the section of Biographical Information, there were three questions inquiring about gender, working experience, and job function of the students. In the next section, Academic Confidence and Computer Experience, questions for the students to answer included :

1. The number of years ago I started using a computer regularly;
2. The total number of hours per week I spend using a computer;
3. The number of hours outside of the classroom that I invested in learning to create hypermedia;
4. I do well in the graduate classes I have taken;
5. I expect to get the following grade in this class: A, B, C, D, E, F.

In the following section, Value and Usefulness of Learning to Create Hypermedia, the questions for the students to rank included:

1. I currently use hypermedia at work;
2. I currently create hypermedia instructional environments;
3. I will be creating hypermedia in the future;
4. The ability to create hypermedia will help me move ahead in my career;
5. I am not sure how creating Hypermedia will fit into my future career;
6. An understanding of the theoretical foundations for the instructional use of hypermedia will help me to succeed as a hypermedia developer.

The two open-ended questions in this section were

1. Which theories were most useful to you, and why?
2. What part of this course is most useful to you, and why?

In the last section, Learning Methods, the questions to be ranked included:

1. The best way for me to learn hypermedia is on my own with the manual;
2. The best way for me to learn hypermedia is on my own with the on-line help;
3. The best way for me to learn hypermedia is on my own with an on-line tutorial;
4. The best way for me to learn hypermedia is on my own with a text book;
5. The best way for me to learn hypermedia is with a personal tutor;
6. The best way for me to learn hypermedia is classroom instruction (lecture style);
7. The best way for me to learn hypermedia is classroom instruction (hands-on participation);
8. The best way for me to learn hypermedia is lab time with an instructor available.

The two open-ended questions in this section were:

1. The best way for me to learn new software is OTHER (Please describe);
2. What part of learning to create hypertext was the most difficult, and why?

The Results

The results of the survey revealed that, while the average years of using a computer of these students was 7.8, with a range of 0 to 16 years, the average computer use hours per week was 19.3, with a range of 1 to 50 hours. The average hours learning to create hypermedia outside the classroom was 2.5 hours, with a range of 0 to 8 hours. With respect to the academic confidence of these students, the results showed that most students either agreed or strongly agreed that they had done well in the graduate classes they had taken up to this point. Among these 22 students, there were only two students indicated that they expected to obtain the B grade from this CBI design course.

Regarding the value and usefulness of learning to create hypermedia, there were only 5 to 7 students who agreed that they were using or creating hypermedia recently. Most of them were hypermedia novices. However, 17 out of 22 students either agreed or strongly agreed that they will be creating hypermedia in the future. In responding to the open-ended questions about which theories were most useful to them, some of the representative responses included:

> "The constructivistic information gave me a name for a set of educational practices I used in the classroom."

> "The review of the learning theories was helpful because they can be applied to any CBI program. The use of CBI in the future is the most interesting information."

> "Integrating instructional systems to the development & design of hypermedia."

> "Screen design—user interactivity—establishing CBT program goals"

As for the question: which part of the course was most useful to them, the majority of the students indicated using the computer (the hands-on experience) to create hypermedia was most useful.

With respect to the learning methods, the three top preferred methods were using classroom instruction with hands-on participation, lab time with an instructor available, and a personal tutor. From the responses, it was found that there were 7 students, whose computer experience ranged from 9 to 16 years, ranked using lab time with an instructor available as their top preference of learning method. The rest of the 15 students, whose computer experience ranged from 0 to 8 years, preferred using classroom instruction with hands-on participation as the learning method. Most of the students (nearly 90%) strongly disagreed that, the best way to learn hypermedia was through a manual. A few students also responded to the open-ended question about other learning methods. These responses included:

> "Practice—clear direction on paper (the ToolBook handout you gave was very concise and useful)"

> "The classroom format with job aids (brief written instructions) worked well for me."

> "Self-paced course (CRI) with instructor available"

While responding to the question of what part of learning to create hypermedia was most difficult, and why, the two most representative responses were :

> "Variables and coding process"

> "There are many aspects and steps to learn in a very limited amount of time."

Discussion and Conclusion

This paper reports the major findings of a survey study for revealing the perceived value and usefulness of learning to create hypermedia of the graduate students, mostly in-service teachers and professional trainers. The findings also revealed the preferences of the learning methods for creating hypermedia among these students.

Primarily, the results showed that most of these students were hypermedia novices. Although they were not using hypermedia recently, they believed that they will need to create hypermedia in the future. The results also indicated that the constructivistic information and learning and design theories were considered to be very important, while hands-on practice and learning-by doing approach were experienced as the most useful strategies for learning to create hypermedia.

Regarding the learning methods, the students with very limited computer experience preferred using classroom instruction with hands-on participation. In contrast, the students with at least 9 years of computer experience preferred using lab time with an instructor available. However, the majority of the students resented the idea of learning hypermedia through a manual. They indicated that the most difficult part of learning to create hypermedia was the programming and coding process. Few students also suggested that self-pace or job aids should be provided. Based on these findings, it is necessary for the future study to investigate what kind of relationships exist between a student's hypermedia experience, learning styles, preferences, and motivations as it relates to learning to create hypermedia.

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Multimedia Lesson Plans

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Educators must understand that teaching roles in a technologically rich environment differ significantly from their experiences when they were students. Because students today are more technologically literate than their teachers, higher education must respond with the training of preservice teachers. To be prepared for life and work in the 21st century, students need to explore as many aspects and capabilities of technology as resources will permit (Peterson & Orde, 1995).

In an attempt to meet this challenge, educators at the University of Central Florida have discovered a unique and innovative way to develop lesson plans. They are using multi-media authoring software which allows students to integrate text, graphics, video, audio, and digitized images into their lesson plans.

In the past teachers have used lesson plans from written curriculum guides or developed their own written plans. A reoccurring problem was the extreme difficulty visualizing the lesson from the written directions. Conversely, multimedia lessons plans allow teachers to add the visual aspect of the lesson. Now lesson plans can be stored and easily accessed!

Benefits of Multimedia Lesson Plans

The benefit of the multimedia lesson plan is to replace the two-dimensional written word with the three dimensional written, auditory or visual lesson. This is a tremendous benefit in many curriculum areas where an auditory explanation or a visual (picture, illustration, or video) would help with the understanding of the lesson. For example, a multimedia lesson plan can show a short video clip with narration on how to solve a math problem, complete a science lab, or perform a gymnastics skill. Also, a multimedia program captures students interest by providing information through a variety of senses. Multimedia has the potential to enhance, enrich, extend, and ultimately transform the curriculum.

Multimedia Software Selected

The multimedia software selected was HyperStudio which is a entry-level multimedia authoring tool. It can be put together using a basic set of navigation and media control functions, none of which really require scripting. In HyperStudio a series of cards are produced which is called a stack. Buttons can be produced on the individual card which allow you to move from one card to another card or to another stack. Each card created allows the individual to combine text and graphics, link cards, add and control audio, and run QuickTime (AVI) movies. Newer versions provide QuickTime support, easy-to-create buttons, animation, record and playback sound capability, audio CD support, live "real-time" video digitizing, built-in paint tools, group built-in- text editor, and "ready-made" templates.

Developing the Multimedia Lesson Plan

A seminar was held in the technology lab to give preservice teachers an opportunity to become familiar with the software. The multimedia portion had four parts: (a) the written lesson plan; (b) credits to reference any materials or products used for the presentation; (c) an author biography which included a picture and gave brief information about the presenter; and (d) a video (to auditorally and/or visually demonstrate parts of the lesson).

A "main menu" card or a table of contents was developed which included "buttons" that represented the parts of the plan. This made their plan interactive because individuals viewing the plan could "click" on a "button" to view the portion of the plan that they chose. Preservice teachers learned or had assistance in video taping, capturing the video, scanning their picture or using the QuickTake camera, and importing graphics. Some chose to add sound or special effects to their production. In addition to HyperStudio, there are many other excellent software packages available.

Other Ways for Educators to Utilize Multimedia

Preservice teachers realized that multimedia allows the creation of an infinite number of presentations for a variety of purposes with different audiences. Some ideas were: to incorporate multimedia lesson plans into their portfolios; to show to administrators as a sample of their work; to gain support from faculty, staff, and parents by producing a slide show; to highlight students' yearly activities; to provide additional information that students would work on independently; to develop and keep as a resource or to share with other teachers; and to provide lessons for learning centers.

Conclusion

This experience will help preservice teachers be able to adjust to the diverse and rapidly changing hardware and software environments they will encounter. In the Editorial page of Technological Horizons in Education, T.H.E. Journal (1995) it was stated that multimedia seems to be the wave of the future, especially for training. Multimedia can bring about significant time-savings, cost-effectiveness and produce favorable results.

According to Mohnsen (1995), more than 30 research studies have indicated a reduction in average learning time for 50% of students using multimedia instructional programs. There has also been shown an increase of 33% to 70% greater mastery in students using interactive technology as compared to students using more traditional methods. Also noted was that students have greater motivation and learning enjoyment because they are actively involved and their attention is focused.

Teachers who experience many aspects of technology and develop or use multimedia lesson plans will have their own teaching tool to improve the quality of their teaching. By utilizing multimedia they can better capture and maintain their students' interest and enhance motivation and enjoyment. Used wisely, today's computer-based multimedia products will make it possible to learn more, in less time, and with far less overhead. Moving ahead educationally with multimedia is all about a collaboration among teachers, students, and technology to make learning more accessible, more meaningful, and more lasting (Dyrli & Kinnaman, 1995)

Additional examples of student multimedia lesson plans may be found on the CD-ROM.

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TEACHING RESEARCH WRITING: A MULTIMEDIA APPROACH

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Multimedia integrates the sounds, images, and textures. It can motivate students to learn and write. To meet the needs of the 21st century, students in schools today will be able to take responsible of learning, cope with new technologies, and work cooperatively in a high-performance team environment (D'Ignazio, 1992). Pre-service teachers and in-service teachers are facing the challenge of training students for the 21st century. For improving teaching effectiveness, presenters have designed an instructional module for pre-service and in-service teachers to teach research writing with a multimedia approach. The instructional module consists of six phases, and is designed to be integrated in subject teaching units through out an academic year. In this paper, presenters will introduce the structure of the instructional module, discuss its potential effectiveness of teaching, and provide teachers with suggestions of implementation.

Background

The instructional module of using computer technology to teach research writing is one of the products of Kennesaw State University's Classroom Technology Initiative (CTI) projects. School of Education at Kennesaw State University initialized ten projects in 1996 and all projects were funded by one of Coca-Cola grants. Fourteen P-12 teachers from six school systems in northwest Georgia and fifteen faculty from Kennesaw State University were involved in the projects. Under the umbrella of CTI, there were ten project teams working on ten different projects. Teaching research writing with a multimedia approach was one of them.

Multimedia is defined as a communication format that integrates several media— text, audio, video, and animation— most commonly implemented with a computer (Grabe and Grabe, 1996). Multimedia approach provides teachers with a variety of tools to facilitate students to create and link information resources, to integrate sounds and images, and to see their learning married to computer technology (Grabe and Grabe, 1996; Thomson Technology Service Group, 1996). Presenters believe that technology has finally given teachers an instrument that can truly enhance the quality of education. If used correctly, computers can be a major asset in the classroom. Using computer as a medium, not only can a teacher teach computer skills, but he or she can also teach many other curriculum related subjects. With the every increasing dependence on computers, a teacher should give students the opportunity to explore all of its possibilities. Teachers need provide students with the chances of use computers to develop computer skills, to learn how to investigate using this instrument. The students also need to learn how to work cooperatively and be responsible for their own learning. Therefore, an instructional module of teaching research writing with a multimedia approach is bom.

An Instructional Module

Presenters have participated in Kennesaw State University's CIT project teams and put the instructional module into practice in an elementary school which is located at northwest Atlanta, Georgia. The instructional module of using computer technology to teach research writing consists of six phases: (a) identifying research topic, (b) generating research plan, (c) collecting and analyzing data, (d) drafting research paper, (e) creating multimedia presentation, and (f) sharing multimedia production. Six phases in the instructional module are not isolated but connected to support each other. They are not exactly linearly structured but can be a circular learning process to be integrated in curriculum. With this instructional module, teachers guide students to learn about computers, facilitate students' research writings, and bring the multimedia into the classroom. Guided by teachers, students accomplish their writing tasks through out an academic year's research units .

Phase One: Identifying the Research Topic

In this phase, teachers facilitate students to locate specific research topics. Students are provided with the opportunities of learning about computers, the experience of on-line research, and the exploration of CD-ROM resources.

Guided by teachers, students read related books and encyclopedias, discuss their readings, and identify their research writing topics.

Phase two: Generating the Research Plan.

In this phase after the writing topics are identified, teachers guide students in exploring the use of computers for brainstorming research ideas and diagramming research plans. Assisted by teachers, students use a powerful ideas organizer package, such as *Inspiration*, to group their research teams, formulate research questions, and map research ideas and tasks. Students work cooperatively to outline research hypotheses, list research procedures, and divide research tasks among team members.

Phase Three: Collecting and Analyzing Data

According to the research plan, each student takes responsibility for collecting and analyzing data. In this phase, teachers help students decide which data is necessary to support or disprove the hypotheses. Students learn how to download appropriate audio and video materials from CD-ROM resources and on-line searches, and to use a scanner or digital camera to get information from printed material.

Phase Four: Drafting the Research Paper

In this phase, teachers supervise students' discussion of their research data and the process of organizing the research ideas and drafting research papers. Teachers may allow students to control their learning process with their cooperative efforts; however, teachers can schedule group conferences to monitor and facilitate students' research projects.

Phase Five: Creating a Multimedia Presentation.

In this phase, teachers provide students with necessary multimedia presentation skills. Guided by teachers, students learn about multimedia, and create research papers with multimedia tools. The research papers will not only be presented in a informative texture format, they will also be integrated with related audio and video materials and animation effects.

Phase Six: Sharing Multimedia Production

Finally, instead of reading the hard copy of their research, students present their multimedia production. This opportunity reinforces students' initiative of reading and writing, and encourages their cooperative learning efforts in class.

Potential Effectiveness

Teaching research writing with a multimedia approach has multiple potential benefits for pre-service and in-service teachers. First, teachers will be able to help students become knowledgeable of computer technology and develop skills in using this technology since the project is computer-based. Guided by teachers, students work at computers to accomplish their research projects. They locate related readings and identify their research topics with computers. They map research ideas and diagram research plans on the computers. They collect and analyze research data through computers. They depend on the computers to create presentations with an integration of texture, sounds, and images. Student research writing is no longer limited to paper format.

Second, using a multimedia approach will allow teachers to make teaching and learning activities more meaningful. In a multimedia instruction environment, teachers allow students to experience the learning with computers; students learn that the computer is more than an instrument to play games or gather information. The computer can also be used to communicate ideas, conduct research, and produce a multimedia presentation. Students, therefore, are motivated to develop not only their technology skills, but also academic research and writing skills. With hands-on research activities, students will learn that the objectives they are being taught are objectives that they will use in their daily life. While creating a multimedia presentation, students generate texture in writing, implement audio effect, and insert related images and animations. Students immediately see their achievements visually, and become proud of their learning.

Third, students become responsible for their own learning and develop cooperative learning skills. In an environment of research writing with a multimedia approach, the majority of communication will be focused on the use computer technology to generate research writings. Students are responsible for coping with new technologies, conducting research, and creating a multimedia presentation. Students work cooperatively while searching for information through the network or from CD-ROM resources. These cooperative activities include assigning research tasks to the group members, outlining research hypotheses and generating research writings together. Their final research papers are the product of the cooperative efforts of the group.

Overall, teaching research writing with a multimedia approach benefits teachers to develop students' technology skills as well as academic reading and writing skills. More importantly, it facilitates the students' learning process which makes them become responsible learners for the 21st century.

Suggestions for Implementation

Obviously, the effectiveness of teaching research writing with a multimedia approach depends on a teacher's initiative. Teachers should take an initiative to implement technology in subject teaching and learning. With a multimedia approach, teachers can offer students more diverse experiences in learning and sharing. However, teachers themselves should first become comfortable and competent in utilizing multimedia mediums while designing instructional plans and delivering lessons in the classroom. The support of administrators and the community are considered equally critical as a teacher's initiative.

Presenters realize that the effectiveness of adopting multimedia mediums into research writing instruction will be enhanced with appropriate multimedia tools which include both hardware and software. For an effective implementation of multimedia mediums in research writing, it is recommended to have a system of 6100 and above for Macintosh computers and a system of 486 and above for DOS/Windows based computers. Either platforms needs 16 MB of RAM memory, adequate audio and video I/O devices, and other necessary components.

There are currently dozens of multimedia authoring packages in the market. Based on the needs of teaching research writing, teachers should consider three categories of software application packages. These categories include the software used to brainstorm ideas and generate research plans, the software used to collect data and draft research papers, and the software to create the multimedia presentation. Here are some suggestions:

Inspiration: Inspiration is one of the products of Inspiration Software Company, and is characterized with its powerful mapping and diagramming functions. It is an ideal package for teachers to guide students to brainstorm and map research topics and plans.

Microsoft Works or ClarisWorks: Microsoft Works and ClarisWorks are two common software packages almost available in all schools. These two integrated packages, provide a word processor, spreadsheet, database, and communication tools, and are effective tools for teachers to assist students in collecting and analyzing research data, and drafting research papers.

HyperStudio or Actions: HyperStudio and Action are two multimedia authoring packages. Both packages are easy to use and learn. They can motivate students to learn about multimedia, learn with multimedia, and learn from multimedia through the research writing process.

In addition to basic knowledge about multimedia tools, it is also important for a teacher to know how to implement those tools in instruction. For teachers who want to teach research writing with a multimedia approach, here are some of useful tips:

- Identify students' technological and academic needs;
- Start with a demonstration to motivate students to write with a multimedia medium;
- Encourage students to work cooperatively in groups;
- Facilitate students in their research and learning process;
- Use guided instruction strategies to assist students in moving from a simple, linear multimedia format to a sophisticated, free structured multimedia presentation format;
- Let students control their learning pace to make learning more meaningful, but monitor students' learning process closely;
- Take advantages of all available technology and allow students to explore all possible resources;
- Integrate the six-phase teaching module into curriculum units to make the teaching and learning more meaningful;
- Provide students with hands-on activities to learn about technology, learn with technology, and learn from technology;
- Share students' "final" writing products at the end of each teaching unit to assess achievement.

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Creating Multimedia: The Difficult Transition for Educators

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This article describes a two-year grant funded by the USWEST Foundation entitled, "Collaboratively Creating Multimedia Modules for Teachers and Professors." The initial developmental procedure was based on the Systematic Curriculum Instructional Development (SCID) process which was utilized to outline the scope of work from conceptual to the pilot phases. This curriculum development involved teams of experts in teaching, computer science and multimedia technology. The primary focus of the project is to teach college professors and K-12 teachers how to use multimedia to enhance their classroom curricula. The second year of the project, underway at the time of this writing, involves pilot-testing in four K-12 schools and at two universities. The author is the primary investigator of the grant. The following reflects on the activities encountered by educators involved with transitions from process to strategies.

The transition from print-based (static) data to electronic-based (dynamic) data is a challenge for faculty who are not accustomed to developing their own text material for students. Most educators are not trained to develop their courseware. Traditionally, they select textbooks, prescribe readings, and use lesson plans and/or lecture notes to follow the sequence of their discipline. The challenge was overwhelming to educators not accustomed to discovering with students a new way of thinking and learning The adjustments were more profound or overwhelming with professors than with K-12 educators.

Making the Transition

Decisions to utilize instructional technology for coursework has piqued interest in instructional design and other curricula development procedures. The expertise for developing courseware via story boarding procedures to place content in Disney, Sesame Street-like frames, which are backed by formative evaluation to define outcomes, is found lacking among many educators. This is a new phenomena brought about by the convergence of technologies associated with television, telephone, and the computer industry.

Academia activity resulting from this convergence identifies a need to associate with the evolving art and science of creating dynamic educational media with computerized multimedia. Developing a dynamic interactive multimedia production to actively display the essence of the course's educational objectives incorporates various skills and expertise associated with both pedagogy and technology.

Lessons Learned

Faculty members knowledgeable about instructional design, especially in depth formal processes such as Systematic Curriculum Instructional Development (SCID), have experience preparing content in sequential, print-based media but likely lack expertise to technologically place such data for non-sequential, electronically dynamic interaction. The instructional requirements for each learning task contains specific performance standards which are utilized to determine training approaches for developing learning objectives, performance measures, and aspects of the training program regarding faculty needs, needed equipment, and subsequent support.

Procedures and Strategies Utilized

This systematic procedure establishes the sequence for developing competency profiles, related materials, supportive media, modules and/or learning guides, and field-tested procedures to judge to what extent competency-based (learning) objectives are achieved in the process. This is done according to an array of outcomes and specific recommendations which are part of the Program Evaluation and Improvement Plan. When these competency-based data are ready to be placed in dynamic electronic computer multimedia screens for interactive media display, the data development process is ended and development of strategy commences. The lessons learned at the initial brainstorming phase help to explain the issues, concerns, and successes encountered when the educational data is manipulated electronically to interact from a production perspective. The scope of work included sorting out distinct differences among faculties in defining a multimedia project which would enhance the teaching-learning process in the classroom. The individual strategy developed by each instructor took into account the following elements:

1. Establish a system whereby the multimedia modules addressing these learning objectives will adhere to adult learner characteristics such as:
   a. to acquire and sustain attention
   b. to assure the project has relevance to their immediate needs
   c. to instill a sense of confidence and desire to stay involved
   d. to promote satisfaction through participation
2. Establish a system whereby multimedia modules addressing these learning objectives will be updated and kept current with new technological developments.

It was established at the onset that there was not a right or wrong instructional design model to use in the task of developing a learning module. However, the opportunity to brainstorm with a cohort group for three days tended toward uniformity in such design endeavors. This was counterbalanced when different teams were organized to begin developing strategies for utilizing computerized multimedia. A sequence of steps helped these educators to be efficient in terms of time and effort to produce quality results. These steps were presented the first hour of a three day workshop. The participants were asked to use generic instructional models until such time each had appropriate knowledge and skill to develop their own style in accord with the tools, environment, and content needed to accomplish the teaching/learning purpose and objectives of their field of study. Everyone was provided the opportunity to show their individual results and explain their efforts a month later. This helped reinforce the learning process even though most participants had not finalized their multimedia projects.

The first step was to provide a process for each participant to obtain a good mental fix on the educational purpose they had in mind. In other words, they had to answer the question, "Why are you doing multimedia?" Many were focused, but many could not answer this question because they felt they were required to "do multimedia in their classroom." Consequently, two of the twenty-five participants dropped out during the second day.

Once the educators were satisfied or comfortable describing their purpose for using multimedia in their classrooms, they had no difficulty developing a mental fix on the appropriate competencies expected of their students. They became focused on the multimedia learning module they intended to produce. They were able to describe the competency or performance outcome their efforts would illicit from students. Such competency statements helped them to determine meaning and understanding of the limits that exist regarding their learning objective. Many chose to clarify and update their thinking to develop the competency and/or performance objectives. A performance objective is education's counterpart of a competency. It describes briefly what you want students to do when they have completed the learning module and are ready to demonstrate the particular competency of the learning module.

This process helped the educators outline what they wanted their students to demonstrate or achieve for each target competency. In essence, they started to research their class content thoroughly to define the appropriate strategies needed to fulfill their teaching assignment. They reread standard sources, located special references, and brainstormed with peers about how to bring new information to their original proposals. In general, these experienced educators were bringing their knowledge up to date before learning about how to use multimedia technology as a teaching tool.

Some chose to develop or refine the performance enablers to further define what they were going to place in storyboard scenarios. Performance enablers are units of study or practice, including activities and experiences, that are designed to help (or "enable") the student to learn the target skill. They break the learning into a few major elements, making it easier and more efficient for the student to master each part. This helped determine the extent of the cognitive (or knowledge) component of the competency. They completed task analysis by working in pairs to devise or refine performance enablers for the practice component.

The workshop multimedia experts provided a series of demonstrations and hands-on exploratory exercises so these educators could determine which multimedia computer program best fit their needs. A considerable amount of time was spent learning the mechanics or functions of the software. The three day workshop ended with instructions and discussions about how the workshop participants would utilize their mentor (facilitator) or multimedia module instructions to complete the following activities during a five week period after the three day workshop:

- Located media materials that may be included as learning activities
- Previewed media materials carefully for suitability for inclusion in their multimedia module
- Developed learning activities for each performance enabler selected for multimedia interactivity or hypertext activity
- Decided on the specific experiences they wanted students to have during the instruction provided with multimedia modules
- Carefully sequenced all prepared data to analyze it all for any needed special instructions.

The participants produced storyboard scenarios by utilizing existing materials or developing new ones to fill in any gaps they discovered which would enhance any electronic or printed resources available to students. A storyboard is a series of sketches or pictures which visualizes each topic or sequence in instructional media to be produced; generally prepared after the research and before scripting multimedia data on the computer frames (screens). Wherever appropriate the educators would enhance their multimedia modules by doing the following activities.

- Devise project and laboratory exercises if these are appropriate.
- Develop the self-checks. Determine which enablers would benefit from self-checks, select the appropriate form of self-check, and write the items and model answers.
- Construct the knowledge test for the cognitive component of a selected competency if such a test was necessary. Prepare an accurate answer key and choose which would be on the Web, if applicable.
- Develop the final performance test and the performance standards. Some chose to have another professor in their program review and critique the standards.
- Review and check all data for any copyright compliance

The introductions were written after the multimedia modules were refined and ready to use with students. At this stage the participants knew what points to stress, and how best to interest the student. The last construction steps were as follows:

- Edit and polish the entire module.
- Review the module first for correct format and structure.
- Go through it again for grammar, usage, and style.

Finally, the module was checked once more for correct spelling, punctuation and capitalization. The next stage is a reunion session with the participants in the cohort who participated in the first three day planning and development workshop. The multimedia instructional modules are scheduled to be used in the classroom during the 1997 spring semester.

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See articles written by Ronald Vetter and Dale Hoskisson in this 1997 issue.

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LearningLinks: A Visual Basic Tool for Developing Hypermedia Learning Experiences

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LearningLinks is an easy-to-use and versatile software tool that allows teachers to prepare hypermedia lessons in virtually any content area. It can be used to implement direct instruction outcomes such as learning definitions, spatial orientations, and interrelationships among specific content elements. It can also be used to promote higher level outcomes defined by exploratory and problem-solving learner actions. Its instruction and testing functions center on a student's interaction with a series of frames, each containing several layers of information and cues pertaining to the current instructional focus. *LearningLinks'* architecture is grounded to powerful learning concepts such as prompting, feedback, reinforcement, and practice—concepts whose instructional utility has been repeatedly demonstrated by research findings gleaned from a series of previously developed teaching simulations (Strang, Badt, & Kauffman, 1987; Strang & Moore, 1994).

This Windows-based tool consists of three Visual Basic program modules: the Authoring Module guides the teacher through content and test development; the Instruction/Testing Module implements instruction and testing; the Feedback Module demonstrates post-instruction and post-testing student feedback.

The Authoring Module

The authoring module allows the teacher to create completely new instructional units or to alter existing units to meet current needs. The following outcomes are achieved via a series of simple button clicks, list selections, text insertions, and sizing maneuvers.

Frame Definition

As many as 10 pictorial and /or text templates can be included in a frame pool. Individual frames function as the stages on which the content is accessed.

Content Definition

As many as 50 instructional terms and their definitions can be included in a content pool that is tapped during instruction and testing.

Hotspot Definition

As many as 12 individual hotspots can be quickly and accurately positioned on each frame. These areas, sensitive to mouse clicks, offer access to additional information during instruction and cues for recall or recognition responses during testing.

Navigation Flexibility

As many as 10 navigation commands can be preset for use during instruction. The active command pattern defines the degree to which the instruction follows a preset series of focused experiences or is controlled by the learner's exploration.

Test Construction

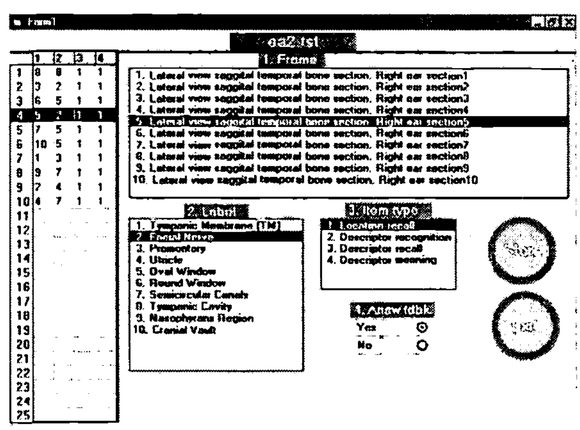

Figure 1. Test Construction Window.

Tests including as many as 25 individual items can be created to assess instructional gains. The test design window illustrated in Figure 1 guides the teacher through the construction of four types of questions.

During test construction, the teacher also determines on an item-by-item basis whether a student, upon answering, will immediately receive feedback as to the accuracy of that response.

Through simple menu selections individual items can be designed to assess learning defined by spatial recall, item recognition, item recall, and item meaning for any content that has been assigned to any frame. A test may include a series of like items or a mix-and-match of item types.

The Instruction/Testing Module

The instruction/testing module allows the student to engage actively via preset navigational selections with each program frame's content. With a lesson offering maximum flexibility (10 command buttons enabled), the student can navigate lesson frames in any sequence, and, as illustrated in figure 2, by a single button click, can activate the following four viewing modes.

Normal viewing. The main instructional and sole testing working environments are active during normal viewing. The frame content and the navigation options menu are displayed. During instruction, all content item hotspots are enabled, and, if preset, current content label-definition links and notepad are also accessible.

Micro viewing. An enlarged view of the content frame is displayed during micro viewing. This mode is particularly useful in instructional applications that include high graphical content.

Macro viewing. The current frame is positioned in a larger spatial context during macro viewing. As with micro viewing, this mode's utility is linked to high graphical applications.

Multi viewing. A sequential array of the current lesson's content frames is displayed during multi viewing. Since clicking any frame within this window activates that frame's normal window mode, the student can freely develop individualized lessons. The student can review the instructional content of previous frames or preview the content of new frames.

Under the maximum flexibility setting, the student also controls the display of all picture-text links at all times and can activate a text box control to record and store personal notes on information pertaining to the current frame. Under the minimum flexibility setting, which is automatically evoked during testing, the student's only option is to progress through the frame and response testing chain that has been predefined by the teacher. In the testing mode, the note box control is used for recording answers to test questions.

The Feedback Module

Key action and time variables are automatically recorded into a sequential text file as a student engages in either instructional or testing activities. Following the completion of these activities, the teacher can easily access the files for an entire class and then generate up to three feedback printings for individual students. The Navigation Record, the first of two post-instruction feedback instruments, is illustrated in figure 3.

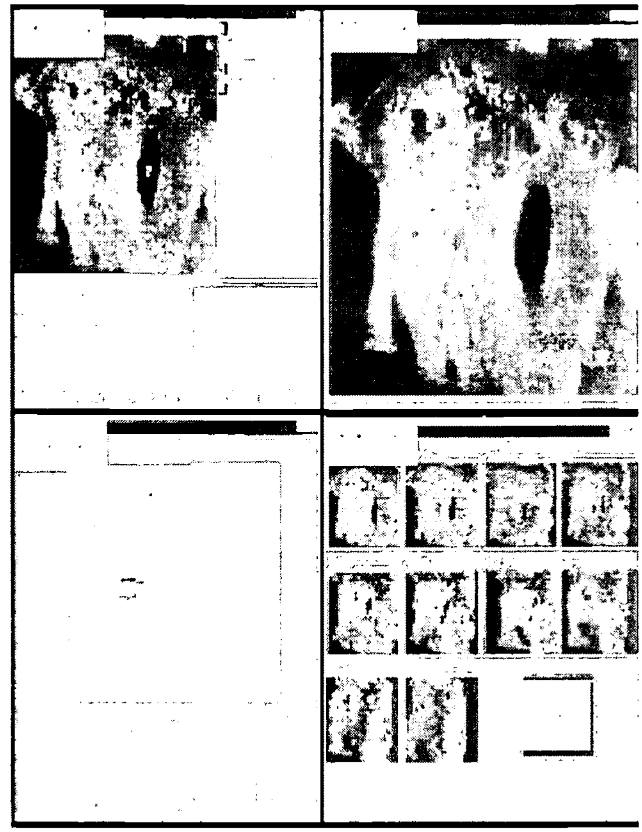

Figure 2. Four Viewing Modes.

This report offers a complete history of the student's movements through an instructional unit, clearly documenting both decisions and their temporal benchmarks. Students provided with a similar instrument (Strang, 1993, p. 10) have found the contextual nature of its feedback to be particularly helpful during a review of their performance on a teaching simulation.

The Learning Pattern Report, the second post-instruction feedback instrument, provides summary information on twenty-three specific variables. These variables are designed to reveal the general patterns that define a student's approach to learning during the instruction phase. Areas addressed by these variables include student persistence, lesson pacing, practice and review, and note taking.

The Test Response Record feedback instrument provides a record of a student's test performance. Accuracy and completion time measures for each item are imbedded in a tabular display which also lists each item's question type and topical focus.

Field Testing

A unit defined by a general content file with several accompanying instruction and testing files is currently being field tested in an audiology course taught at the Curry School of Education. This unit contains a series of macro-sections of the human temporal bone that demonstrate spatial organization of this structure. Participants are graduate students who are familiar with the temporal bone content. An initial series of trials was designed to assess the instruction phase's ease of use. The three students who completed this phase were encouraged to use the note-taking option to critique the tool's operating features and also to create a "wish list" of potential future enhancements. Feedback obtained from this preliminary testing resulted in several small program changes.

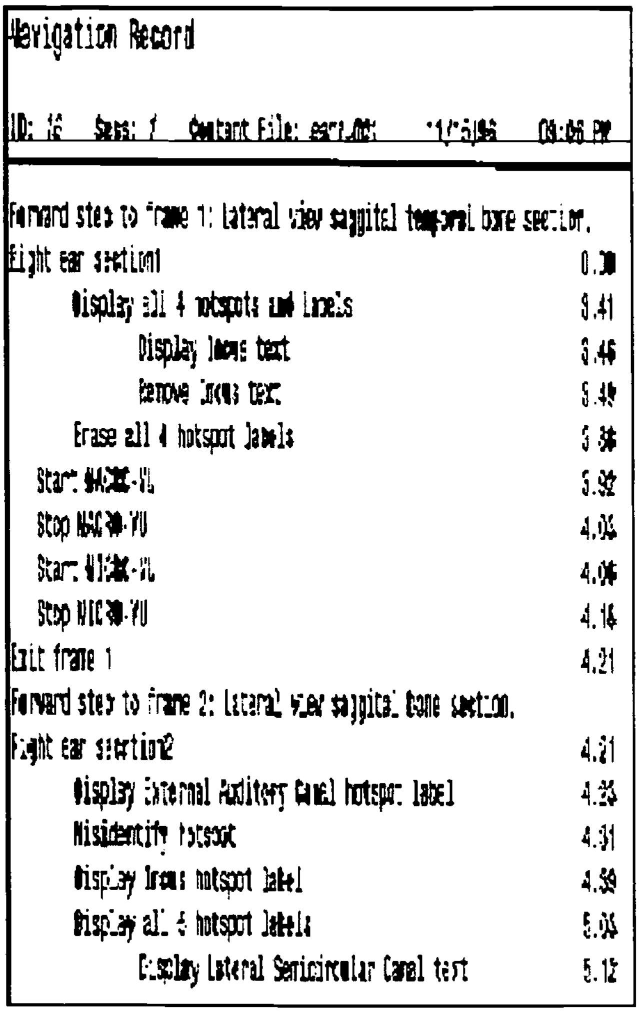

Figure 3. The Navigation Record

More recently, a second series of trials was implemented to explore student navigation during the instruction phase. A review of fifteen student Navigation Records yielded the following three general patterns:

a. Six students employed a superficial strategy defined by simply moving from frame to frame without accessing either definition information or hotspot locations;
b. five students employed a more sophisticated strategy that included accessing definition information but did not include locating hotspots; and
c. four students employed the most comprehensive strategy that included accessing both definition and hotspot information.

Information in the notes files that students created during their instruction generally complemented the pattern defined by their navigation choices. Beyond these early results, the relationship between navigation patterns and content acquisition and retention must be explored. This exploration includes using both program-designed testing and assessment obtained in the larger context of the course in which *LearningLinks* is employed. Finally, new content must be developed and included in the field testing process. Content in areas including statistics, technology training, and human development is currently under review.

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Preservice Teacher Education

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This section of the proceedings presents papers on preservice teacher preparation regarding technology in education. As in previous editions of the proceedings, you will find papers here on the integration of technology into specific methods courses, the systematic efforts of institutions at technology training for teachers, and video technology education. Also, a fourth traditional theme received greater attention this year than in previous ones: instructional management with technology.

With the emergence of the importance of the Internet, the World-Wide Web, and technology-mediated communications in education another new major trend has emerged for 1997 ... we call it virtual teacher education. Another, smaller, new trend also developed: technology and paradigm shift. Finally, the section closes with a paper on technology and preservice teacher attitude.

More than in most previous years, the papers in this collection document a continuing improvement in the field. They build upon earlier work to bring us better-developed perspectives on technology in education. We hope that you enjoy and profit from reading them as much as we have.

Specific Methods Course Integration

Dunn (Washington State University) describes how preservice teachers use presentation software to draw and to animate visual models to develop conceptualizations of rational number operations. Gimenez (Universidad de La Rioja, Spain) portrays the integration of technology into the music education curriculum. Johnson (University of Central Arkansas) depicts preservice teachers enrolled in a reading course dialogue electronically (email) with practicing elementary teacher mentors. Knop, Gehring, & Tannehill (Ohio State and Ohio Wesleyan Universities) indicate how email and online resources are integrated into a physical education *Medical Aspects of Sports* course.

Systematic Preservice Teacher Technology Education

Brush (Auburn University), Ledford & Peel (East Carolina University), and Parmley, Navarrete, Benton, & Nilles (Kansas State University) each offer papers on the development of coordinated college-wide approaches to technology integration across the teacher education curriculum. In the Auburn process, ISTE standards were included in the objective base. Thomerson (Valdosta State University) documents a different direction: extension of the course – development of an intermediate-level applied educational computing course. Ferry & Brown (University of Wollongong, Australia) use student multimedia journals to enhance technology education for preservice teachers. Jackson (St. Mary's University of Minnesota) and Doty & Hillman (Elmhurst College) each offer papers centering on the evaluation of the use of a student-developed technology portfolio to enhance college-wide integration of technology training for preservice teachers. Lan (University of Alabama at Birmingham) offers lessons to be learned from an analysis of the evolution of computer education and teacher training in Shanghai secondary schools. Powers (Indiana State University) bases technology training on the standards of the Interstate New Teacher Assessment and Support Consortium. Zhang (Concordia College) presents survey-based recommendations for preservice teacher technology training.

Video Technology

Lund (Robert Morris College) describes teaching preservice teachers about the use of television and video production in the secondary school communications curriculum. Stephens, Fabris, Leavell, Buford, & Hill (Southwest Texas State University, University of Houston, and University of Houston – Clear Lake) offer guidelines for the production of random-access (CD/Laserdisc) video-cases that enhance instruction.

Instructional Management with Technology

Matthew (Louisiana Tech University) presents an evaluation of PDA-based classroom anecdotal record-keeping by preservice teachers using the Newton MessagePad. Wellington (University of Sheffield, UK) explains evaluation of online, hypertext-formatted readings for students enrolled in a postgraduate education certification program. Zhang, Borkowski, & Bao (Universities of Maryland and Shippensberg) characterize the use of LAN-based *teaching theaters* and *lectureware* instructional management systems to enhance the teaching performance.

Virtual Teacher Education

Breithaupt (Brigham Young University) depicts collaborative technology education for preservice and inservice teachers. Fryatt & Gregg (Nechako Electronic Busing Program, Canada) design virtual practicums for pre-service teachers. Greene (Appalachian State University) has preservice teachers connect learning theory with concrete practice in an early field experience: the technology-rich Fifth Dimension project. Justice & Espinosa (Texas A&M University – Commerce) tell how classroom supervising teachers and university faculty use *cognitive coaching* strategies to guide interning preservice teachers in the integration of technology for teaching. Marcovitz (Florida Atlantic University) presents student teachers as technology change agents. LaMaster & Tannehill (San Diego State and The Ohio State Universities) cause preservice teachers to use email to mentor students in the field. McDonald & Stephens (Stephen F. Austin State University) offer online teaching experiences for preservice teachers

Technology and Paradigm Shift

Allen (University of Central Florida) argues the importance of teaching thinking and problem solving with technology and offers a model for preservice teacher engagement in such. Diem (University of Texas at San Antonio) establishes the importance of attracting technologically-proficient minority candidates who can work collaboratively to the teaching profession and describes of the use of summer institute programs to achieve these ends.

Preservice Teacher Attitude Toward Technology

Knezek, Christensen, & Rice (University of North Texas, Texas Center for Educational Technology, and Lamar University) used a compendium of 14 previously-published instruments to study changes in 32 dimensions of teacher attitude during information technology training.

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Using Technology to Construct Mathematical Understanding: Developing Preservice Elementary Teachers' Conceptualizations of Rational Number Operations

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Preservice elementary teachers' use of general-purpose presentation software programs to build dynamic, interac tive visual models for operations with rational numbers in a K-8 mathematics methods course was the focus of the present study. Two interrelated issues are addressed in this paper: (a) the preservice teachers' conceptualizations of multiplication and division of fractions; and (b) their responses to the use of technology to build dynamic imagery for these mathematical concepts. In addition to providing insight into preservice elementary teachers' responses to technology and their conceptualization of operations with rational numbers, this study was designed to provide some guidance to university faculty seeking to design elementary mathematics methods classes that enhance preservice elementary teachers' understanding of rational number operations.

Throughout the course, the use of technology, specifically the computer, was encouraged and promoted as an essential component of concept development. Computer-generated, dynamic, interactive, visual models were utilized to enhance concept development by providing a bridge between traditional manipulatives (e.g., fraction bars) and symbolic representations of rational numbers. The preservice teachers worked with two general-purpose presentation programs, *PowerPoint* and *Kid Pix*, retrofitted to the educational environment. The software allowed them to draw and animate visual models of rational number operations. Unlike static, inert representations of rational numbers, the technology was dynamic (changing as a function of time and showing continuous transition of intermediate states) and interactive (allowing for the manipulation and modification of the models).

Theoretical Framework

For many preservice teachers, their own experiences learning multiplication and division with rational numbers involved memorizing algorithms, plugging in values, and manipulating symbols. Rather than promoting relational knowledge (conceptual structures that enable the mathematics learner to know what to do and why), these instructional experiences appear to encourage procedural knowledge - "instrumental understanding" and "rules without reasons" (Skemp, 1978). The use of such superficial strategies may encourage an over reliance on direct rather than analytical approaches to problem-solving resulting, ultimately, in limited reasoning and understanding of word problems (Sowder, 1988). Indeed, research that reveals preservice teachers' misconceptions about the multiplication and division of rational numbers suggests that they may inadvertently pass their misunderstandings onto their own learners (Post, Harel, Behr, & Lesh, 1991; Tirosh & Graeber, 1989).

Multiplication and division of rational numbers are complex operations because, in addition to being difficult to represent with concrete and pictorial analogs, they do not map readily onto whole-number models (Taber, 1993). Technology may facilitate learning by providing physical representations of abstract strategies and concepts, making them tangible for inspection, manipulation, and discussion (Derry & Lajoie, 1993). Current reform efforts concerning the nature of teaching and learning mathematics emphasize the role of the computer in improving mathematics teaching and learning (Kaput, 1992; NCTM, 1989). However, many preservice and inservice teachers lack confidence in using computer technologies for education (Piña & Harris, 1993).

Because research suggests that the effective use of broad-based teaching repertoires fosters higher student achievement (Brown & McIntyre, 1993; Hiebert, 1991), educating elementary teachers in methods of mathematics instruction that utilize technology may result, ultimately, in both teachers and students in developing broader and deeper understandings of mathematical concepts.

Methods and Data Sources

Twenty undergraduate elementary education majors enrolled in a mathematics methods class for preservice elementary teachers participated in the study. The participants were seniors and juniors enrolled in the teacher preparation program at a large, research university. Student demographics revealed that ninety percent of the participants (n=18) were women and ten percent of the participants (n=2) were male. The preservice teachers ranged in age from 20-27 years, with the majority (n=19) of the participants aged 20-23 years. Participants were selected according to the following criteria: (a) elementary education majors, admitted to the teacher certification program, who were in their junior or senior year at the university; and (b) had no social or personal ties to the researcher.

The researcher examined the experiences of the participants in a course designed to help them prepare to teach elementary school mathematics. The mathematics methods course is an integral part of the elementary teacher preparation program at a large, research university. The majority of the preservice teachers in this study had completed at least one mathematics content course prior to enrolling in the methods course. This particular methods course was offered during a six week summer session. The course was taught in an educational computer lab and, throughout the six weeks, the use of technology, specifically the computer, was encouraged and, promoted as an essential learning tool. Technology was utilized to provide a bridge between concrete and abstract models of rational numbers. Unlike printed illustrations, the technology was interactive, enabling the preservice teachers to manipulate and change the models.

In addition to meeting as a whole class, small groups met with the instructor, before, during, and after class. Out-of-class discussions were held with preservice teachers individually and in small groups. The instructor emphasized a constructivist, experiential, collaborative approach to learning mathematical concepts. The preservice teachers were encouraged to work in small groups, collaborate on their assignments, and utilize technology to visually represent mathematical concepts (NCTM, 1989).

This study utilized a qualitative research framework to explore the experiences of the preservice elementary teachers utilizing technology as an integrated approach to learning mathematical concepts. The use of a qualitative research framework illuminated the perspectives of the preservice teachers and enabled the researcher to gain an understanding of the nature of the interactions of the participants with the computer in designing visual models. Data sources included semi-structured open-ended interviews; participant observations of the class; and collection of classroom artifacts, including student assignments, portfolios, and a written final exam. Following completion of the assignments, interviews, each lasting approximately thirty to forty-five minutes, were conducted with five of the participants in order to obtain additional information about their conceptualizations of the multiplication and division of rational numbers and their responses to responses to using technology to create interactive, dynamic, visual models of these mathematical concepts.

Assignments were designed to provide information about the preservice teachers' reasoning strategies and to assess their conceptual understanding of the multiplication and division of rational numbers. Because the researcher sought to ascertain the participants' thinking about operations with rational numbers, rather than simply performing the given operations, the preservice teachers were asked to write both expressions and word problems, design computer-generated models, and reflect on their thinking. Participants were given time to work on the assignments during class. In addition, they were provided access to the instructor and the computers before and after class. Two relatively general-purpose programs, with origins outside of education, *PowerPoint* and *Kid Pix*, were retrofitted into the educational environment. The programs could be further modified by the preservice teachers. Assignments included the following items:

- Item 1: Write a number sentence and design a model to illustrate: *Rosario has 1½ kg of sugar. She plans to bake pan dulce and each batch requires 1/4 kg of sugar. How many batches of pan dulce can she make?* Reflect on your thinking.
- Item 2: Write a word problem for the expression: 1/8 x 3/4 Illustrate and solve your word problem using a model - not the algorithm. Reflect on your thinking.
- Item 3: Write a number sentence and design a model to illustrate: *Teik has 7/8 meter of silk fabric. He uses ½ of it to make a sarong. How much silk did he use to make the sarong?* Reflect on your thinking.
- Item 4: Write a number sentence and design a model to illustrate: *Curtis can plow 1/3 of an acre in one hour. On Tuesday, he plowed 3/4 of an acre. How long did it take him?* Reflect on your thinking.
- Item 5: Write a word problem for the expression: 2/3 ÷ 1/5 Illustrate and solve your word problem using a model - not the algorithm. Reflect on your thinking.

Results

Preservice teachers' (n=20) responses into the five items were categorized across five major variables (Post, Harel, Behr, & Lesh, 1991). The variables included: (a) answer: correct or incorrect; (b) solution strategy: types; (c) explanation: adequacy of logical structure and flow of explanation; (d) procedural vs. conceptual; and (e) reference to model: supportive or nonsupportive.

The data indicate that while 35% of the preservice teachers were able to correctly identify Item 1 as a division problem, only 10% were able to provide adequate explanations and demonstrate conceptual knowledge. Similarly only 10% of the preservice teachers were able to create a model that was both correct and complete. One preservice teacher, whose response was typical of those who were able to provide a correct and complete model, explained her thinking and her model:

> This type of problem would have thrown me before - but now that I finally see how it works, it makes more sense - all it's really asking me is 'how many 1/4s are there in 1½?' - so I created a model shows all the 1/4s in 1½ - I took the 1½ and showed it dividing up into 1/4's - then you can see the six 1/4s as they're counted off (Interview, Female, Junior).

In response to Item 2, the data indicate that 70% of the preservice teachers applied the standard multiplication algorithm. Only 10% provided a supportive model that was both complete and correct and only 5% demonstrated evidence of conceptual understanding. Interestingly, while 70% of the teachers attempted to apply the standard algorithm as a solution strategy, because of application of an incorrect algorithm, only 15% were able to arrive at the correct answer. Many of the preservice teachers who created word problems and models for a subtraction, rather than a multiplication expression, relied upon "rule without reason" strategies (Skemp, 1978). One preservice teacher, whose explanation was shared by other participants, elaborated:

> I remember that when you multiply and divide fractions you are going to have the opposite effect of when you multiply and divide whole numbers - so, in this case, where I'm multiplying two fractions, I'm looking for a word problem where I end up with less than what I started with. In my model, I wanted to physically show the process of getting smaller (Interview, Female, Senior).

Although the data reveal that 35% of the preservice teachers correctly identified Item 3 as a multiplication problem, an equal percentage of the participants (35%) mistakenly identified the item as a division problem. Additionally, 30% of the preservice teachers mistakenly identified Item 3 as a subtraction problem. The following response is typical of preservice teachers who were able to write appropriate number sentences and models and explain their reasoning:

> Has, uses - you're taking something away here - it's obvious we're making smaller because he's using up the silk. So, I know we're talking about multiplication here because when you're making smaller in fractions, it's a multiplication problem. The model was harder to come up with - how do I know it's showing multiplying and not subtracting? I think, take ½ of 7/8'- then I can begin - look, try showing 7/8 of a meter, that's the blue - then show ½ of it - the yellow - watch it now, the green is 7/16 of it, you can see it, 7/16 of a meter, that's what he used (Interview, Female, Junior).

While nearly all of the preservice teachers (75%), recognized Item 4 as a division problem, the data indicate that only 40% of them were able to write a correct number sentence for the problem. An even smaller percentage, 15%, were able to create supportive models that were both complete and correct. One preservice teacher's articulation of how the models moved her toward a conceptual understanding of the problem was shared by many of the participants:

> When I used to see a problem like this I couldn't tell what operation to use - when I was forced to move away from the algorithm I began to see it as division - but I had to see it first - in the model - then I began to see the meaning. The model shows you 3/4 and the number of 3rds in it - that's 3/4 divided by 1/3 (Interview, Female, Senior).

When presented with a number expression for the division of two fractions, the data reveal that 70% of the preservice teachers wrote word problems for the subtraction of fractions. However, 40% attempted to solve the expression using the standard division algorithm. This discrepancy between their word problems and their solutions of the numerical expression suggests a possible reason for their inability to provide adequate explanations or supportive models. The preservice teachers' explanations of their strategies demonstrated a move away from relying on the standard algorithm toward a conceptual understanding of the expression. For example:

> I used to look at a problem like this and want to flip the numbers and multiply - now the first thing I think to myself is 'how many 1/5s in 2/3?' Writing a word problem is the easy part - the model takes more thinking - but once you've done it, the model makes the meaning of the problem much clearer (Interview, Female, Junior).

While the preservice teachers had previous experiences performing routine computations with rational numbers, the creation and use of computer-generated, dynamic, interactive, visual models to enhance concept development was unfamiliar to them. In addition, the majority of participants had not been exposed to word problems involving computation with rational numbers. The results of the present study suggest that using technology as an integrated approach to learning computation with rational numbers caused cognitive conflict between the preservice teachers' ability to manipulate symbols, create the models, and explain the meaning of the operations. Many of the participants shared the feelings of one preservice teacher who reflected:

> As I began to start my operations, I thought this would be the easiest part of my assignments. I soon found it to be the most difficult. I feel this is so because of a couple of different reasons. One is that I do not remember doing story problems that involved multiplication and division of fractions. When I was making my problems, I also found trying to visually solve the problem difficult. The second is that I've never been exposed to technology in this way before (Interview, Male, Junior).

Initially, many of the preservice teachers attempted to employ the standard algorithms to solve the problems and then, based upon their results, create the models and word problems. However, these preservice teachers were unable to explain their conceptions once they had created the models. This finding is consistent with the work of Hiebert and Wearne who observed that, once procedural knowledge is acquired, "it is difficult for students to penetrate their own routinized procedures with meaningful information" (Hiebert & Wearne, 1987, p. 397). In addition, several of the participants held the belief that technological proficiency follows, rather than facilitates, mathematical understanding. Many of the participants who attempted to rely solely upon the standard algorithm to work their way through the assignments shared the response of a preservice teacher who expressed his feelings as follows:

> One word sums up my experience with these problems: frustration. Multiplication and division with fractions must be one of the most difficult concepts to write word problems and models for. It took me almost an hour to come up with just two word problems and create the models that correspond with them. To be honest, if I've struggled this much, I can't imagine giving this to a fifth-grader who didn't know the math (Interview, Male, Senior).

As the preservice teachers acquired proficiency with the software, they began to develop relational knowledge and construct conceptualizations related to the multiplication and division of fractions. However, their lack of experience with technology posed some initial difficulties. In addition to high levels of frustration, many of the preservice teachers exhibited a need for constant guidance and approval from the instructor. The preservice teachers reflected on their experiences with both the technology and their developing understanding of the underlying mathematical concepts. For example:

> My lack of computer experience has been a problem as far as this course is concerned. I think I can understand the models once I've made them but it was difficult and took a lot of explaining and then I'm still not sure if what I've done is right. Part of it is that, before this course, my only computer experience was word processing and part of it is that I rely too heavily on the algorithm (Interview, Female, Junior).

> When I was making my models, I found visually trying to solve the problems difficult. After I was shown different ways of creating dynamic models, the visuals began to make more sense to me. I think that now I could accurately portray these meanings to my own students (Interview, Female, Senior).

The high ratio of preservice teachers to computers made it necessary for the participants to work cooperatively, in groups of three or four. It appears that this collaboration, because it encouraged discussions about both the technology and the mathematical concepts may have facilitated the preservice teachers' construction of understandings. As one preservice teacher explained:

> I never thought about having kids work together at computers like this in math - it's different than what I imagined my own class would look like. But now that I can see how it helped us - working together, talking about it - it could benefit my own students (Interview, Female, Junior).

Conclusions and Significance

This study investigated preservice elementary teachers' conceptualizations of rational number operations and their responses to using technology to create interactive, dynamic, visual models of these concepts. Interviews with the participants encouraged them to verbalize their understanding of the mathematical operations and explain their conceptualizations of those operations. The data from the present study reveal that, while the preservice teachers are able to manipulate symbols and provide correct answers to problems involving multiplication and division of rational numbers, they initially lacked the relational knowledge to provide explanations for the mathematical relations, concepts, and operations (NCTM, 1989). These results also provide evidence to suggest that the preservice teachers' knowledge of computations with rational numbers is more procedural than conceptual.

In the present study, the general-purpose software computer environment appears to have played a role in the preservice teachers' developing relational knowledge of computations with rational numbers. Because of its dynamic and interactive nature, the software appears to have facilitated the preservice teachers' transitions between the concrete and symbolic representations of rational numbers. However, lack of computer experience initially hindered several of the preservice teachers' attempts to utilize the technology. Additionally, because of inadequate subject matter preparation, many of the participants had difficulty understanding the mathematical problems.

As the preservice teachers gained experience with the software, they evinced a progressive construction of concepts related to the multiplication and division of rational numbers. The results of this study suggest that traditional manipulatives and symbolic representations may not be adequate for developing preservice teachers' conceptualizations of operations with rational numbers. The data that emerged appear to support the usefulness and efficacy of technology to enhance preservice teachers' understanding of mathematical concepts and, ultimately, improve their preparation for teaching mathematics for understanding.

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Technology and Music Education: An Integration into the Music Education Curriculum at the University of La Rioja

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Since 1993 music technology has been used as a part of the music teachers' arsenal at the University of La Rioja in Spain. Knowledge of these types of tools is integrated into the curriculum through Armonia Funcional (Functional Harmony), a one semester subject. Also music technologies are used as a didactic resource in other degrees offered by this university. The present article will present both several curriculum aspects and pedagogical reflections related to the use of technology into curricula as well as its incidences in learning processes.

Infrastructures at University of La Rioja

In the academic year 1993-94 Music Lab had five workstations each made up of a MIDI synthesizer, MIDI interface, Macintosh computer, headphones , sequencer soft (Master Tracks), editor score soft (Encore) and a generator of rhythmic-harmonics (Band in a Box). Also Music Lab included a liquid crystal display, a mixing board, a CD-ROM drive, an amplifying system, a deck tape recorder and a postcript laser printer. In 1994-95 four complete workstations were added. LocalTalk net for using common resources such as printer or hard disk drives was installed in 1995-96.

As a complement, other software is available for students' use, i.a. Finale, Cubase or Practica Musica, as well as several musical works in CD-ROM format. In this current academic year we have added three complete workstations, to make a total of twelve. Also, we have purchased a multitrack recorder.

Curricular Aspects

Integration of Music Education and other university degrees is important at the University of La Rioja. We consider that Function al Harmony must be basically practical, as pupils in professional situations will use his/her knowledge of harmonization, arranging and instrumentation in order to release his/her own didactic materials beginning from melodic lines, folk & popular songs or musical works carried out by either groups or individuals. So in this subject it is more important to acquire skills and capabilities in the above mentioned fields rather the conceptual and theoretical elements; these are undoubtedly useful in other situations and studies but in some way they are out of context in this subject which has a low number of academic credits (4.5 or 45 hours).

We also need to consider the evident heterogeneous class groupings due in large part to ingress of people without previous musical experiences into these studies as well as the lack of musical skills to that they arrive with. Because of this, we have considered offering to pupils some extra reinforcements in form of aural training software that helps them in order to consolidate both capabilities and skills. The technology is also a teacher's tool in other university degrees such as Maestro de Educacion Infantil (Early Childhood Educator), Maestro de Lengua Extranjera (Foreign Language Teacher) or Maestro de Educacion Fisica (Physical Education Teacher).

Organization of Subject "Armonia Funcional"

Armonia Funcional is an obligatory subject of the university; in the Spanish educational system this means that each university requires a limited number of subjects, i.e., Armonia Funcional; while, another organization called Consejo de Universidades (University Council) requires other subjects called "troncales" which are also compulsory, in this case to all Spanish universities. These, along with the obligatory optatives and free configuration courses, make up the curriculum of a given university degree. Armonia Funcional is inserted into a Music Education Teacher's curriculum in the second year. Three years are needed to achieve a degree. Armonia Funcional have two different blocks: Foundations of Harmony and Music Technology. In the first, we broach theory directly related with Harmony as an academic discipline such as voicing chords; we also give notions on composition and arranging in order to deal with scholarly curricular materials of value in his/her future professional life.

In Music Technology we give some technological basics, such as communication between computers and MIDI devices or the use of technological tools which support an active methodology based music education, like Orff, Kodaly, Willems, Martenot or Dalcroze. Also, pupils learn to deal with multitrack recorder. Of course, apart from subject length, pupils can take practical complementary classes as electives.

We will trade materials elaborated by our pupils with others educative centers from USA, Germany, Korea and Italy, via email.

Subject's Program

As mentioned before, in Armonia Funcional practical contents carry more weight than the theoretical (75% vs. 25% of schedule). So the subject is devoted to aural training of chord and harmonic progressions, composition of melodic lines, harmonization, arranging and scoring (popular songs and pupils' melodic lines and harmonizations). These activities are released by means of technology. Contents before mentioned related to composition, arranging and scoring are elements that are not explicit from the subject's program and they make up a hidden part of the curriculum.

The Use of Electronic Dialoguing To Extend the Educational Community

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The use of interactive telecommunications has tremendous potential for teaching the language arts, especially if teachers are knowledgeable about its use. Electronic dialoguing is a motivational telecommunications technology that allows students to have ongoing discussions via the computer. According to Reutzel and Cooter, Jr. (1996) there are three major advantages of utilizing electronic dialoguing. First, the reason for writing is authentic and motivational because a real person is awaiting a communication and second, planning and scheduling is extremely flexible on the part of both audiences because they may respond at their own convenience. Finally, it offers a real world opportunity to use writing skills with an understanding audience. The purpose of the project I am going to describe was to model how technology can be incorporated into the curriculum of a reading methods course for preservice teachers to facilitate learning as well as provide hands on experiences with computer applications.

Project Description

The following is a description of a project conducted with preservice teachers in a reading methods course in Arkansas using electronic dialoguing. The reading methods course in which this project was conducted is the first of two reading courses preservice teachers are required to enroll before student teaching. One major goal of the course is for preservice teachers to gain a thorough understanding of different reading philosophies, advantages, and disadvantages of each and varying approaches teachers use to teach reading as a result of their philosophy. It is one thing to read about the theory behind different reading philosophies in a textbook and a very different thing to actually observe the approach a teacher uses to teach reading as a result of their personal philosophy.

All students enrolled in education courses at the university are required to participate in a field requisite. Each student is placed in an elementary classroom for a specified number of hours, one day each week throughout the semester, and asked to complete a certain number of requirements outlined by each course the student is enrolled. For example, one field requirement for the reading methods course I teach is to keep a journal documenting the students' observations of reading instruction and the learning environment along with any comments the students may have. After many observations and in collaboration with the teacher, the student is to determine the teacher's reading philosophy. The cooperating classroom teacher is asked to provide time for the student to complete these requirements, observe the student's performance and provide feedback as well as continue daily instruction. Many times the student and the teacher are overwhelmed and as a result have little if any time to discuss the theory behind the methods the student has practiced or observed.

Goodlad (1988) submits two fundamental conditions needed for collaboration to be effective: (1) frequent opportunities to share experiences with other persons in similar roles, and (2) opportunities to reflect upon how theory and research can inform practice. Goodlad states that developing and maintaining a method for ongoing communication between the school district and the university should be given the highest priority if collaboration is to have a chance of succeeding. Therefore, a specific goal of this project was to provide an avenue for the preservice teachers to gain a greater understanding of different philosophies of reading through collaboration with practicing teachers across the country via electronic dialoguing.

At the beginning of the semester, I provided each preservice teacher with an e-mail account through the university. I then assigned each preservice teacher with a mentor "e-pal." All of the e-pals were practicing elementary teachers located in various regions of the US. I solicited participation for the e-pal mentoring project through a request on a listserv. All of the mentors had taught three or more years in a self-contained K-5 elementary classroom.

All of the preservice teachers participated in a training session on how to use e-mail prior to sending their first message to their e-pal. All students had previously taken a required educational technology course (approximately one semester ago), but most stated that they did not remember how to use e-mail. Following a brief demonstration and subsequent practice session, all students sent their first e-mail message to their e-pal. After this initial group session, all further correspondence was on their own time outside of class. An additional class period was dedicated to showing students how to join listservs and newsgroups and to use Netscape as a resource for information.

Electronic Dialoguing Collaborations

I requested that the preservice teachers begin their collaborations with their mentor e-pals by asking about the approach they use to teach reading. From then on, collaborative topics were determined by the preservice teachers and their mentor e-pals. Initially, I was concerned that the students may need more structure as far as topics for collaboration. I contacted the mentor e-pals and asked for their input. It was obvious from their responses that the informality of the collaborations allowed the students the freedom to ask questions they believed relevant. Topic variations ranged anywhere from assessment to discipline. One mentor e-pal simply stated, "I think it should be easy for the students to ask almost anything of an experienced teacher...especially since I will not be judging their performance. I hope this could be a comfortable learning experience."

There was no requirement as to how many times a student must collaborate with the mentor e-pal. As a result, communications ranged from weekly to a total of once or twice for the entire semester. Overall, the students were very impressed with their mentor e-pals and became very close to them. The mentor e-pals took their roles very seriously and spent hours responding to the students' questions. During class, I would provide many opportunities for the preservice teachers to discuss the messages they received with was an excellent way to gain insight as to the differing philosophies teachers hold across the US. The students also discussed the motivation and enthusiasm inspired by communicating through electronic dialoguing.

Outcomes of the Project for Preservice Teachers

The outcomes of incorporating electronic dialoguing into the reading methods course were three fold. First, students were able to see telecommunications as a multifaceted resource. Students were given the opportunity to experience the power of technology as a tool for communicating, problem solving, brainstorming, and finding information. Additionally, students were involved in a different type of field experience in order to gain a deeper perspective on different philosophies possible. The project provided the students with a broader set of experiences than were available during their field placements by extending the face-to-face collaboration through electronic dialoguing. This ultimately provided a more powerful context for learning. Finally, students collaborated with experienced, technology-using teachers. The mentors were able to share their experiences as classroom teachers as well as encourage students to view technology as a tool to improve their professional lives.

Outcomes of the Project for Mentor Teachers

I was able to ascertain the benefits of this project for the mentor teachers that participated through a survey administered electronically. In general, the mentor teachers gained the satisfaction of being able to transfer skills and knowledge accumulated through extensive professional practice. The questions from the preservice teachers provided opportunities for the mentor teachers to reexamine their own classroom practices and the effects of accepted instructional techniques on the teaching/learning process. The unique aspect of this project is that it capitalized upon the classroom teacher as teacher educator and gave them the opportunity to expand the teaching role while remaining a classroom teacher.

Conclusion

It was obvious by the end of the semester that the preservice teachers had benefited greatly from participating in the electronic dialoguing project. Through hands-on experience, they gained an understanding of how technology can promote collaboration and sharing of ideas, which is one of the most promising areas of telecommunications for teachers in the battle against isolation. Recent advances in microcomputers and telecommunications have produced low-cost computer-based networks that can allow us to extend field experiences throughout the teacher preparation process. Through the use of telecommunications, teacher educators can provide an electronic educational community in which preservice teachers can learn through interactions with mentor teachers. This helps to establish stronger links between teacher education programs and classroom teaching practice. As one student stated, "It is amazing to me that you can get on a little screen and a little keyboard and talk to people clear across the world. That just shows that we really are a global community."

Mentoring benefits everyone involved: the mentor, the student, the university and the school system. The combination of real life application and effective instructional practice increase the likelihood that these preservice teachers will incorporate the use of technology into their teaching in the future. The positive outcomes of this project indicate that those of us involved with the preparation of teachers must engage in providing students with opportunities to apply technology skills so that effective teaching is modeled.

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Technology in the Classroom: Learning Options in Physical Education Coursework

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Technology infusion into classroom coursework has been demonstrated to enhance student learning (Tosteson, 1996; Padron & Waxman, 1996). The value added comes from the increased potential for student communication (Smith, 1996) and increased access to current information from multiple sources, particularly via the World Wide Web (Land, 1996). With this in mind, technology was infused into an upper level physical education course at a private college in central Ohio. The project was not an empirical study, but instead, an attempt by an instructor to make her class more meaningful to students. This paper will discuss the infusion process and report the results from the instructor's and students' viewpoint.

Background

I became involved in this project while helping a physical education instructor at a small Ohio liberal arts University develop instruction that infused technology into a college level foundations course. The instructor was in her second year teaching at this institution and second year of teaching this particular class. She had five years of teaching experience at the college level behind her and was strongly based in the course content. From previous experience teaching this class, she recognized that a different instructional strategy was needed. Students were coming to the class with varied backgrounds, experiences, and interests requiring instruction to be more responsive to the learning goals of all students. Beyond that she was interested in finding ways for students to increase their professional interactions among peers and with practicing professionals in their career areas.

This instructor was avidly interested in exploring instructional and learning possibilities using varied technology sources. She knew of multiple technological resources and their availability on campus. Further, she was ready and willing to take some risks in her classroom, provided they lead to an increased potential for greater present and future student learning. In a sense she was like the famous space traveler, Buzz Lightyear, the affable astronaut from Disney's movie *Toy Story*, whose motto " To Infinity and Beyond", seemed to characterize her continued search for new and better ways to understand what we do and how we do it. Buzz's existence in *Toy Story* was framed by his continual exploration of known limits as he tried to be the first to break through those barriers and help create a new reality. The teacher in this project ascribed to a similar philosophy, trying new methods and media that might extend options for student learning, discovery, and problem solving.

The Course

The class, Medical Aspects of Sports, was an upper level physical education required class. It was intended to be taken after students mastered prerequisite study of anatomy and physiology. The class was designed for physical education majors, potential coaches, and students preparing for graduate school particularly in science related physical education subdisciplines and other health related fields.

This particular semester 21 students were enrolled, 14 from physical education and 7 non-majors from either zoology or microbiology. One instructor did all the teaching although she enlisted the cooperation of several librarians to facilitate the on-line library search process. All students had access to computers, the University communication system (VAX), and E-mail accounts at the student computer lab. The course objectives were to:

1. Study the causes of a variety of athletically related injuries and to examine prevention measures for these injuries;
2. Study the affect of certain variables on sport performance. These were specific variables like present fitness level, present and past nutrition, and present and past injuries;
3. Study the affect that special conditions, like asthma, exercise induced asthma, environmental conditions, or ergogenic aids has on sport performance, and perform an all encompassing personal fitness assessment and use this information to design a training and nutritional program.

Given these objectives, technology infusion was intended to supplement reading, lecture, and lab materials with several additional, and hopefully user friendly, information and problem-solving resources. Increasing inter-student communication was a further purpose. We hoped to use E-mail to break the mostly one-way teacher to student interactions into multiple-way conversations where students were encouraged to value peers' ideas. Additionally, we wanted to create incentives for student initiated and sustained interactions with professionals in their field. Another purpose of the infusion process involved introducing students to several methods of problem solving allowing them to choose the most appropriate one for their content and problem. Finally, and perhaps most importantly, we hoped to make the class more fun. We thought that learning might be more fun when available through multiple media resources. Since students vary in what they think is fun, options using different technologies allowed students to choose the medium they enjoyed most.

Delivering the instructional sequences in this context where technological skill was not the primary content focus required some special arrangements. First, three hour long class sessions were devoted to introducing technological skills. These were the first, third, and fifth Friday classes of the semester. These classes met in the student computer lab where all students had access to a computer. These class sessions were supported with extensive documentation. The intent of each session was to walk students through the process steps using the documentation to support progress. Those who mastered the process moved on to their content related task using that medium. After guiding students through the process, the instructor offeredremediation during that session and via E-mail after the session. The technology options incorporated into the instruction were:

1. On-line library searches where students learned how to conduct a search and what kinds of things they had access to beyond University holdings;
2. E-mail, which would become the primary communication system for inter-student and student-instructor interactions;
3. Internet newsgroups which were introduced to allow students access to "conversations" among professional and lay individuals with common interest in specific sport content;
4. Gopher, an internet search tool, which was introduced as a way of searching for topic specific information at a multitude of sites, and;
5. World Wide Web, which was introduced as a bonus. Half way through the quarter, the University gained access to the Web at their public computing sites. The instructor was able to shuffle her instruction enough to introduce and provide support for students using it.

Given the course objective, it was important to determine the level of technological skill students had prior to entering the class. From this assessment, instruction could be developed to support and facilitate student learning of the basic technological skills necessary to access each medium. The assessment was a simple questionnaire used to determine students' prior experience. It included seven questions asking students the degree to which they had experienced E-mail, Gopher, and the World Wide Web. Of the 21 entering students, three quarters had at least limited experience accessing and using the E-mail system. Less than half had at least limited experience accessing and using the E-mail system while less than one third had ever used a Gopher. Very few students, in fact 2, had ever accessed World Wide Web and none had ever downloaded information from a site.

The Projects

Assessment supporting the infusion process took the form of a technology project which culminated in student demonstration of skills necessary to use the media effectively to find content related material. Since the purpose of infusing technology was to increase opportunities for learning and problem solving, the five technological instructional steps were each linked to a content based task. For instance, E-mail supported inter-student and instructor-student communication. The introduction to Newsgroups culminated in each student sharing an article and related search process with their fellow students via E-mail. The intent was to provide each student with sport specific articles documenting injuries, conditions, and prevention issues.

The Weather Project was a problem solving task with the objective of demonstrating the varied uses and breadth of information that can be found using the Gopher system. Relative to course content, this project focused on students applying knowledge of how environmental factors, like temperature, elevation, and humidity might affect performance in two physiologically different sporting events. Each student was assigned a "pick" city, a specific competition date, and given the Gopher address serving that region. After accessing Gopher, students' searched for sites that might contain information they would need, like Weather Service or the Geographical Service. They determined what questions were relevant to ask and where to find the answers. They, then summarized the impact this environment had on the following 2 activities: one, requiring maximal endurance lasting 30-45 minutes and the other a repetitive anaerobic event.

World Wide Web exploration supported the final research presentation and involved accessing, navigating, and locating information sources specific to their research topic. These findings were incorporated into their research topic presentation, including a printed copy of the sport specific menu to share with the class. Finally, the technology project was the opportunity for students to thoroughly investigate a specific question. Each student, using multiple media resources prepared a written summary of findings and presented this and the specifics search process to the class. An example of this process documented by one student is as follows: the topic generally search was "tennis elbow". The student's question generated from earlier search processes was "What are some ways of alleviating the pain of tennis elbow, including prevention or form changes". This student found most of the information by reading and interacting on newsgroups under FAQ (frequently asked questions) of rec.sport. tennis.

The students investigated a variety of interests as indicated by the breadth of a selected list of topics and questions they searched. For instance, one student was interested in facts about cholesterol and trends for healthy living. Her search process included using Gopher and World Wide Web under general headings of health and nutrition. A student trainer in class interested in the best rehabilitation after knee surgery, searched both World Wide Web under general health, injury, and knee exercises and a Gopher site at the University of Illinois under the same headings. A student interested in caffeine and its effects on athletes used World Wide Web to access the US Food and Drug Administration to find information. A basketball player interested in injury rehabilitation wondered what the difference was between cardiorespiratory responses to exercise performed on land versus in water. She searched World Wide Web and Gopher generally under health and specifically under the headings hydrotherapy and rehabilitation. Another student, planning a diving trip to the Caribbean, asked the question of how to prevent decompression sickness in diving. He found information under a scuba listserve and in various World Wide Web sites, one of which was a NASA site.

What Did We Learn?

Several methods were used to evaluate the success of embedding technology into the Medical Aspects of Sports class. First, the quality of student projects provided a demonstration of the extent of learning at each of the five technological infusion instructional stages. Problems were discovered and attempts made to remediate after each project stage. Student logbooks were

checked periodically for evidence of student understanding and application of knowledge. Additionally, at the end of the semester, students were encouraged to evaluate the course and give feedback. However questions guiding the evaluation were specific to the course in general, and did not elicit student response to the technology infused in the course. After the quarter, the instructor also was asked to evaluate the success of the technology infusion in her class. In addition, the instructor kept a journal of her perceptions of successes and failures throughout the semester.

A number of problems specific to the way technology was infused into the course arose throughout the semester. For instance, we learned that technology itself can create dynamic problems. For example, during the weather project, the Michigan underground weather access "went out". This technological glitch added to the student and instructor frustration. Back-up plans would have been very appropriate in this situation, but instead it took the student time to figure out it was not a student error but a technological failure that caused the problem. When the student informed the instructor of the problem, it took the instructor time to generate a new site and Gopher. It worked out, but at a time loss and frustration cost for both the instructor and student.

We also learned that the final project may have been too big and that given the instructional time frame and size of the project, instructor expectations may have been too high. Perhaps more importantly we learned that extensive advanced preparation and planning are necessary to "carry off" a redesigned class including technological infusion. On the other hand, the technology mediums did seem to increase inter-student communication and sharing of ideas. World Wide Web was fun, easy to access, and rewarding for students who worked with it. The instructor found that more material could be covered in the class in less time. Students were doing more problem solving and searching for content driven by related, but interest specific questions, instead of instructor guided inquiry generated in the lecture/lab. Additionally, E-mail supplemented the instructor's teaching resources allowing her to be more accessible to student questions, beyond office hours and phone calls.

Recommendations

In conclusion, after this first attempt at infusing technology in the Medical Aspects of Sports class, several changes to the present instruction seem prudent. First, much has been learned from the first attempt. Many of the materials can be used again with small changes. However, time does need to be spent to create alternative plans for responding to technological failures and student failures using technology. Second, the class needs to be structured to allow more time in lab settings for both content and technological learning. This may include decreasing the amount of material covered or increasing the time spent at each activity. This may also include peer mentored activities or cooperative group activities so the instructor could take advantage of the competencies and experiences students have when they enter the class. Finally, the culminating technology project needs to be subdivided into smaller parts allowing students to get feedback and earlier remediation from the instructor. The breakdown of the final project into subparts, each worth a portion of the final grade and due in a sequential manner, would give added incentive for students to complete the task in a timely manner and with more guidance.

The take home message hopefully delivered by this demonstration is that infusing technology into physical education foundations coursework can create more opportunities and methods for students to learn and more choice in how they learn. Physical education instructional delivery decisions that infuse technology are risky, both from the instructor and student's viewpoint. The risk arises in the potential for frustration simply from learning how to use the media, even though it is that learning that can drive future student inquiry. At the risk of over-simplification, "To Infinity and Beyond" implies instructional delivery decisions that can empower students to explore their knowledge limits. The beauty of infused technology is that, once some basic skill in using each medium have been acquired, there are few right or wrong ways to find information. This is important to promote problem solving and inquiry minded questioning.

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Teaching Pre-Service Teachers to Use Technology in the Classroom

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There is little argument among leaders in the field of educational technology that teacher training institutions are not adequately preparing undergraduate teacher education students to effectively integrate technology into their teaching. Although technology is becoming more and more prevalent in today's schools (Ely (1995) has noted that the student/computer ratio in U.S. schools has dropped from 1/75 in 1984 to under 1/12 today), research continues to show that teachers feel that are not prepared to effectively use technology in their classrooms (Bosch & Cardinale, 1993; Office of Technology Assessment, 1995; Topp, Mortensen, & Grandgenett, 1995). Because teachers still feel uncomfortable truly integrating technology into their instructional activities, they continue to use computers for low-level, supplemental tasks such as drill and practice activities, word processing, educational games, and computer-based tutorials (Ely, 1995; Hunt & Bohlin, 1995; Lazlo & Castro, 1995; Office of Technology Assessment, 1995). Some researchers have even gone so far as to state that "...few teachers routinely use computer-based technologies for instructional purposes" (Abdal-Haqq, 1995, p. 1). Thus, our education students are graduating with little knowledge as to the instructional applications of one of the most revolutionary sets of instructional tools of the past two decades. As the use of technology tools increases in the K-12 environment, schools will be looking to university teacher preparation programs to provide them with staffmembers who are not only trained to use technology, but have the ability to provide other staffmembers with models and examples of how to effectively use technology in their classrooms.

While most researchers agree that more technology training is needed for teachers, numerous suggestions exist in the literature regarding the content of the training and the methods for delivering the training. In terms of content, suggestions for topics to be covered in preservice or inservice teacher education courses include multimedia, problem-solving applications, networking, the internet, curriculum integration, software evaluation, telecommunications, use of applications and tools, hypermedia, and a host of other areas (Abdal-Haqq, 1995; Baron & Goldman, 1994; Taylor & Wiebe, 1994; Walters, 1992). In terms of the most effective methods for providing teachers with technology skills and experiences, many researchers believe that technology skills should be integrated with graduate and undergraduate methods courses, thus providing students with specific skills and concepts for using technology in their specific content areas (Weibe, 1995). Others believe that well-designed instruction which provides teacher education students with technology skills and experiences in a variety of content domains and gives students opportunities to apply technology in those domains is the most appropriate training methodology (Abdal-Haqq, 1995). However, nearly all researchers agree that teacher education programs should focus on training prospective teachers to integrate technology in their teaching and learning activities, as opposed to providing a "survey" of computers and instructional technology. As West (1994, p. 104) states, "Do not require [teachers] to sit through a survey of computing history or a course in computer programming."

This paper will describe the revisions and enhancements made to an undergraduate teacher education course focusing on the use of technology across the curriculum. Prior to its redesign, this course focused on introducing students to issues and research in educational technology, with an emphasis on the history of educational technology, identification of different computers, programming languages, and basic technology skills for classroom management purposes. Through redesign of the content, materials, and evaluation criteria, this course now emphasizes pedagogical uses of technology and provides students with opportunities to develop, apply, and evaluate technology-based instructional materials for classroom use. A project-based learning environment was created within the class, in which students complete activities directly related to the use of technology in their specific content areas.

Through the completion of these activities, students not only acquired knowledge regarding the

Course Development Process

The development process for this new course took place in several phases. First, information was collected for teacher education faculty in order to determine the necessary skills and experiences pre-service teachers need to effectively integrate technology into their content area, and were compared with national standards and benchmarks for technology skills for practicing teachers. Once these data were collected, the overall objectives for the course were developed using this information, and activities were constructed and sequenced to guide students towards meeting those objectives. Materials were developed to assist students with completing the activities, and these materials were provided to the students in multiple formats. Finally, students were asked to evaluate each course topic and class activity so that the course could be improved upon each successive quarter. Each of these processes are described in detail below.

Data Collection

The first step in redesigning this course was to open a dialogue with the teacher education faculty at Auburn in order to receive their views regarding important skills and experiences pre-service teachers needed in the area of technology, particularly skills related to teaching in their content areas. Faculty in math and science education were consulted first due to faculty members' extensive knowledge of instructional technology. Faculty in early childhood, social studies, language arts, and art education will be consulted as the development process continues. The math and science faculty members initially consulted provided an extensive list of technology skills they felt prospective teachers would need. These skills were condensed and categorized into the following areas:

- *using technology for productivity*. This included such areas as basic word processing, database, and spreadsheet skills, electronic search skills, and electronic mail (e-mail) and world-wide-web (www) teaching resources.
- *using technology for teaching*. This included presentation hardware and software, multimedia and hypermedia, interactive video, telecommunications, e-mail and the www, instructional software evaluation and integration, and using productivity tools in the curriculum.
- *using technology for organization and administration*. This included electronic testbanks, electronic gradebooks/attendance software, lesson plan designers and other electronic curriculum aids, and organizational tools such as inventory software and seating charts.

The faculty interviewed also emphasized the need to inform students of both the possibilities and limitations of instructional technology. They felt that students needed to exit the teacher education program with knowledge that would eliminate their fear of technology and enhance their skills in integrating technology into their classroom activities.

One area that teacher education faculty did not address was technical skills such as hardware troubleshooting and programming. In terms of hardware, they felt that schools needed to provide personnel to assist teachers with technical problems and hardware troubleshooting. In addition, they felt that programming skills such as BASIC or Pascal were best left out of the undergraduate instructional technology courses. Once again, they felt that emphasis needed to be placed on the use of available technology tools in the curriculum as opposed to teacher-created tools.

After these data had been gathered from the teacher education faculty, they were compared with national standards developed by the International Society for Technology in Education (ISTE, 1996; Thomas, 1994). ISTE, in conjunction with the National Council for Accreditation of Teacher Education (NCATE) have developed a series of technology skills which should be used as guidelines for state endorsements in instructional technology teacher education. The first set of skills serve as foundations and prerequisite preparation for a technology endorsement. These skills were used as a benchmark for comparing how information gleaned from interviews with teacher education faculty compare with national standards developed by ISTE. A comparison is provided in Table 1.

While many of the areas (particularly those dealing with integrating technology into teaching) were identified in both the teacher education faculty interviews and the ISTE technology standards, there are several areas which were not addressed by both sources. For example, many of the basic technology skills identified in the ISTE standards were not deemed important by the teacher education faculty. Similarly, many of the administrative/ organizational skills and experiences discussed by the teacher education faculty were not included in the basic ISTE standards. Based on these inconsistencies, it was decided to use both data sources as guides for determining the overall objectives and activities for the revised pre-service instructional technology course.

Development of Objectives and Activities

Using the data described above, objectives were developed to address each area identified as an important technology skill/experience for pre-service teachers. The objectives were categorized as either *skill* (S) objectives or *knowledge* (K) objectives. Skill objectives required the student to perform some operation or develop some product using a technology tool. Knowledge objectives required the student to develop classroom policies, synthesize current research, or describe potential uses of different technologies in various settings. These objectives are summarized in Table 2.

Table 1.
Comparison between technology skills identified by teacher education faculty and ISTE technology standards.

ISTE Technology Standards (Level 1) Teacher Educator Technology Skills
Basic Technology Concepts
• operating a computer and installing software
• knowledge and use of computer terminology
• computer troubleshooting
• operating computer peripheral devices such as scanners video cameras
• knowledge of adaptive devices for students with special needs
• knowledge of distance learning technologies
• knowledge of technology applications in business and industry
Technology for Teaching
• use of telecommunications, electronic mail, and the world-wide-web
Personal/Professional Use of Technology
• use of productivity tools such as word processors, databases, and spreadsheets
• use of tools to develop electronic multimedia presentations • use of telecommunications tools to access information • use of computers to collect, analyze, synthesize, and communicate information • knowledge of ethical, legal, and human issues concerning use of technology*Technology for Productivity*
• use of word processors, databases, and spreadsheets
• use of electronic mail and the world-wide-web *Technology for Teaching*
• use of electronic presentation hardware and software
• use of multimedia and hypermedia software
Application of Technology in Instruction
• knowledge of software evaluation and integration guidelines
• knowledge of current instructional technology research
• use of technology to design and develop student learning activities, and to assess learning
• use of technology to design student learning activities which address ethical and legal issues regarding technology
Technology for Teaching
• instructional software evaluation and integration • use of productivity tools in the curriculum

Table 2.
Objectives for EM370 course.

Technology Skill Area EM370 Course Objectives
Basic Technology Concepts (ISTE)
S.1. Students will demonstrate the operation of a multimedia computer and CD-ROM software.
S.2. Students will demonstrate the use of a peripheral device designed to import multimedia into a computer. K.5. Students will identify adaptive devices which can be used to provide access to computers for students with special needs. K.6. Students will describe educational uses of distance technology such as instructional television and telecommunications. K.7. Students will identify how technology is used in various business and industry settings.
Personal/ Professional Use of Technology (ISTE)
S.3. Students will use a database program for data collection purposes.
S.4. Students will use presentation software and hardware for information communication purposes.
S.5. Students will use a world-wide-web browser for data collection purposes.
K.3. Students will describe their ethical and legal responsibilities regarding personal and professional use of technology.
Application of Technology in Instruction (ISTE)
S.6. Students will use a hypermedia authoring tool to develop an instructional activity.
S.7. Students will use word processing, spreadsheet, and graphics software to design classroom learning activities.
S.8. Students will use world-wide-web resources to design classroom learning activities.
S.9. Students will use off-the-shelf instructional software to design classroom learning activities.
K.1. Students will read and synthesize current research in the field of instructional technology.
K.2. Students will demonstrate knowledge of software evaluation methods and techniques.
K.4. Students will describe methods for teaching ethical and legal issues regarding technology.
Using Technology for Productivity (Teacher Education Faculty)
S.3. Students will use a database program for data collection purposes.
S.8. Students will use a world-wide-web browser for data collection purposes.
Using Technology for Teaching (Teacher Education Faculty)
S.4. Students will use presentation software and hardware for information communication purposes.
S.6. Students will use a hypermedia authoring tool to develop an instructional activity.
S.7. Students will use word processing, spreadsheet, and graphics software to design classroom learning activities.
S.8. Students will use world-wide-web resources to design classroom learning activities.
S.9. Students will use off-the-shelf instructional software to design classroom learning activities.
S.10. Students will use video-based information to design a classroom learning activity.
K.2. Students will demonstrate knowledge of software evaluation methods and techniques.
Using Technology for Organization/ Administration (Teacher Education Faculty)
S.11. Students will use test generation software to develop a classroom assessment device.
S.12. Students will use the computer to develop either an electronic gradebook or an electronic portfolio assessment device.

The activities for the course were designed to integrate as many of the objectives into each activity, thus allowing students to demonstrate mastery of several objectives through the completion of each activity. Activities were developed in five areas: data collection and analysis, classroom integration of technology, classroom organization, multimedia development, and information synthesis. Each of these activities are described below.

Data collection and analysis. This consisted of two electronic database projects. The first project required students to read, summarize, and critique nine journal articles dealing with current issues in instructional technology (course objectives K.1 and S.3). Each article was selected by the instructor and disseminated to the students at the beginning of each week. Students would read the articles and enter their critiques into a class-developed database. The second database project required students to select and evaluate five pieces of instructional software using evaluation criteria discussed in class (course objectives K.2 and S.3). An evaluation template was constructed by each student using database software, and the evaluations were entered into their databases.

Classroom integration of technology. This involved the development of four instructional lessons. Each lesson was required to utilize a specific technology tool or product (course objectives S.1, S.5, S.7, S.8, S.9, and S.10). These included a spreadsheet application, an instructional video program, videotape, or videodisc, a piece of instructional software, and an internet source. Students were required to develop a lesson plan (including target subject/grade level, objectives, materials, lesson description, and evaluation methodology) using each technology tool/resource. In this way, students were integrating a variety of instructional technology tools and information sources into classroom instructional activities.

Classroom organization. These projects were designed to introduce students to software which could assist them with tasks dealing with classroom management and assessment. Students were required to use computer software to develop a classroom assessment device and develop a strategy for recording assessment information (course objectives S.11 and S.12). Teacher productivity tools such as test generators, electronic gradebooks, and electronic portfolio development packages were demonstrated in class and provided to the students in order to complete these projects.

Multimedia development. This involved requiring student groups to design, develop, and demonstrate a multimedia project dealing with their instructional content area. Using Hyperstudio, a simple multimedia authoring tool, student groups designed and created projects dealing with a topic relevant to their content area. Students were required to incorporate sound and graphics into their projects. Once the projects were completed, each student group demonstrated their projects to other class members using electronic presentation hardware and software (course objectives S.2, S.4, and S.6).

Information synthesis. These activities were designed to assess student knowledge and understanding of important instructional technology issues in education (course objectives K.3, K.4, K.5, K.6, and K.7). Issues dealing with computer ethics, adapting the classroom environment based on student needs, internet access in schools, and future trends in instructional technology were discussed in class using a variety of techniques. These discussions were used as a basis for two take-home assignments. Each assignment required students to use the information discussed in class to develop a solution to a problem they may encounter in the classroom. Examples of the "problems" students were asked to solve included: "Develop a plan to teach your students about the benefits and problems with information available on the internet.", "Design a class activity to inform students of the ethical and legal issues involved in accessing inappropriate information via a computer.", "What are some steps you would take to help your school plan for future uses of technology?", and "What are some actions you should consider if you are going to have a student with special needs placed in your classroom?" Through these scenarios, students were able to demonstrate their understanding of important instructional technology concepts discussed in class.

Material Development and Dissemination

In order to assist students with the completion of the activities required for the course, numerous materials were developed. In addition, information resources (both electronic and other) were identified and needed to be disseminated to students in an organized and timely fashion. Thus, an electronic database of course materials and information resources was developed for the class and posted on the world-wide-web (the location is *www.auburn.edu/~brushta/em370.html*).

The course database is divided into five areas. The *Instructor and Course Information* section includes information regarding instructor contact information, office hours, the course syllabus, meeting times and dates, and student information (only if students allow this information to be posted). The *Course Topics* section includes a list of weekly topics covered in the course, along with objectives and class activities associated with each topic. This area is also linked to information and www sites which can assist students with preparing for class discussions. The *Course Materials* section includes lesson plan and database templates, an overview of the required text, a list of required and supplemental readings, and a list of administrative, instructional, and productivity software available to the students. This software list is linked to descriptions of the software and the publishers' internet sites, if available. The *Supporting Links and Information* section includes a list of links to internet sites related to topics discussed in class. Finally, the *EM370 Forum* section is an area where students in EM370 can participate in electronic conversations, leave electronic messages for the instructor, and communicate with other members of the class during non-class hours. The structure of this area is similar to other electronic forums, where students enter information on the screen and it is posted to a common "text box" that everyone viewing the page at that time can see.

Evaluation of Course Topics and Materials

This is the first quarter we have offered this course in its new format. Thus, continuos formative evaluation is crucial in order to determine areas of the course that need revisions and improvement. We are currently in the data collection phase of the evaluation. We have developed and disseminated course evaluations to all participating students, and are in the process of analyzing the data to determine revisions which need to be addressed prior to the delivery of the course in the winter and spring quarters.

Summary

This paper has provided a rationale and design for a pre-service teacher education course dealing with the integration of technology into classroom activities. While evaluative data is limited, preliminary results show positive student reaction to this course. However, this is only the first step in the development process. Results of formative evaluations will assist with making the course more relevant to the needs of future teachers. Also, with rapid changes in instructional technology, this course will need to be continually revised and updated in order to provide pre-service teachers with the skills and experiences they will need to effectively use technology in their future professional placements.

With continued collaboration between faculty in instructional technology and teacher education faculty, it is hoped that eventually many (if not all) of the topics covered in this course will be introduced in teacher education courses. In this way, instructional technology faculty can work with teacher education faculty to provide technology training to pre-service teachers while they are in the process of learning their craft. Until then, however, instructional technology faculty need to work hand-in-hand with teacher education faculty to continue to provide pre-service teachers with relevant technology skills and experiences in their classes.

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Preparing Preservice Elementary Teachers to Use Technology

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North Carolina (1995) has established basic technology competencies that all students must pass by the beginning of the second semester of the senior year. These standards address a broad range of competencies related to computer applications. The competencies are to ensure that all educators can use information technologies to improve student learning, support effective teaching, and enhance overall teacher productivity.

Karen Sheingold of Educational Testing Service captured the scope of the problem when she asked:

> How do we help teachers teach in ways they were not taught, to create classrooms unlike the ones they studied in, and to develop confidence that they are doing the right thing for their students? (Sheingold, 1995, p.2).

The challenge for teacher educators is to prepare preservice teachers to use technology as a tool as well as meet the technology competencies. In response to this challenge, an interdisciplinary study team was established to plan a developmental framework for integrating technology into the current elementary education curriculum. Preservice teachers were required to use various computer applications throughout their classes. The framework includes use of technology as well as modeling by teacher educators of computer use integrated into the curriculum. The preservice teachers are tested in Senior II semester to determine their level of proficiency.

While all courses previously required the use of some technology, the model provides a view of the entire elementary program and coordinates computer applications in a sequential manner to develop technology skills and applications. The model includes 1) the development of a framework to ensure competencies are met, 2) modeling of technology use by teacher educators, and 3) experiences to utilize what is presented in theory through practice in field based practicum accompanied by university faculty in public schools.

Faculty in the Elementary and Middle Grades Education Department at East Carolina University were interviewed to determine the level of technology used in course delivery and in student course requirements. The study team developed the matrix of developmental tasks for the students to demonstrate proficiencies by the end of Senior I with course assignments that could be placed in their portfolio.

Technology Uses in the Elementary Curriculum

Sophomore I

ELEM 2123: Early Experience for the Prospective Teacher

- Apply for User-ID
- find and retrieve a lesson plan from the Internet.
- Evaluate an interactive curriculum software program.
- Word process student reflections of the standards.

Junior I

ELEM 3235/3236: Curriculum and Instruction in the Elementary School

- Select resources from the WWW.
- Introduce and use adaptive technology laboratory for use with unit.
- Evaluate educational software.
- Download public domain software off the Internet to use in the practicum.
- Create and word process a letter to parents about the unit.

ELEM 3250: Language Arts in the Early Childhood and Elementary School

- Word processing/introductory desktop publishing including line spacing, check spelling, grammar, word usage

Junior II

ELEM 4525/4526 Classroom Organization and Management in the Early Childhood and Elementary School

- Use of basic computer operation skills
- Use of word processing and desktop publishing skills
- Use of telecommunications to communicate on-line between students and faculty

READ 3204: Fundamentals of Reading

- Word processing of lesson plans and Idea File
- Portion of log must be sent via e-mail.
- Use of Readability software to analyze readability of texts
- E-mail to communicate with professor
- Internet chat room or electronic bulletin boards by ECU students to stimulate communication and inquiry ; possible communication with other teacher education students or with children
- Use of software such as CD-ROM (Enact) encyclopedia for research for lesson plans or papers

SCIE 3216: Teaching Science in the Elementary School

- Spreadsheets and data analysis through graphing
- Clip art and charts to add visuals to assessments

Senior I

ELEM 4550: Social Studies in the Early Childhood and Elementary School

- Search and retrieve information from the Internet.
- Use information from an existing database such as ERIC on the Internet.
- Assess technology/multimedia of the site school and create an annotated bibliography.
- Word process a newsletter to parents for the unit.
- Create a children's literature file for the units on a database.

READ 3210/3211: Assessment, Design, and Implementation of Elementary Classroom Reading Instruction, and Practicum

- Lesson plans to be word processed
- Use of Internet as retrieve for plans
- Use of clip art in creation of student materials
- Computer technology should be planned to help differentiate instruction when needed
- Use of telecommunications via the Internet (chat rooms, bulletin boards) to stimulate interest in content areas or in communicating with others
- Layout and manipulation of group profile on a computer database
- Use of available technology at school site
- E-mail for communication with faculty
- Use of Internet and computer software/CD programs for motivational / instructional purposes, if available
- Use of videotaping for reflection and self-assessment

The Office of Technology Assessment (1995) estimated that the number of computers in K-12 schools would reach 5.8 million during 1995, one for every nine students. Notwithstanding this growth, investigations into computer use for K-12 schools and classrooms have discovered that computer use is not achieved fully by the plurality of teachers. Our survey indicated that like the K-12 population, our university faculty also were not using technology to its greatest potential. Obstacles for this included lack of knowledge of applications.

For preservice teachers to have appropriate modeling of technology use in the university classroom, faculty must have adequate skills. Faculty in the Department of Elementary and Middle Grades Education were surveyed using the Technology Awareness and Use Survey developed by the Educator Technology Group of North Carolina. Since the survey was developed specifically for the North Carolina Competencies, it addressed the level of proficiency for each competence area we are currently addressing with our preservice teachers. The survey addressed five areas: personal use of a computer, instructional technology, the ubiquitous computer, access to computers, and access to telecommunication resources. As would be expected, the area of use with greatest frequency was personal use of a computer. However, the majority of the faculty used the word processing software primarily for typing for personal and professional use. The areas of greatest weakness were use of telecommunications, spreadsheets, multimedia, and databases.

As result of the surveys several departmental professional development opportunities were provided with the use of telecommunications. In addition professional development workshops were offered by the Education Technology Specialist for the School of Education to provide the skills needed for faculty. These workshops addressed specific topics needed by the faculty but were not mandatory. Additional workshops were available for faculty in the summer and fall. In the most recent workshops, only one faculty member registered to participate.

A more comprehensive survey was administered in the fall. The Basic Technology Competencies for Educators Survey is a self-assessment tool developed by the Educator Technology Group of North Carolina. Findings again indicated faculty knowledge and skills of multimedia, telecommunications, spreadsheets, and databases were not sufficient to model for their classes. The subsets addressed each area of technology from the previous survey. In addition each skill and subskill had four levels of response: do not know, know, but need additional help, know and use, and able to teach. The most glaring finding was that although many faculty felt comfortable using their knowledge and skills, they did not feel comfortable in teaching the skill.

For our the preservice teachers to have the level of proficiency needed, university faculty must become more proficient in the knowledge and skills of technology throughout the elementary curriculum. The outcomes of the survey warrant problems of incorporating technology modeling by faculty in the elementary courses. From this survey, recommendations may include recognition of faculty effectively using technology in their courses. Pairing of faculty to develop presentations and assignments incorporating technology should be encouraged. Professors who are supportive of technology use in the classroom will need to participate in the "selling" of technology if changes are to occur.

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Developing and Teaching an Intermediate-Level Applied Educational Computing Course

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The College of Education at Valdosta State University (VSU), Valdosta, GA, has for over ten years required all education majors to take an entry-level computer course entitled, "Introduction to Educational Computing." Unlike many institutions, the introductory computer course is taught by the College of Education rather than the College of Business. This allows the focus of the course to be geared towards the type of computer applications most frequently encountered by teachers.

While attempting to address the needs of future teachers, this 50-hour, entry-level course covers word processing, spreadsheet, database, presentation, Internet, electronic mail, and operating system software as well as basic computer concepts. The results of this course have been an overwhelming success. Students consistently rate the course very high on course evaluations and in-service teachers state that entry-level teachers graduating from VSU are very computer literate. The course is so popular that it is required by many non-education degree programs such as nursing, psychology, and sports medicine.

for many years, students who have taken this entry-level educational computing course have often been more computer literate than many of their professors in the College of Education. Thanks to a strong emphasis on faculty development workshops and funding for up-to-date computer lab facilities, this situation is quickly changing. Faculty in the College of Education are now beginning to incorporating computer technology into their courses as well as requiring students to use the computer skills learned in their entry-level educational computing course to complete class projects.

Due to the ever-increasing emphasis placed on educational computing applications by faculty in the College of Education and the popularity of the required entry-level computer course, students have started asking about appropriate follow-up computer application courses in which to enroll. Although this is wonderful news, it has created a problem. Although the College of Education does offer many upper-level computer courses, each upper-level course generally focuses in-depth on one particular piece of software. In addition, these courses are usually designed for business education majors exclusively and are not as well suited for many other education majors. Also, most education majors have very few electives and can take only perhaps one upper-level computer elective. The need arose to offer a follow-up intermediate-level educational computing course that covers a wide range of software and topics that was appropriate for all education majors.

Planning the New Course—Applied Educational Computing

From the initial days of planning this new intermediate-level educational computing course, the desire to make it a project-based course was of top priority. Because such a wide mix of software is taught in such a short period of time in the entry-level course, instructors only have time to teach the basics of each software package. Unfortunately, most of the time is spent learning the software and working practice problems in class—little time is left for putting what has been learned to practice in any type of meaningful way. This is frustrating to students because by the time they begin to understand how to use a particular software package, it is usually time to move on to the next software package about which they know little or nothing. The entry-level course has taught the student the minimum skills needed to use the computer in an educational environment but has not allowed the student to put his or her skills to practice. Too often, the skills learned in the introductory computer course are never put to use in any meaningful way after completion of the course. Even though it appeared that students had learned the skills needed to complete computer application projects assigned to them by College of Education faculty in other courses, the students often seemed at a loss as to how to get started on a project all by themselves. The need for a course that allowed students to be creative and complete practical, instructional-based projects in the students' own subject areas was of top priority. Based upon this emphasis, the new course was given the name "Applied Educational Computing."

What Should be Taught

Since only the basics of each software package (wordprocessing, spreadsheet, database, presentation, Internet, and e-mail) are taught in the 50-hour introductory level course, tremendous amounts of information are left that could be covered in the new follow-up course. However, if attempts were made to try to master all concepts of each package, the end result would be very similar to the problem encountered at the end of the introductory level course. Students would have learned a great many new skills but would not be able to put them into practice.

Before deciding upon which additional topics should be taught in the new course, a study was made to determine what types of computer application projects are most frequently being used by classroom teachers. For example, it was found that teachers, in addition to typing letters and tests, often use word processing software packages to create programs, brochures, newsletters, tables, and signs. Creating mailing labels and form letters by utilizing mail merges with either word processing or database software packages was also found to be very useful. Teachers use spreadsheets to calculate grades, prepare budgets, keep track of fund raisers, and create charts and graphs to be used as overhead transparencies. Database packages were used to keep track of student records and also to display educational content arranged by subject and category. Presentation software packages were used to present class lectures, prepare class handouts, and create self-paced learning modules that students can work through at their own pace. The Internet was used not only to acquire research information needed by the teacher and students but also to create HTML homepages that can be used by students as a base to explore the Internet. These are just a few examples, but it was decided that the skills needed to complete these types of projects were the skills that would be taught in the new "Applied Educational Computing" course.

Additional Topics

It is very probable that the students electing to take this new "Applied Educational Computing" course will be the future leaders in regard to computer technology in their respective schools. With this in mind, the students must be up to date on relevant issues when purchasing and evaluating computer hardware and software to be used in an educational environment. It was also determined that students must be knowledgeable about topics such as adaptive hardware and software devices available to special populations. They must also be able to demonstrate knowledge and skill in detecting, diagnosing, and repairing computer hardware and software malfunctions. Valdosta State University is predominately a Windows-based computer campus. However, many school labs in the South Georgia region are equipped with Macintosh platform computers. It was decided that students should be taken to one of the Macintosh labs on campus to learn basic Macintosh platform operations. These are just a few of the additional topics that were included in the content to be covered in the "Applied Educational Computing" course.

Course Structure

The first Applied Educational Computing course was taught Spring Quarter, 1996. It met twice a week for 2 1/2 hours each day for ten weeks. The first week was mainly spent reviewing old information learned in the introductory course. Handouts and notes were used extensively due to the fact that a textbook was not required or used in the course. In order to learn the new skills, the students and teacher completed example problems together using the aid of a projection device. Students were then required to complete class exercises assigned to them by the instructor in much the same way they did in the entry-level computer course. Next, students had to be creative and create a couple of their own exercises and problems similar to the class exercises that the teacher had assigned. Once the new concepts had been successfully learned, the individual student projects were assigned (see Appendix A and B). These projects required the students to be creative and complete practical, instructional-based materials suitable for use in the students' own subject area.

Course Evaluation

Two examinations over course content accounted for 30% of the overall course grade. The two exams, one given at midterm and the other on the final exam date, were mainly composed of hands-on computer exercises but also contained objective questions dealt with during the quarter. Classwork/homework assignments assigned by the instructor accounted for 30% of the course grade. The two projects combined to count for 30% of the overall course grade. The remaining 10% of the course grade was accounted for by two oral presentations. One oral presentation was a short mini-lesson which the student was required to complete in his/her future teaching area, using Microsoft PowerPoint. The other oral presentation was required to be on using adaptive hardware and software with special populations.

Results and Conclusions

The results of the first "Applied Educational Computing" course were very encouraging. The students who took the course were highly motivated and did outstanding work. The most encouraging part of the course was the outstanding job the students did on their individual projects. The creativity and professionalism shown on these projects proved that the course was a success. Students were very positive on the course evaluations and stated that they would recommend the course to their friends.

Appendix A

APPLIED EDUCATIONAL COMPUTING — PROJECT #1

General Guidelines:

Be creative. Pick a topic in your teaching area or major area. Since you will be required to create tables and graphs, make sure the topic area you choose has a certain amount of numeric or statistical content. The topic area might be a unit of study for a particular course you might one day teach. Perhaps you are planning a big event at your school or business and you want to promote and educate the public. These are just a couple of examples—you decide. The more creative you are the better!

Requirements:

Listed below are the minimum requirements that must be included in your project. All of the exercises you create should relate to the same topic area you are presenting or promoting.

PowerPoint: A 12 slide presentation. The presentation must include at least one graph. Use transitions and builds as you see fit. Save your work on your disk and print handouts — 3 slides per page.

Quattro Pro: Create and print on paper three original graphs of any kind that you could use as transparencies to present information on your topic.

Create a spreadsheet that could be used to help keep track of information, budgets, finances, data, related to your selected topic.

WordPerfect: Create at least two tables that could be used as handout information to your targeted audience.

Create a newsletter with columns and graphics—the newsletter must fill up at least two pages. An example might be a monthly or quarterly newsletter updating parents or others about what is going on in your classroom, school, or business. It could be a weekly reader full of information you want your students to read and study.

Create a program like the one you worked in class. Plan a banquet, meeting, or occasion where a program is needed. It could be a PTO meeting or a promotional dinner for something. It could be an outline of events that will take place at your school or business during the day, week, or month you present your topic. It should be printed on front and back of a sheet of paper.

Appendix B

APPLIED EDUCATIONAL COMPUTING — PROJECT #2

1. Create WordPerfect Form Letters for a minimum of six records that illustrate how you might use this word processing feature in your subject area. Also, print mailing envelopes for each of these six letters.
2. Create a Paradox database table that contains educational content that can be browsed and studied by individuals trying to learn about the topic you choose. The table must contain at least ten records and seven fields including one memo field. Create an attractive Form for the information and create and Print a Free Form Report that displays all records and fields.
3. Create a Paradox database table that contains mailing address information as well as some other meaningful data for at least six records. Create a form letter dealing with a topic in your subject area that utilizes all of the fields in your table. Print a copy of the form letter for each record in your table.
4. Create an original HTML Home Page that contains educational information about a particular topic in your subject area. The page must include at least two links to other related sites. Use the example we created together in class as a guide.

NOTE: Please turn in your diskette containing all project files as well as a sheet of paper listing filenames used for each part of the project.

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Using Multimedia with Preservice Teachers to Enhance their Experience with Technology Education

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This paper reports on the use of a multimedia journal to enhance a subject in technology education. The multimedia journal was used to assist in the delivery of the subject and to record the progress made by students. It is argued that multimedia used in this manner complements and extends upon the teaching program and becomes an integral part of the learning process. This study discusses the development and evaluation of a new subject in technology education, and demonstrates how a multimedia journal can be used to assist preservice teachers to further their understanding of the design and make process.

The movement toward national curricula in the United Kingdom and Australia revitalized interest in improving science and technology-related primary school education (D.E.S., 1985; Australian Academy of Science, 1991; Curriculum Corporation, 1994). However, as educational planners produce new primary school science and technology curricula, they are also morally obligated to provide teachers with support documentation and professional development courses (Renner,1990). Past practices such as providing one-off inservice given to a fraction of teachers have been strongly criticized by Ingvarson (1987) who argues that more consideration needs to be given to other ways of providing inservice and preservice training of teachers. Teachers need relevant preservice experience with technology education and this paper outlines an approach that employed multimedia to complement and extend the technology education of preservice teachers.

Technology Education in Australian Primary (elementary) Schools .

A study conducted in New South Wales, Australia (Ferry, 1993) showed that only 50% of primary teachers had taught technology-based units, and 80% needed assistance in planning, implementing and evaluating such units. Interview data from this study showed that teachers were reluctant to teach technology education because they had little or no experience with the processes involved. Yet in 1991 the Australian Academy of Science and the Australian Science Teachers Association recommended in that technology become an integral part of primary school experience for all Australian children (Australian Academy of Science, 1991).

Current research associated with technology education suggests that there is a lack of opportunity for primary teachers to train in the processes involved in technology education (Layton, 1993). Therefore technology education is unlikely to receive sufficient attention in many Australian primary schools.

Preservice Teacher Experience in Technology Education

Technology education in primary schools it is expected to developed through integrated, interdisciplinary investigational topic work. It follows that a technology subject that introduces preservice teachers to the strands of technology education should also use an integrated, interdisciplinary investigational approach so that preservice teachers have first-hand experience with the processes that their pupils would experience. The subject also has to empower trainee teachers in the design and make process (Bonollo, 1993) and develop trainee teacher competence, confidence and enthusiasm. A certain amount of judgment is required in order to match the challenge to the persons and this requires a negotiation and mentoring process in which lecturers and preservice teachers are fully aware of the outcomes of the subject (Lewis & Bonollo, 1994; Ramsden, 1990).

Restructuring of the four year Bachelor of Education degree for primary teachers at the University of Wollongong provided an opportunity to offer a fourth year elective subject related to technology education in primary schools. Two lecturers shared the responsibility for this subject. It was also important to us to develop a resource that could be used in the future by preservice and classroom teachers. Two parallel processes were put in place to meet these needs: one concentrated upon the delivery of the subject to the students and the other concentrated upon the task of developing a multimedia "class journal" that would become a resource for preservice and classroom teachers. While both lecturers involved in the subject had expertise in multimedia and technology education, it was convenient to divide the responsibilities and to collaborate on a "need to know" basis. Therefore the more experienced lecturer in pedagogy took overall responsibility for the delivery of the subject and the more experienced one in multimedia took overall responsibility for the development of the multimedia "journal".

Subject Organisation

The subject was allocated three hours of face to face teaching for one semester. Care was taken to present the technology/design process as recursive and non-linear, and Figure 1 shows the model that was presented in lectures. Lectures and tutorials were scheduled to support the stages in the technology/design processes that the trainee teachers could be expected to experience as they developed their prototypes. They were required to keep a reflective journal that contained their responses to the different stages of the technology/design process. Tuman (1992) claims that reflective journals represent a new form of "engineering literacy" and they have a legitimate place in the design and make process. Journal writing helps the student to construct knowledge and various researchers argue that there is a need for engineers to write their own knowledge (Winsor, 1990; Johnson, Lee & McGregor 1994). The reflective journals provided a mechanism for students to integrate and make use of ideas, and to test them (Boysen, 1994; Lawson, 1980).

When we were planning the subject we were concerned that anxiety associated with assessment and the perception that engineering was a "male" subject could adversely affect the outcomes. Initially most students were very worried about how they would be assessed, and discussion centred around product assessment versus process assessment. It was agreed to give equal weight to both product and process. Other researchers (Boysen, 1994; Boyapati, Inglis & Phillips, 1994) also support this approach.

Another factor reported in the literature was a student perception that subjects associated with processes such as construction, design and engineering were more suited to males (Nandy, 1979; Georg, 1993; Wiley, 1992). As the majority of students were female and were prepared to enrol in what was perceived to be a high risk subject it was important that both lecturers provided support and acted as mentors. In an attempt to address the dual issues of anxiety and perceived gender bias we allowed students to consult with the lecturer of their choice.

The Electronic Journal

The electronic journal was in HyperCard form and entries were gathered during the session. Each entry contained a photograph (taken with a Canon ion camera) of the preservice teacher plus a title for their prototype. Buttons allowed the browser access to selected sound files chosen from interview tapes, photographs of various stages in the development of the prototype, and selected entries from the reflective journals. Sketch diagrams of the initial prototypes of the projects completed were scanned and included in the electronic journal.

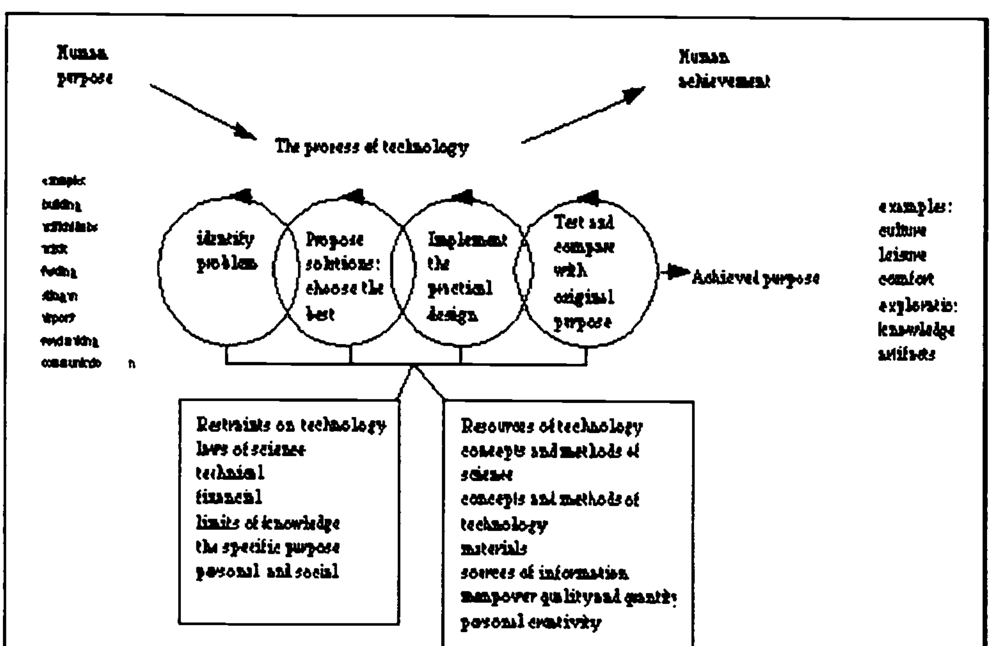

Figure 1. A Model of the Processes Involved in Technology as it Responds to a Human Purpose (from Fensham, 1990, p. 17)

The HyperCard stack used 6Mb of memory and was recorded on compact disc for regular use. We intend to expand the electronic journal as new ideas are developed. Later the compact disc will be available to classroom teachers for professional development purposes.

The Navigation Screen. The nine buttons available to students and were labelled: help, course selection, back ground to this subject, other activities, project results, evaluation, theories behind the practice, and student briefing. The buttons that students used the most were project results and the evaluation. When students click on these buttons the screen displays selected images of projects plus relevant excerpts from written journals. This display provides students with some photographs of the stages involved in a specific design and make project, plus a photograph of the final product, and the designer's evaluation comments about their project.

The Journal Entry. Slide icons indicated that a photograph could be viewed when students clicked on this icon. Responses to interview questions were played through the speakers of the computer when students clicked on a loud speaker icon. The text of the interview question and a photograph of the person responding also appeared on the screen. The student photograph proved to be a popular as current students often contacted students from the previous year's cohort to seek advice.

The preservice teachers had little previous experience with the design and make process, and the tasks of developing the prototypes was very challenging for them. A decision was made to be available for informal consultation at specified hours during the week, and this was of great benefit to those who were reluctant to ask for help when part of a large group. As a project was completed, two sessions called "show and tell" were organised. During "show and tell" sessions trainee teachers presented their completed projects to peers. While these sessions were informal, participants were required to explain why they had chosen their project, the design brief followed, the processes followed (by referring to Figure 1), what was achieved, and how they could continue to improve their project. Each individual presentation ended with constructive suggestions from peers and the lecturers.

Sixty eight students have completed the subject -twelve were males and fifty-six females. The youngest was twenty two years old and the oldest forty six (mean 29.5).

Evaluation Data

Data were gathered from three sources: a university evaluation survey of the subject, journal entries and interviews. The university survey was constructed and administered by the centre for staff development (an independent university body). All subjects were interviewed during a three week period after their projects were completed. The interviews were open-ended and follow up questions were be asked.

Results and Discussion

The subject was evaluated by the university centre for staff development . The instrument uses a five point Likert scale to rate the various questionnaire items. The highest score is five and the lowest one, and a mean of 3.4 (S.D. 0.5) is regarded as standard for most subjects. The mean for this subject was 4.75 (S.D. 0.4), higher than most subjects. Therefore the subject appears to have been well regarded by the students Table 1 summarise the student responses to relevant question from the survey.

Table 1.
Preservice Teacher Responses to Survey Questions, *n=68*

Item	Response
I have felt enthusiastic about attending lectures in this subject	4.81
I felt enthusiastic about attending lectures in other subjects	3.01
My enthusiasm for this subject has increased greatly	4.72
The subject material has been very interesting	4.67
Lectures have stimulated me to think about the subject	4.81
I am confident that I will be able to teach this subject	4.81

It can be seen that the outcomes of enthusiasm for the subject and confidence in teaching designing and making appear to have been realised. The other sources used for this study were the reflective journal entries and the transcripts from the interviews. Whilst both sources of data support the view that the outcomes of competence, confidence and enthusiasm were achieved, it needs to be acknowledged that the factors that led to the success of this subject may not transfer to a different context.

The following quote selected from the reflective journals represents some reactions of participants. Fiona , a female trainee teacher aged in her mid twenties. Her chosen task was to design a removable parcel shelf for hatchback cars. "It is important to make use of other people to listen to your ideas and discover whether or not what you want to do and what you say you will do are the same thing...the experience has been extremely rewarding, especially in the sense that I have solved my own problem."

Two important themes emerged from the interviews transcripts and from the journals. One theme was the importance of collaboration with a wide range of people; many of whom were not "experts" but sympathetic listeners (mentioned by 74% of subjects). These people acted as a non-threatening audience with whom the learner could "sound out" ideas. A study by Tibbitts, Collits and Lucas (1994) supports these findings. They report that it is important for students to share and discuss projects in a non-threatening situation.

The other theme was the satisfaction gained from solving a problem that was different to anything attempted previously (mentioned 81% of subjects). During the process of solving their chosen design problem the trainee teachers had to develop new skills that were required to compete the task. Thus they had to take responsibility for their own learning. The findings of a study by Boyapati, Inglis and Phillips (1994) support these results as they too found that a great deal of personal satisfaction comes "autonomous learning".

Use of the Electronic Journal. The electronic journal proved to be a popular and 88% of preservice teachers used it on more than one occasion. Besides its reference value, it had a motivational value as the preservice teachers were delighted when given the opportunity to present their prototypes in this form. They also appreciated the opportunity to see how others had approached their project. Future research will investigate how learners use the material in the electronic journal to help them in the design and make process and such research will involve tracking learners as they use the electronic journal.

As the first version of the electronic journal was completed during the first session that the subject was delivered. Features of the journal that appealed to the preservice teachers were:

- access to the pictures, printed text and sound. They could browse and select the features that were relevant to their interests. For example some were contented to browse at the pictures of projects, while others wanted to read the related text or listen to relevant interviews.
- access to the ideas of others. They often used the pictures of students in the previous cohort to find students with whom they could discuss their ideas.

Those that chose to use the journal tended to produce better projects. It cannot be claimed this effect was due to the journal as the sample is small and no control group was organised. It may just be that the more conscientious students used the journal.

Conclusion

The data supports the interpretation that the preservice teachers had developed their competence and confidence in designing and making skills. Triangulation from multiple data sources suggests that the findings are reliable for this group of preservice teachers, but no claim is made about transferring the findings to a different context.

The way in which the subject was delivered challenged preservice teachers to become independent learners and to develop their technological literacy, technological awareness, technological capability and to use information technology. It also allowed them to be actively involved in the process of design and make rather than just focusing upon the final product. We felt that the multimedia journal added another dimension to the learning process and presented students with a holistic view of their participation in the design and make process. In particular, the use of excerpts from recorded interviews from students, the inclusion of text from journals and photographs of projects focused student attention and encouraged them to reflect on their role at critical stages in the process. We also feel that the multi-media journal was a popular and effective innovation, but it was not a panacea and should not replace "real life" experience with the design and make process.

Nevertheless some important principles have emerged:

1. when equal emphasis is placed upon the process and the product preservice teachers tend to respond positively to an approach to designing and making that emphasises integrated, interdisciplinary and investigational work.
2. the product-focused assessment procedures often "imposed" by university administrators can have an adverse effect upon learners enrolled in a subject that challenges them to develop a whole range of new skills which cannot always be identified in advance.
3. the benefits of "learning by doing" cannot be underestimated. The majority of trainee teachers enrolled in this subject now appreciate the processes that their students will experience as they undertake a design and make project.
4. it also important that preservice teachers reflect upon what they are doing and we feel that the multimedia journal can be an effective tool for reflection.
5. the traditional lecture/tutorial means of subject delivery was not always appropriate in the context of this study.
6. a subject that is perceived to favour one gender group over another can generate anxiety in enrolled students. Lecturers need to be aware of this situation and to develop strategies that help to dispel such perceptions.
7. "show and tell" sessions provide a good forum for swapping ideas and also help to boost the confidence of the more anxious members of the class.

In future years we intend to create web pages as a means of conveying this information to a wider audience.

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DEVELOPING STUDENT GENERATED COMPUTER PORTFOLIOS

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The development of portfolios by preservice teachers can provide a wonderful opportunity for students to reflect upon their strengths and weaknesses prior to entering the profession. Now, with the advent of new technologies that have become common place in our schools, the opportunity for preservice teachers to develop their own computer portfolios provides them with many significant benefits including a greater understanding of technology.

At St. Mary's University of Minnesota, preservice teachers upon leaving the teacher education program are developing their own menu driven computer portfolios. Included in these computer portfolios are such items as text casts of philosophical beliefs, voice casts of effective teaching strategies, and digitized videos of actual teaching performance. This capstone project allowed preservice teachers an opportunity to both self reflect and assess their recent student teaching experiences. This project was not without some challenges. Some of the most problematic technical issues that students had to overcomes were; dealing with limited disk storage capacity, finding a balance between quality of video output and file size constraints, producing a usable end product for a job search, and creating CD-ROM versions of portfolios.

The process of preservice teachers developing their own computer portfolio however had many positive outcomes. First, these preservice teachers benefited by reflecting upon their student teaching experience as they compiled their own effective teaching characteristics. Second, the end product became a very valuable instrument in the student's job search. Third, the opportunity to author their own computer portfolio provided students with an increase capacity to infuse technology later in their classrooms.

The development of a computer portfolios through the use of Macromedia Director was an extremely valuable learning opportunity for our preservice teachers. Many of the preservice teachers spoke of their intent to take their new found knowledge of technology and apply it directly to their classrooms. In the end, both future teachers and their students will benefit directly from this process.

Value of Portfolios

My observations of students striving to put in place their most exemplar pieces of work along with writing and rewriting their most current philosophical foundations revealed a sense of value portfolios have upon my student teachers as they prepare to enter the profession. Their portfolio in the end represented, in essence, a capstone to their preservice teacher education. The pride of their accomplishments are now exhibited through their portfolio.

Furthermore, the reflection needed to successfully complete their portfolios provides a springboard to future development. They came away from this experience knowing that while they have made great strides in becoming solid young teachers, they still have much to experience and work towards in becoming outstanding teachers.

The value of creating a portfolio that will be shared with others makes the nature of this portfolio not only an individual possession but also a public document. This development of a publicly shared portfolio requires people to be active, socially responsive, and willing to transform his or her teaching from a private to a public experience (Schram, Mills, and Leach,1995, p.71). By having students preparing a portfolio with one of the intended outcomes being its use in their job search, the portfolio becomes extremely public with regards to the quality of their personal teaching experiences.

The value of having students develop a portfolio for use in a job search makes this experience not only a exercise in reflective teaching, but also a very meaningful exercise tied to improving their opportunities for a job. This added component of producing a portfolio not only for their and our programs sake, but for others, resulted in preservice students placing even more emphasis upon the quality of their portfolios.

Determining the Portfolio's Content

There are undoubtedly a multitude of items that could be included in a preservice teacher's portfolio. Thomasena Adams (1995, p. 569) referred to the items that were to be collected to rest solely on the assessment information that is needed to respond to specific and general questions about preservice teachers. In a somewhat similar way, I approached this question of what students needed to include in their portfolios by setting forth a set of standards that students should be able to demonstrate through evidence collected in their electronic portfolios. The major emphasis of our students' portfolios were to but forth their highest quality work which demonstrated the standards of knowledge, organization, and teacher effectiveness.

Because of constraints in data storage, students were restricted to selecting only the best pieces of evidence to be included in their electronic portfolios. They also were expected to maintain a more traditional portfolio which would contain additional evidence of meeting these standards of teacher effectiveness. Perhaps one of the most important factors I discovered in having students complete a computer generated portfolio was to allow them to determine how they were going to demonstrate their mastery of effective teaching. When preservice teachers are given the responsibility to demonstrate the standards based upon their analysis, synthesis, and evaluation of their evidence, it forces them to reflect upon the quality of teaching and learning taking place in their classroom.

Developing the Portfolios with Multimedia Director

The utilization of Multimedia Director as the software foundation for our students' portfolios was based upon the belief that it will better prepare our students to be more effective in infusing technology into their own classrooms. Perhaps one of the most beneficial uses of Multimedia Director is its value in producing a diverse set of multimedia applications for use in the classroom. Teachers who are well versed in Director can take advantage of this software with their students to teach them how to produce their own multimedia presentations.

The interactive capabilities of Multimedia Director script language allows for students to develop menu driven programs that are very user friendly. While this does require time for teaching students how to effective utilize the powerful tools Director has to offer, the benefits of this knowledge far exceeds the time requirement. With this project however, I choose to assist the students by providing them with a template which included the scripting needed to complete their portfolio projects. This was done to meet a time requirement that didn't allow for the necessary teaching of scripting versus time needed to develop their portfolios.

Students had access to a PowerMac lab (Mac 7500/100 with video input capabilities). To digitize their teaching videos, they utilized Apple Media Conferencing by recording into the self view window video clips from their teaching experiences. Since digitized video clips require large amounts of data storage, students who were planning on sending their electronic portfolios on 1.3MB disks with their resumes, choose to record their videos at one frame per second and set their sound preferences at a six to one compression. Videos were saved as quick time video files which were easily imported into a Director cast member for later use.

Students also scanned in images with the use of Photoshop. They then added any enhancements to those images and saved them as PICT files which Director utilizes. Students with images saved in a variety of other formats, utilized a graphics conversion program to place all images into PICT files before loading them into Director cast members.

Text cast members were either copied over to Director or composed right in the text cast page. Students were encouraged to compose utilizing a word processor before copying them over to Director because of the access to spell checkers in most word processing programs.

Positive Outcomes of the Project

I found three very distinct benefits from having students complete their own computer generated portfolios. First, these preservice teachers benefited by reflecting upon their student teaching experience as they compiled their own effective teaching characteristics. Second, the end product became a very valuable instrument in the student's job search. Third, the opportunity to author their own computer portfolio provide students with an increased capacity to infuse technology later into their classrooms.

By engaging the students in developing their own portfolios, it required them to analyze what they had accomplished during their student teaching experience. They came away from this process with a clear understanding of how they were effective in the classroom and teaching areas they needed to refine in the years ahead. The work they did in developing their philosophy statements/beliefs further defined their understanding of what makes them effective in the classroom. Without spending considerable time reflecting upon these areas, the portfolio would have simply become a series of video clips and meaningless documents for others to view. The importance of communicating clear philosophical beliefs and following those beliefs up with documented evidence makes a truly significant difference in the quality of the portfolio.

I have little doubt that the technological expertise the students demonstrated with their computer generated portfolios had a very positive impact upon their securing job offers. While I did not conduct follow up interviews with school administrators who hired these students, several students returned from interviews with comments directly related to how impressed the interviewers were with their computer generated portfolios. In many ways, the use of computer generated portfolios sends a subtle, but powerful message that the educator who is applying for this job is computer literate. A knowledge base that many districts are seeking candidates with.

Included in this exercise were two teachers who had returned from their first year of teaching to complete the masters degree program. On several occasions, they made repeated comments about how they intended to incorporate Multimedia Director into their curriculum when they return to school. They were coming up with specific examples of how they could involve their students in a multimedia project and their beliefs that multimedia presentations are an important skill for students to master.

Traditional versus. Computer Generated Portfolios

Both types of portfolios have benefits and drawbacks. The strength of the traditional portfolio is that one is often looking at original documentation with an unlimited supply of materials. While the materials may be cumbersome to page through, and at times locate, access is generally available.

With a computer generated portfolio, the ease at accessing video clips with a click of the button is truly user friendly. Making duplicates of the portfolio is very easy and can be done at a minimal cost. However, it does require that the user has access to compatible equipment. The other drawback is the data storage limitation that a computer generated portfolio presents. Students wishing to utilize a 1.3 MB disk will only be able to record approximately one minute of video at one frame per minute to be include in their portfolio, those utilizing a CD-ROM disk will be able to record over 600 MB onto their disk. While the CD appears to be the answer to the storage demands of digitized videos and images, producing one for every application is both expense and time consuming.

One case study dealing with evaluating electronic portfolios found it to be clearly superior to paper portfolios because the ease of accessing the information (Bushweller, 1995, p. 19). The majority of computer generated portfolios developed by our students took between five and ten minutes to review. A time frame that should work well for school administrators reviewing teacher applications. These computer generated portfolios were produced for either Apple or PC's and required no special software for most computers before running.

Summary

Our students experience with building computer generated portfolios resulted in a very meaningful end product which allowed self reflection, a very user friendly product, and improved knowledge base in technology. As technology becomes more prevalent in our classrooms, the need to take advantage of utilizing computers for portfolio development is even more valuable. The limitations of data storage capacities faced by students today is quickly diminishing as access to larger storage devices become more available. In the future, the questions educators will be asking themselves isn't if they should utilize electronic portfolios, but how they should utilize them.

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An Analysis of the Evolution of Computer Education in Shanghai Secondary Schools: Relevant to American Schools?

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In America and throughout much of the world, hi-the industry has become the locomotive of economic growth and development. Viewed globally, growth resulting from technological applications is driving both old and new economies. New enterprises in cellular and digital personal communications will create in the United States more than a million new jobs by soon after the turn of the century (Mike Mills column for the Washington Post). Computer systems for the control of manufacturing processes are being installed not only at GM and most other North American corporations, but also in China and central and south America. China's next great leap forward will be computer-assisted manufacturing. Japan is already state-of-the-art in manufacturing, and South Korea, Taiwan, and Singapore are not far behind.

Asia is the world's fastest growing technology market. Latin America is second, first in the rate of growth of PC acquisitions. The good news for North America is that, most this technology must be imported into these developing counties. As hardware sales increase, so must software sales as well as sophisticated support systems — instruction, consulting, installation, and maintenance. South Florida has become a kind of a HMO for Latin America's technology health (David Poppe, *Miami Herald*,12/3/96).

Reform and more open-policies have brought thriving hopes to China. As the largest city in China and an international metropolis, Shanghai has been the spearhead in setting up and running a system for the projected market economy. The rapid economic development has created urgent needs to train a workforce who can function well in hi-tech environment.

In Shanghai, education has been quick to respond to this need. Computer education in Shanghai secondary schools (grade 7-12) started in 1978. Today, Shanghai has built a group of trained computer teachers and educators who are actively exploring innovative teaching methods, publishing teaching materials, and establishing exam systems for computer education. This paper presents an analysis of the evolution of computer education in Shanghai secondary schools and the relevance of that experience to the schools of America.

Curriculum

The Shanghai schools make computer education a part of the core curriculum at eighth and tenth grades. The stated purpose of computer education is to prepare students for the "future of modernization." Students learn to understand the concept of the computer, improve their overall knowledge of science and technology, and become computer literate. The curriculum of computer education includes five basic categories:

1. Computer basics,
2. Computer operation and application,
3. Introduction to commonly used software,
4. Programming, and
5. Computer impact on modern society and on human society.

In the eighth grade, the focus of computer education is on operational skills. For example, keyboarding, Chinese language processing, and disk operation. Very little time is spent on operational principles of the computer or on programming languages. In the tenth grade, computer education aims at introducing students to basic computer knowledge, disk operating systems such as DOS, WINDOWS, as well as databases, programing languages, application programs, and computer impact on modern society. Students are taught to see their futures in terms of technologies' impact on China's future.

After school programs are available in many secondary schools and at the Youth Science Activity Center in each city district. According to the interest of the individual, a student can choose to study Pascal, C, BASIC, program design, and software/hardware concepts. Some offer more specialized programs such as multimedia and computer-assisted instructional software development.

Equipment

Hardware upgrades have been continuous and costly. Starting with Apple and 286 platforms, upgrades were soon made to 386, and today, most computers are above 386 level. All schools with grade level 7 through 12 have more than 25 workstations, some have more than 50. Some schools have their own local area network (LAN); some LANs are connected to Shanghai Institute of Education's central information system, making possible "the dream of resource sharing." Some schools have established multimedia PC networks through the sponsorship and collaboration of Shanghai businesses. Multimedia will soon be introduced into the classrooms in a number of Shanghai secondary schools in the near future.

Computer-Assisted Instruction (CAI)

CAI is an important part of computer education. Some schools started to develop CAI software soon after Apple computers were available in schools. Some examples of instructional software include: *The Structure of the Heart*, *Cell Split*, *The Formation of Mountains*, *Mineral Distribution*, *The Second World War*, etc. Software development on old Apple computers were very much confined by the limited storage space, low speed and display resolution. More recent instructional software were developed on 386, 486, and Pentium machines by most schools. Some examples include: *Typing (Chinese) Practice*, *Little Musician*, *Test Your Intelligence*, *Miao Miao Can Draw*, etc. Test bank software for secondary school computer education, computer operating systems, and secondary school entrance examinations are also available to students.

Today, some software companies are working with experienced teachers in the field to develop multimedia instructional software that will operate in WINDOWS environment. These software cover the topics of foreign language, mathematics, physics, biology, etc. Educators in Shanghai recognize that good software development must be a joint effort with specialists in psychology, education, computer-assisted instructional design, and computer programing.

Teacher Training

In 1984, when computers first appeared in Shanghai schools in large numbers, schools were facing a severe shortage of computer teachers. At that time, most secondary schools in Shanghai had only one or two computer education teachers; more than 90% of them were trained in math or physics; their rank and promotion were decided in the discipline where their had received training and so was their teaching evaluation. Some teachers, mostly those who were trained in physics or mathematics, taught themselves how to operate the computer. These teachers became the first computer educators in Shanghai secondary schools. It was a small pool of excellent teachers, but not adequate for student classroom demands.

It quickly became imperative to train other teachers to teach computers. In order to enhance the knowledge-base in computer education and improve the stability and reward system for this group, Shanghai Institute of Education as well as some district institutes of education, the former Office of Computer Education Research of Shanghai Education Bureau, and the China Center for Computer Education in Primary and Secondary Schools jointly launched a series of training programs to prepare teachers for the field and to provide in-service training.

Prior to assignment in the field, perspective computer teachers were required to go through an education program which focused on:

- The purpose of computer education,
- Instructional objectives and requirements,
- Teaching contents,
- Basic knowledge and operational skills of the computer,
- Curriculum development
- Computer text analysis, and
- Teaching method study.

For those teachers who had already started teaching computer subjects, training was provided at an advanced level. Examples include:

- Hardware/software knowledge,
- Discipline-specific knowledge,
- Latest development in computational statistics and measurement,
- PASCAL and C languages,
- CAI software development and software engineering,
- PC maintenance and repair,
- Computer education research in primary and secondary education,
- Computer graphics,
- Network and multimedia technology,
- Operating systems such as WINDOWS and UNIX, and
- Computer English.

Today, the number of trained computer education teachers in Shanghai secondary schools has greatly increased. According to the statistics provided by Shanghai Institute of Education, by fall 1996, there are about 358 trained computer teachers, whereas before 1991, all computer teachers were trained in another field. Since 1991, 95 graduates from four-year computer sciences programs and 148 from two-year computer science programs have been assigned to secondary schools in the city. This greatly strengthened the computer education program in Shanghai secondary schools. The table below summarizes this change.

Table 1.
Numbers of Trained Computer Education Teachers In Shanghai Secondary Schools*

Sources of Training	Before 1991	By the end of 1995	By Fall 1996
Graduates from 4-year programs	0	30	95
Graduates from 2-year programs	0	0	148
Trained from other sources	0	150	358
Total	0	180	601

* *This number does not include computer education teachers who are trained in other fields. They are the main force of computer education in Shanghai secondary schools by far.*

Presently, a basic training network has been formed in Shanghai to include the secondary schools within their respective districts and counties. Institutes of education at the district level are responsible for providing computer education training at the basic level. The Shanghai Institute of Education is responsible for training computer education teachers at intermediate and advanced levels. The training focuses on the utilization of the most recent texts and software in computer education, and on the hands-on practice. By providing secondary schools with competent computer education teachers, a ripple effect will reach students as well as impact other teachers.

The Relevance of the Shanghai Experience to Schools in the U.S.

In the U.S., while leading edge users of cyberspace are adjusting from a PC-centric environment to a netware-centric and digital environment, at the school level, many are still introducing word processing or sometimes nothing at all. Despite the recognized need for teachers to use and teach new technologies, there remains a large percentage of teachers unprepared to cope with technology in classrooms. While China started and remains somewhat behind most American schools in access to technology, it is impressive how rapidly Chinese education administrators have been able to mobilize from limited resources to train teachers to bring technology into the curriculum. Similarly, the willingness of teachers to learn enough computer technology to make effective use of it in the classroom may be instructional to American teachers and teacher educators.

Several observations can be made from the Shanghai experience which have relevance to the practice in the U.S. The first is computer training for teacher in the America. According to a report by the Congressional Office of Technology Assessment, in the process of acquiring hardware and software for the students in the schools to use, "teachers—perhaps the most critical part of the educational equation—often have been overlooked. Even when teacher technology training needs are addressed, it is often in the form of short-term, one-shot arrangements." Although the intention of such training is to familiarize teachers with a specific application or provide general computer literacy, in reality, it is difficult for most computer-illiterate teachers to learn enough to be able to apply what they have learned in short-term courses. The skills are then forgotten or become obsolete, or even worse, teachers become more frustrated because the lack of proficiency and support. In short-term training, teachers often learn isolated computer knowledge and skills and don't relate applications to curriculum integration, which is essential if technology is to become a truly effective instructional resource. A more comprehensive teacher training curriculum, such as the one introduced the Shanghai approach, may provide an alternative to get teachers comfortable with technology, or at least over the feelings of "inadequately trained to use technology sources, especially computer-based technologies." (OTA Report Summary, p3)

Second, the Shanghai experience features centralized in-service teacher training at both city and district levels. The institutes of education system provides a natural network for this task. Since the system is already in place, computer education training just adds another piece of curriculum. In the U.S., the federal government and private sectors have tended to focus more on technology assistance and funding to K-12 schools than to colleges of education. While this approach may address the current needs, it does not greatly influence the improvement of in-serve teachers' technology skills, nor teacher preparation or quality control of teacher education over the long term.

Finally, the top-down planning system and the pressing need to share relatively scarce resources at the government levels, and the sense of urgency to be able to function in a hi-tech society at the individual level, have created the best extrinsic and intrinsic motivations for teachers to participate in computer training. But in order for teachers in the U.S. to reach that level of enthusiasm, instead of merely staying in the constant loop of "good intentions, moderate action, and lack of impact", accessibility of hardware/software and availability of occasional and uneven training and support are not enough. Educational policy must be designed to move teachers through the stages of *intention* and *action*, and to the confidence and ability levels necessary to make an *impact* on student learning through the use of technology.

Reengineering pedagogy represents a profound paradigm shift which is well underway in the U.S. economy and culture. But too many school teachers and not a few teacher educators remain well behind the power curve. To avoid crashing the system, we must apply the increased energy and forward motion to accelerate progress. That means that teachers must learn enough about the relevant technologies to apply them in their professional lives, and to translate them to their students as part of the integrated learning of the subject matter.

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INTEGRATING TECHNOLOGY THROUGH THE GUIDELINES OF INTASC STANDARDS

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Instructional technologies are an issue that continue to haunt teacher education programs. The issue of how to introduce pre-service teachers to technologies and encourage their use in the classroom setting has yet to be resolved one way of the other. A recent survey of Indiana teacher education programs conducted for the North Central Regional Educational Laboratory (Powers, 1996) found that of the schools responding to the survey, the majority required their students to take a stand-alone technology course. Furthermore, technology did not appear again in other teacher education courses. When the technology was integrated into existing courses, it was done only on a course-by-course basis and not curriculum-wide. One teacher education program reported that it had no technology component in it's program.

Technology in teacher education is only one movement which has been affecting education. Simultaneously, many states are moving towards standards-based education, not only in the K-12 schools, but also for the accreditation and licensure of teachers. One such set of standards was developed by the Interstate New Teacher Assessment and Support Consortium (INTASC) and released in 1992. This consortium is composed of state education agencies, higher education institutions, and national educational organizations These standards are built upon and compatible with those developed by the National Board for Professional Teaching Standards and represent those principles which should be present in all teaching regardless of subject matter or grade (CCSSO, 1996a). The ten principles/ standards (see Table 1) incorporate knowledge, dispositions, and performance (CCSSO, 1996b). At present, sixteen states have adopted the INTASC principles for use or for adaptation in the development of their own standards.

At first blush, the ten INTASC principles appear to have little to do with instructional technology. Only within Principle #6, "The teacher uses knowledge of effective verbal, nonverbal, and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom," is any form of media (and not necessarily technology) mentioned. However, when the standards and related components of knowledge, dispositions, and performances are more closely examined, and issues of assessing these components are analyzed, the possibility and necessity of technology integration becomes more apparent.

Integrating Technology Through INTASC

To truly integrate instructional technologies into the teacher education curriculum, there are two levels in which technology could be found: Instruction and Assessment. The following section will examine both of these levels and provide a handful of suggestions and recommendations for how technologies can be integrated and employed. The suggestions offered here are by no means all-inclusive. Individual programs might present opportunities not considered in this paper.

Instruction

In order to address all of the INTASC principles and the accompanying knowledge, dispositions and performances within a teacher education curriculum, instruction can not occur as per usual. An analysis of the principles reveals that there are no subject matters that stand alone. For example, subject matter cannot be addressed without regard to instructional strategies or knowledge about the general community. In other words, teacher education faculty will need to adopt new paradigms and new instructional strategies to adequately address and model the principles.

Stand-Alone Technology Courses. The model of the stand-alone technology course is one facet which would need to change. In order for students to be able to fully understand how technology relates within all ten principles, instructional technology needs to be used in courses that ultimately expound upon all ten principles. Although this may mean that some of the control that can be exercised by technology faculty may be lost, the power of the number of additional faculty which will needed to teach and use these technologies and therefore be exposed and cognizant of instructional technologies is overwhelming.

Table 1.
Ten INTASC Principles

Principle 1: The teacher understands the central concepts, tools of inquiry, and the structure of the discipline(s) he or she teaches and can create learning experiences that make these aspects of subject matter meaningful for students.
Principle 2: The teacher understands how children learn and develop, and can provide learning opportunities that support their intellectual, social and personal development.
Principle 3: The teacher understands how students differ in their approaches to learning and creates instructional opportunities that are adapted to diverse learners.
Principle 4: The teacher understands and uses a variety of instructional strategies to encourage students' development of critical thinking, problem solving, and performance skills.
Principle 5: The teacher uses an understanding of individual and group motivation and behavior to create a learning environment that encourages positive social interaction, active engagement in learning and self-motivation.
Principle 6: The teacher uses knowledge of effective verbal, nonverbal, and media communication techniques to foster active inquiry, collaboration, and supportive interaction in the classroom.
Principle 7: The teacher plans instruction based upon knowledge of subject matter, the community, and the curriculum goals.
Principle 8: The teacher understands and uses formal and informal assessment strategies to evaluate and ensure the continuous intellectual, social and physical development of the learner.
Principle 9: The teacher is a reflective practitioner who continually evaluates the effects of his/her choices and actions on others (students, parents, and other professionals in the learning community) and who actively seeks out opportunities to grow professionally.
Principle 10: The teacher fosters relationships with school colleagues, parents, and agencies in the larger community to support students' learning and well being.

This model does not imply that traditional technology faculty have given up the opportunity to work with teacher education students in favor of integrating technology into methods or instruction courses. Rather, technology faculty can collaborate and team-teach with other teacher educators, thereby also modeling Principle 10, to ensure that certain skills are learned and then integrated into an ultimate student performance.

Field Work. Due to the emphasis on performance, there is an apparent need to have pre-service teachers out in the field with K-12 students to a greater degree than ever before. The possibility of conducting entire university/college courses in the field is not outside the realm of possibility. The field work provides two distinct advantages to the inclusion of instructional technology.

First, when confronted with technology requirements in the teacher education program, students are often not able to make the connection between what they do in class, and what they ultimately might be able to do in their own future classroom. By offering the teacher education class, with inclusive technology, in the field setting, students not only integrate technology into their teaching and assessing performances, but are doing so on equipment that is hopefully representative of what K-12 schools offer (the disadvantage could be working with a field school that does not have adequate equipment). At the same time, given careful field placements, students can also observe their field teachers using technologies for personal productivity, teaching, and assessment.

Second, teacher education faculty, and technology faculty in particular, may not spend a great deal of time out in the field. They may not have an accurate assessment of what equipment is available in the local school systems. Some colleges/universities may have a plethora of equipment that far exceeds the capabilities and cost constraints of local schools. Conversely, many K-12 schools may be better equipped, or at least have a different variety of equipment, than can be found in the teacher education institution. By conducting classes in the field, technology faculty can better communicate with students as far as what is practical and possible in the teaching situation. Faculty can also point out real-life examples of teachers who are effectively using technology in their classrooms. None of the above is to the exclusion of courses taught on-campus, but are a viable alternative and possibility for meeting the INTASC principles.

Assessment

Very few components of the INTASC standards can be assessed through traditional assessment. The emphasis with these standards is on performance. In order for a pre-service teacher's final performance to be judged as adequate, there must likewise be developmental performance assessment, both in the university classroom and in the field, throughout the teacher education program. All of this assessment points to a definite need and opportunity for the inclusion of instructional technologies. Some of these technologies include videography, telecommunications, electronic portfolios, and distance learning.

Videography. When discussing the assessment of performance, the need for video-taped evidence is never far from consideration. In a perfect world, small teams of teacher educators would be able to observe every teacher education student at multiple times in order to arrive at defensible evaluations of performance. However, given the more realistic constraints of time, faculty load, and limited faculty resources, other methods must be employed to provide documentation and evidence of performance.

The idea of videotaping instruction for review is not at all new, it is just not often employed. To be done effectively, students must rely on other students to do a good job of videotaping their performance, this might involve some storyboarding. Then, to make effective use of evaluation time and portfolios, students should also be able to carefully edit and present videotapes to faculty. All of these are teachable skills, but may not have been emphasized in the past in teacher education programs. With the new demands of performance assessment, it becomes critical.

Telecommunications. Many performances can be assessed out in the field and documented through videotape. Knowledge can be assessed perhaps through traditional testing procedures. However, some of the performances such as reflective practitioner (Principle 9) and the dispositions are not as easily addressed and documented. These are often factors which faculty have informally assessed over the past perhaps by talking about a student's attitude, or level of professionalism. Yet, the faculty member was only called upon to provide documentation for these instances in cases of extreme behavior and circumstances.

The use of electronic communication can provide the basis for some of the documentation and assessment. One method would be through the use of e-mail. Students can e-mail instructors personal journals which include reflections on performance. Journals can also be accomplished through the use of notebooks, but maintaining the notebook documentation for a student's pre-service career could become a storage nightmare. Additionally, only one person could hold the documentation. With the use of electronic mail, the student, as well as the assessment team, can maintain copies of all communication.

More public reflections can also be captured through electronic class discussions (Dutt, Powers & Personett, 1996). Again, the documentation can be collected electronically, and captured in a way that would be difficult to document with in-class discussion. Students become more accountable for their thoughts and actions and must learn to defend their positions, which incorporates a number of the principles. With electronic discussions such as listservs or newsgroups, students are also given the opportunity and time to reflect. In-class discussions must move along quickly due to time constraints. Students may have difficulty formulating their thoughts, or may be too overwhelmed by other class members to speak. The electronic option gives students the opportunity to formulate their thoughts, as well as reflect back on the thoughts and performances of their peers.

Electronic discussions can also provide insight into many of the dispositions that the ten principles expect. For example, the second disposition for Principle #1 states: "The teacher appreciates multiple perspectives and conveys to learners how knowledge is developed from the vantage point of the knower" (CCSSO, 1996b). When controversial issues are being discussed on something like a listserv, the tolerance of an individual to the perspectives of others, as well as their ability to convey their viewpoint and the substantiation of that viewpoint is apparent. The same argument could be made for traditional in-class discussion on controversial issues, but the documentation is not as readily available.

Electronic Portfolios. Performance does not need to occur only in the field. The type of work a student produces for developmental assessment can demonstrate many of the principles, along with the accompanying knowledge, dispositions and performances. Portfolio assessment is increasingly used both in the K-12 schools, as in teacher education programs. The INTASC Standards will bring a greater push for portfolio assessment as pre-service teachers seek to document their ability to plan multidimensional lessons, provide assessment and feedback, and work with the community.

However, if developmental assessment of performance is to take place, these portfolios need to become a part of the student's overall, maintained record. States and accrediting bodies will judge the effectiveness of schools and colleges of education by the performances of their graduates. When you consider the potential bulk of these portfolios, which will include video documentation, paper documentation, and electronic documentation, another storage nightmare comes to mind. How much better it might be to have students develop ongoing, living electronic portfolios.

The use of electronic portfolios would also tie back to the instruction issue of inclusive technology use. Students would need to learn a variety of computing skills in order to effectively develop an electronic portfolio. These skills become immediately useful when put to use in the development of a portfolio which will continue with them over their pre-service teaching career, and beyond (INTASC also covers professional development for teachers).

Distance Learning. Earlier, the need for offering courses in the field was described. In that discussion, it was also assumed that the instructor would be available in the field. Realistically, that may not always be possible, particularly if a faculty team is working with a cohort of students. Distance technologies, including Internet, interactive video, one-way video, and audio could be used to bring faculty from the campus in touch with students in the field. By no means could distance learning substitute for the need for faculty to also be in the field with their students, but given the demands of faculty, distance learning technologies could relieve some roadblocks.

Distance learning can also considered to work both ways. Pre-service teachers will not always be able to be in the field, and a small community might place some prohibitions on how many students are in the field at one time. The same distance technologies that could bring the college/university classroom to the K-12 classroom, could also bring the K-12 classroom to the university/college classroom. How powerful it could be to observe a master teacher working with his/her students and provide critique real-time while sitting on campus. A debriefing session would not need to take place days later with the observing students, and if time permits, the master teacher could even join the debriefing session in order to provide further explanations.

Conclusion

There are a large number of stumbling blocks ahead for institutions which must incorporate the new standards into their curriculum, many of which are not curriculum-related. However, what almost must be considered is the vast potential that the standards also bring with them. Specifically, the Ten INTASC Principles present new opportunities for the inclusion of and need for instructional technology in a way never before presented. Although it might be at first easier for a teacher education program to sweep aside technology considerations because they aren't elaborated upon in the principles or accompanying knowledge, dispositions, and performances, these programs will soon struggle under the weight of providing instruction and assessment under the guidelines of the standards. This weight can be lessened through the effective and inclusive use of instructional technologies.

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How to Better Prepare Preservice Teachers with Modern Technology

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Nationwide there is a growing consensus among educators and the public that we need to seriously examine our curriculum in teacher education. The question most often asked is, "Are we preparing our education majors for tomorrow's changing world, and how should we accomplish this?" Among all of the proposed changes, teaching with technology is one of the major components we should consider.The information explosion has changed the nature of knowing from the ability to recall information to the ability to define problems, to retrieve information selectively and to solve problems flexibly, which therefore changes the nature of learning from the need to master topics in class to the need to learn autonomously. Learners need to learn how to revise their ideas and select information, and to synthesize it from the vast pools of resources.

The traditional "educational technologies," such as paper and pencil, chalkboards, printed textbooks, manipulative and flash cards and other resources used to help students develop their basic skills, concepts and generalizations have been partially replaced and augmented by a variety of technologies available to assist learners in the gaining of knowledge and skills. Many technologies can support research analysis, problem-solving and communication effectively (Means and Olson, 1993). One of the most dramatic changes in the last twenty years has been the profound advance in technology, which has gradually found its way into classroom instruction through the increased availability of computer and computer-related technologies (Goodlad, J. I., 1984). As the special needs arise for all preservice teachers to be prepared to play a major role in implementing instructional technology in teaching and learning, we as teacher educators must continue to play a vanguard role in helping these new teachers find effective and meaningful ways to continue to introduce the new technologies into the classroom setting. Exactly how this is to be done continues to be a subject of intense discussion.

The NCATE (National Council for Accreditation of Teacher Education) has promulgated a list of recommendations for candidates seeking initial teacher certification or additional endorsements; these can be summarized as receiving the necessary foundations to operate a modest computer system in order to successfully utilize software and explore, evaluate, use and apply current instructional principles, research, and appropriate assessment practices to the use of computers and related technologies.

A variety of publications have discussed the increasingly important role that technology plays in teacher education. In turn, today's inservice teachers are becoming increasingly aware of the benefits derived from computer-aided teaching at all levels: from grade school education through higher education.

In attempt to address these issues and to rethink the current curriculum (Shanker, A. 1990), and to search for a clearer picture of what the trends are in the area of preservice teacher training with technology, a short survey was conducted among 11 instructors currently teaching technology courses in different colleges and universities where preservice teachers are trained, in order to find common features in the curriculum and to exam the necessary of restructuring the current curriculum in the related area.

Summary of the Survey Results

In all, 11 surveys were mailed out to education division in 10 Concordia colleges and universities within CUS (Concordia University System) and one state university. Eight were returned, representing a return rate of 73%.

Only one of the respondents indicated that there is not a special course offered on their campus, but that they are redesigning an education 300 course (Audio Visual Methods, which has been determined to be out of date.) and are planning to integrate technology into a variety of the classes that education majors are required to take.

All the schools except one represented in the survey that do offer a course specially designed in instructional technology have made this course a required course for their education majors. The length of the time that such a course has been offered varies from as many as 21 years to two years, with an average of 7.4 years. While the basic reason for the course's existence is because of recently enacted state requirements for accreditation, however, most schools have required their students to take the course from the time of its inception. It is a 2 or 3 credit hour course. 63% of the schools surveyed in his pool do not require the purchase of any textbook; where textbooks are used, the books *Computer Essentials in Education* , *Using computer in the Classroom, Multimedia Literacy* and *Computers in Education* were cited.

The majority of schools responded that only one platform was taught in the classroom, either Macintosh or IBM, the decision of which platform to use largely determined by factors such as limited facilities, and limited personnel. Another school indicated that facilities permitted the introduction to both platforms, but that the instructor would decide at the outset with platform he/she would cover in the course, and then cover only this platform. Only two colleges indicated that both platforms were covered in the relevant course.

Almost all the schools treat this course as a production course despite some of the traditional aspects of lecture and class discussion. One respondent indicated still searching for a better way to design and deliver the course. The determining factor for most schools is that students spend most of their class time learning the necessary skills to produce something assigned to them as projects.

The basic skills expected of the students when they complete the course also vary from the very rudimentary to using multimedia author ware to create a presentation or a teaching tool for classroom use. Particular skills mentioned among the respondents included the use of email, word processors, spreadsheets, databases, Web searches and HTML authoring, graphic programs (including LOGO), and some BASIC computer language programming.

Grading systems varied among the schools, with some assigning percentage grades for individual projects, while others graded the students' work more holistically. In the latter case, it was typical for students who did satisfactory work on assigned projects to receive "B" grades, while "A" grades were reserved for students whose projects involved more complexity than what was actually called for in the individual assignments.

As far as the technology component of the curriculum was concerned, I found no decisive similarities. In fact, the survey results showed a variety of approaches and content, as well as profound differences among objectives from each school. Thus questions are raised, such as, "What should we do to better prepare our future teachers?" and "What is the best way to prepare our future teachers to meet the demand of the rapidly developing technology?" Or, "Should any standardized requirements of technical skills be developed statewide or even nationwide?" On the other hand, the survey results do give valuable information, on the basis of which we can examine the existing curriculum involving training in the use of computers and related technologies in education programs with an eye toward seeking improvement. Most educators would contend that we need to seriously rethink the current education programs because of the many aforementioned advances in instructional technology in order to prepare our preservice teacher for their respective futures.

Concerns

The major concerns raised from the data above are:

1. Students' attitude toward learning to use technology;
2. Appropriate textbooks to use to aid the process of theory building and understanding of teaching with technology and learn how to design the curriculum with the use of technology;
3. Basic skills as prerequisites;
4. Basic skills as required when completing the course;
5. Designing a course with limited facilities and personnel;
6. Setting the course time constrains; Exposing the student to both major platforms (Mac and IBM);
7. Software and hardware selection.
8. Information from Interview

Five students who are currently taking the Media for the Classroom at one of the Concordia Colleges were interviewed with a major focus on the discussion about two commonly used platforms. All of the five students agree that an exposure to both two platforms is of great benefit. On the basis of this exposure, many students concluded that they now had a clear basis on which to select personal computers for use in their future classrooms. All agreed that, perhaps even more importantly, they are likely to find themselves employed where a computer system is already in place, and an exposure to both platforms will greatly facilitate the ease with which they can become familiar with the established system. In addition, the students responded that the well-rounded education gained through the study of both platforms will allow them to more quickly assist their future colleagues in important decisions concerning their future schools' computer systems', both in terms of general enhancement, as well as in terms of assessing software and hardware issues of the systems.

Suggestions

1. Micro as well as macro plans are required for the restructuring of instructional technology curricula (Newby, T.J.; Stepich, D.A.; Lehman, J.D. and Russell, J.D., 1996);
2. More faculty and staff members should be involved.
3. Serious consideration of the course hours should be given, possibly resulting in increasing the number of hours per week from two hours to three hours;

4. Develop standards for course prerequisites and course content;
5. Encourage exchange of ideas among colleges of education;
6. Encourage collective decisions on selection of hardware and software; avoiding extreme personal preference;
7. Develop a more holistic evaluation system.

Conclusion

The industrial age has been replaced by the information age. The teacher's role is to assist students to find and put information together in unique and different ways, to critically analyze it and to relate the information to their existing knowledge and skills. As teacher education professionals, we should keep in mind that we have to restructure the approach to teaching with technology (Niess, M.L. 1991) so as to address the needs of today's learners and realize that technological skills combined with research based theory will eventually translate into improved classroom teaching of tomorrow's inservice teachers.

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Teaching Television and Video Production in the Secondary School

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To meet requirements for teacher certification in communications in the state of Pennsylvania, candidates must demonstrate the ability to teach typical language arts subjects, such as literature, composition, and grammar, and they must also have expertise in teaching at least one form of non-print media. The media specialty at my college is television and video production; therefore, our student teachers divide their time between high school English classes and electives in media. Our methods courses for these communications certification students must include, along with language arts, strategies for teaching both the technical and intellectual skills required to carry out the various steps in the video production process.

Incorporating Video Production into the High School Curriculum

Many high schools and middle schools in Western Pennsylvania now offer some form of instruction or experience in video production. Schools with Channel One equipment use the system to broadcast morning announcements into every classroom. Some of these schools reach a high degree of professionalism, using news roll-ins, computerized weather reports, and an array of on-camera student talent.

In elective courses or as after-school club activities, high school students plan and shoot public service announcements, cover sports and other school activities, and create documentaries, instructional videos, and imaginative projects ranging from music videos to children's puppet shows, story hours, cooking shows, soap operas, talk shows, and man-in-the-hall interviews.

Even though television (studio) or video (non-studio) classes are elective courses, many schools do assign letter grades, and school boards will not willingly spend large amounts to furnish cameras and equipment unless real educational goals are being met. Therefore, a high school television/video course must have formal objectives, planned activities, and evaluation instruments comparable to more traditional courses.

Preparing Pre-service Teachers for Video Production Classes

To prepare our communications majors to teach video production in high school, we require college classes in studio and non-studio production, post-production (editing), and media management. But a person who knows how to plan a production, operate a camera, create effective sound and lighting, and carry out editing and graphic enhancement may still not be able to teach these skills to others, particularly high school students.

Therefore we have built into our program a variety of opportunities for pre-service teachers to gain hands-on experience in teaching video technology to students of varying motivation and previous knowledge. During our methods course, we invite groups of high school and middle school students to the campus for half-day sessions in our television studio.

Working together, the pre-service teachers create lessons that take the high school students through the process of learning the camera functions, scripting, story-boarding, shooting and lighting techniques, in-camera editing and graphics enhancement. During the summer, pre-service teachers can participate in the video camp we offer for high school students. At other times in the school year, we have arranged mini-courses for various groups of interested secondary students.

Through trial and error, success and failure, the students (both high school and college) learn together that it takes hours and hours of work to produce even a three to five minute television or video program, and that good ideas and pre-planning are more important than the glitz of the technology.

Challenges of Teaching the Video Production Process

Until they take a formal class, many students perceive television as a form of entertainment rather than a tool for education. The hours spent watching MTV, sports, and soaps far outweigh any brief exposure they may have had to serious documentaries or news. Therefore the teacher must often direct students towards projects that are acceptable in the school environment and do-able in terms of the time, equipment, and expertise available.

In one of the off-campus, after-school, mini-courses our pre-service teachers conducted, the high school students were broken into small groups or production companies to produce several five-minute segments for a video magazine. To give the students a sense of "ownership" of the project, the pre-service teachers gave them absolute freedom of subject matter. Time had to spent convincing one group that "gang violence" was too broad, that an erotic murder mystery would not be appropriate, and that we lacked the technical expertise to create a fantasy creature somewhat like "Gumby."

The pre-service teachers came to the video production workshop with notebooks full of paper for each student in the class, expecting them to keep journals of all phases of the project. What they found was that students did not want to write anything. They just wanted to have fun with the camera, starting immediately. To get the high school students to discuss and decide on a clear purpose, identify an audience, and sketch a story board or write an elementary script took two complete three hour sessions.

During these same sessions, the pre-service teachers had lesson plans for demonstrating the parts of a camcorder, basic shots, lighting, and sound principles. But the high school students did not want to be told how to do anything; they just wanted to do it themselves. Finally the pre-service teachers asked each group to plan and shoot an interview of another student in the class. When they reassembled to show the footage to the entire class, their own disappointment and embarrassment at the poor results helped the pre-service teachers establish the need to know and the need to plan. The pre-service teachers determined that learners need an awareness of the many small steps that must be taken on the way to acquiring skill with a complex new technology.

The three groups eventually created enough footage for three five-minute segments of a video magazine program they planned to share with parents and friends. Having invested at least twenty- five hours into these brief programs, they came to realize that television may be easy and relaxing to watch, but it is extremely difficult to create.

Teaching Strategies for the Video Production Class

Teaching a video production class requires careful planning of when and how to introduce technical information. Some teachers treat the subject like a science course, requiring students to know optics, physics, and mechanics, while others stress aesthetics and creativity. At the very least, teachers must be able to provide knowledge and experience in basic videographic techniques: composition, shot sequence and variety, clean entrances and exits, purposeful transitions, sufficient lighting, avoiding unnecessary zooms, and using a tripod or other means to steady the camera. The teacher must plan a combination of lecture and hands-on experience that will give students what they need for each step of the process. Using other student products and professional models, the teacher can demonstrate what works and what doesn't, and then let the students try to create their own effects.

Until recently, few textbooks have been available for use in high school television and video classes (some recent publications are listed at the end of this article). In many cases, the person teaching the class has no preparation other than experience with home video. We have all heard complaints of schools that buy a room full of computers but refuse to hire a trained teacher or secure training for current staff. Similarly, teachers assigned to television and video classes need and deserve training and support to put the technology to work for the good of the students.

Educational Outcomes of Video Production Classes

For the past five years, I have taught methods courses and observed student teachers in English and in video classes. As a traditional English major, I experienced some of the same fear of machinery as other liberal arts majors—I did not want to submit my classes to the whimsy of a machine. While I am still an imperfect videographer, I have learned and observed enough to appreciate the power of video technology to enhance language arts skills of secondary school students in many ways.

1. Writing Activities: purpose statement; description of intended audience; script (words that will accompany visual images); production log (record of what was accomplished on each shoot); written evaluation of professional and student video work; self-evaluation and reflection on what was learned during the video production process.
2. Speaking Activities: interview skills (planning and asking good questions); on-camera presence requiring professional language and demeanor; ability to speak within groups to negotiate differences.
3. Research Skills: using print and electronic data bases to gather information for documentaries, news, and interviews.
4. Group Skills: accepting responsibility for carrying our various crew positions; investing time and effort for the sake of a good group product; surrendering personal agendas to the goal of the group.
5. Problem-Solving: using creativity and imagination to solve production problems, such as talent (actors) not showing up, props, mikes, and lights disappearing, batteries going dead, and interview subjects having nothing to say.

6. Self-esteem: gains in confidence as a result of acquiring a useful technical skill that can open up job opportunities or enhance college opportunities.

Summary

More and more secondary schools are offering video production classes or opportunities for experiences in video clubs. New schools or schools undergoing renovation are often blessed with fully-equipped television studios. This technology offers many ways to achieve a variety of educational goals, providing teachers have the requisite training. In my observations of pre-service teachers giving mini-courses and student teachers working in high school settings, I have observed many positive results. In addition to achieving technical goals of learning to handle video equipment, students improved their language skills, enhanced their self-esteem and ability to work responsibly in groups, and had the satisfaction of producing a creative product they could share with parents, friends, and possible employers or college admissions officers.

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PRODUCING VIDEO-CASES THAT ENHANCE INSTRUCTION

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To prepare preservice teachers for their role in the classroom, colleges and universities have traditionally provided students an opportunity to observe K-12 classrooms before they enter field placement and/or student teach. This practice has obvious benefits for teachers-in-training, however, it may limit observers' attempts to critically analyze what they have seen. Students usually observe different classrooms alone or with a partner. Therefore, when whole class discussions are conducted, the conversation is limited to verbal descriptions of the unique and unrelated events recollected by each of the participants. In addition, the events observed cannot be replayed in order to carefully and critically analyze interactions. Certainly being in a classroom and observing the interactions first hand is a valuable practice. However, providing students an opportunity to collectively view and carefully critique videocases of various classroom activities can enrich their learning.

Commercial videotapes, which are often 20-40 minutes in length, can provide edited videocases of classroom practice. Despite the growing quantity and improving quality of these tapes, the videotape format makes them inefficient tools because they limit exploration to a linear viewing of video-cases. Video *minicases* are short vignettes selected as examples of teaching practice. When they are engraved on a laserdisc or CD-ROM, they can be superior to both long-laying or short-playing videocases on videotape because the laserdisc and CD-ROM offer quick and random access to *minicases*.

Research on videocase methodology used in laser disc and CD-ROM programs suggests that when students view video *minicases*, they are able to examine the dynamics of K-12 classroom from multiple perspectives (Abate & Hannah, 1994; Fabris, 1996; Risko, 1991; Spiro, Feltovich, Jacobson, & Coulson, 1992; Stephens, 1995). They are able to compare their interpretations with those of others viewing the same case, and they are able to replay the events in order to look at the multiple layers of interactions as they unfold.

With the increasing availability of multimedia authoring programs and with increasingly affordable video editing/digitizing technology, videocase instruction will likely be used more commonly for preservice teacher education. Multiple video *minicases* can be recorded on CD-ROM and laserdiscs.

In order to make video minicases powerful instructional tools, several matters must be considered. The most important of these is the purpose and format of the product. Additional considerations are the time to be invested, selection of a delivery mode, cost of production, copyright and other legal issues, and the evaluation process. This paper will discuss these considerations and the decisions made when four videocase-based instructional programs were designed and produced by the presenters using laserdisc and CD-ROM.

Four Sample Video-case Based Programs

The four video-case based instructional programs produced are described briefly: Literacy Education: Application and Practice (*LEAP*) (Stephens, 1995); Integrating Technology into the Elementary Curriculum: A Hypermedia (*I-TECH*) Learning Environment for Preservice Teachers (Fabris, 1996); Delivering Instruction with Video Images of Reading (*DIVIR*); and Putting the Pieces Together: Educating Students with Behavior Disorders (*PPT*).

Literacy Education: Application and Practice (*LEAP*)

The design and development of *LEAP* reflects the notion of cognitive flexibility theory (Spiro & Jeung, 1996) and includes video minicases a laserdisc, software that controls the laserdisc player, and a collection of books on the program's topic, the reading/writing workshop approach (see Atwell, 1987, and Rief, 1992 for a detailed description of the approach). The minicases are naturalistic portrayals of middle school teachers and can be randomly accessed, explored, and interpreted from a variety of perspectives.

Integrating Technology into the Elementary Curriculum: A Hypermedia (*I-TECH*) Learning Environment for Preservice Teachers

This is exploratory study that profits from the flexibility and power of hypertext learning environments (Spiro et al., 1992) to create an information-rich context for examination, discussion, and evaluation of actual technology-enhanced classroom practice. This multimedia package of resources for methods instructors and teachers-in-training includes two major components: (a) a prototype CD-ROM containing video-based minicases that illustrate the multiple new roles the students, the teacher, and the technology play in a technology-rich elementary classroom and (b) a software support system that facilitates the manipulation and critical analysis of the classroom video *minicases*.

Delivering Instruction with Video Images of Reading (*DIVIR*)

Like *LEAP*, this program frames video *minicases* in an interactive, software guided environment. In the minicases, advanced teachers-in-training can be observed instructing young readers on the use of cognitive strategies that will help with vocabulary development, word identification, and comprehension. *DIVIR* also includes a section on how to administer a structured informal reading inventory. The user is guided through the video images on three levels: surface (a holistic analysis of the strategies demonstrated), intermediary (a guided analysis of series of sequences within a video minicase), and deep (an critical analysis of the strategies from varying theoretical perspectives.)

Putting the Pieces Together: Teaching Students with Behavior Disorders (*PPT*)

PPT is an interactive multimedia CD-ROM project that is designed for the preparation of pre-service and novice general and special education teachers. It introduces best and least restrictive practices for instruction of K-12 students with behavior disorders through text and video scenarios. *PPT* is intended to provide initial information, therefore, the video *minicases* are activity-based.

Determining a Purpose and Format

Before the design and development can take shape, the creator of a video-case based program must clearly articulate a purpose for the product. The discussion that follows this section of the paper will make increasingly clear the reasons why this stage is so important. Much time, effort, and money will be spent. Keeping focus of the goal will insure that the path to completion is efficient and the final product is well-structured.

The following questions can elicit a statement of purpose and guide the design and development process:

1. What is the content to be delivered?
2. How is the content to be delivered?
3. What theoretical model or models frame the program?
4. What assumptions are made about the potential user of the program?
5. How will the program be evaluated and assessed?
6. How will the creator of the program know that what occurred when the product was used resembles the intended outcome?

LEAP*, *I-TECH*, *DIVIR, and ***PPT*** each had different and definite purposes. *LEAP*'s content is the reading/ writing workshop, a nontraditional approach used to teach literacy in K-12 schools. Twenty-three short *minicases* of three middle school teachers who use the approach can be viewed on a laserdisc. *I-TECH*'s content is the use of multimedia technology in the elementary diverse classroom. It contains over 50 *minicases* culled from the 40 hours of naturalistic episodes captured on videotape and burned on a CD-ROM.

Both programs are framed in cognitive flexibility theory (Spiro et al., 1992) and can be described as constructivist methods of delivering instruction. Capturing interactions that were neither rehearsed nor scripted for the video was of primary concern to the creators of these programs so that they provide a "window" through which the user could examine and analyze the complexity of a real context from a number of perspectives. The creators assumed that students using *LEAP* and *I-TECH* would bring prior knowledge, either from experience or readings, to their viewing of the *minicases*. In a collaborative setting, *LEAP* and *I-TECH* would facilitate dialogue and encourage critical analyses of a multitude of issues embedded in the *minicases*. This would then lead to social construction of notions about teacher-student interactions in the classroom.

The content of *DIVIR* is diagnostic and prescriptive reading instruction. The content of *PPT* is best teaching practices for students with behavior disorders. The purpose of both programs is to guide advanced teachers-in-training through demonstrations of prescribed strategies used in classroom settings. In the case of *DIVIR*, the intended users are students preparing for, or enrolled in, a practicum course, the capstone course in the series of reading teacher preparation courses. The practicum entails one-on-one tutoring of an at-risk child in a clinical setting. *PPT*'s intended users are enrolled in a core course designed to provide general teachers for inclusive classrooms and to provide special education teachers with an introduction to general concepts related to special education.

Unlike *LEAP* and *I-TECH*, where cases are naturalistic and users are encouraged to become critical observers as they view the layers within a *minicase*, *DIVIR* and *PPT* captured more structured, pre-planned and deliberate interactions and users are encouraged to imbibe the particular strategies being demonstrated. Creators, thus, framed the programs within a more cognitive-behavioral theoretical model. However, components of these programs do support more critical analyses and socially constructed interpretations that can occur in a collaborative setting.

Scheduling Time for Design and Development

Time is a critical factor when planning and producing a video-case based program. Besides investing time in the conceptualization and planning of the program, the creators must invest time in all of the facets of videotaping, editing, and evaluating. The time involved in formative and summative evaluation will be discussed elsewhere.

Unless a media support group is available, the creator must be prepared to allot considerable amounts of time to taping, and particularly, to editing. In order to capture enough *minicases* to represent naturalistic classroom interactions or enough *minicases* from which to select the best demonstrations of a particular strategy, many hours of tape must be used. Twenty-two hours of tape were reduced to one hour in the production of *LEAP*. The many hours of tape were reduced to 54 short digitized segments for *I-TECH*, and some 7 hours of tape were reduced to 20 minutes of QuickTime movies in *DIVIR*.

To determine how much videotaping needs to be done, the creators should, after determining the purpose, examine potential settings and models. Is there more than one classroom that should be video-taped? How long are classes? How many days should camera-persons be in the classroom before the students become accustomed to the camera and therefore perform naturally? (That occurred after 3-4 days in the *LEAP* videotapings.) How many models should be video-taped in order to select a good representation of a given strategy? How long will each strategy take?

Schedules are important and require much coordination. If a classroom is being taped, permissions must be secured from the district office, principal's office, teachers, and parents of the students in the classroom. That process often may take days or even months. Once this process is accomplished, camera-persons and teachers must be coordinated so that the appropriate classes are being taped on selected days.

When raw tapes arrive at the editing suite, time once again becomes critical because all processes The developer begins by logging the raw video. This process of tape logging is again time-consuming. However, a detailed tape logging eventually saves time and avoids frustration when the program assembly process begin. The result is a library of organized video footage that later facilitates the viewing of video segments and can be copied directly into an edit decision list (EDL).

To produce visually effective *minicases*, two cameras should be used—one to follow the key player in the interaction—most likely the teacher—and one to follow the secondary player(s)—usually the student(s). When using insert editing techniques, a *minicase* will show not only the teacher's performance but also the students' response/ reaction to that performance. Selecting the "A-roll" section on which the "B-roll" clips will be dropped, and then dropping those short clips of "B-roll" in precisely the right location on the "A-roll" section can become a tedious and protracted process, particularly for the novice editor.

If nonlinear editing is selected—as in the case of *I-TECH*—the next step is to digitize the analog video signal of tape into computer data. This require specialized hardware and software. After the video capture comes the task of editing for length and appropriateness, adding titles, rendering all transitions, and making the movies. This step also requires special video-editing software such as *Adobe Premiere*. The resulting video clips or QuickTime movies can be exported to a variety of formats.

In the making of *PPT*, one camera was used so the issue of insert editing was avoided.

Finally, how much time is entailed in the designing and developing process will also be greatly influenced by the selected mode of delivery.

Selecting a Mode of Delivery

CD-ROM? Laserdisc? These are the two more desirable modes of delivery because the user is allowed to access video-cases quickly and randomly. It is an efficient tool particularly when it is used to support group dialogue and user-computer interaction.

Laserdiscs indulge the viewer with a large, exceptionally crisp image and stereo sound. If the purpose of the video-case instructional tool is to explore layers of interactions, nuances, facial expressions, etc. as in *LEAP*, then a laserdisc may be the most effective medium. However, it may not be the most convenient. To use a computer-controlled laserdisc, three pieces of equipment and a variety of cables are required: the computer system, laserdisc player, and TV monitor. This can become particularly cumbersome, if not prohibitive, if individuals or small groups are to use a laserdisc at the same time. For large group viewing and discussion, however, the laserdisc played on a large TV monitor, is an ideal way to view the cases.

CD-ROM is a convenient, effective mode for interactive video-case exploration. Video-cases are produced as QuickTime movies and imported into the software that can be created in a number of authoring programs such as *HyperStudio*, *SuperCard*, *HyperCard*, *MacroMedia Authorware*, and *Macromind Director*.

As with laserdiscs, CD-ROM has a disadvantage: video images are not as clear as they are on laserdisc, and when projected from a computer screen to a large size, the image is less clear and bright. Also, to avoid a jerky image during playback, QuickTime movies are usually no longer than two minutes. Sections of a single episode that is longer than that time frame must then be "patched," or played back to back in order to view the entire episode. In *DIVIR*, for example, there are three sections of the informal reading inventory, a process that normally takes about 45 minutes and that was edited to approximately 5 minutes. The viewer must click to watch the first part, then click again to watch the subsequent parts.

While longer videos are potentially more powerful in terms of leading the audience down a particular path, incorporating shorter clip segments in a supporting role adds clarity to a message. Further, using the QuickTime controls, the user can manipulate the movie playback and audio volume.

Examining Cost of Production and Replication

The cost of producing a laserdisc and of producing a CD-ROM is difficult to estimate because several factors must be considered. For example, in both cases, videographic equipment is needed: cameras, videotapes, tape decks, microphones, cables, and possible lights and light umbrellas. Super VHS cameras, tape decks, and tapes are recommended because they are relatively affordable and can provide a high quality, pseudo-professional quality video. Cameras range between $800 and $14,000 and tapes are approximately $12 for 60 minutes. Telescopic or "zoom" microphones, which can capture otherwise garbled sound from across an average classroom when aimed at the speaker, range from $100 to $300. Pressure zone or "pancake" microphones give the object to which they are attached the qualities of a microphone and cost approximately $150-300. Playback decks are $800-2400.

The cost of an editing suite can range from $6,000 to an unlimited price depending on the sophistication of the system and the desired quality of the end product. Many universities do provide editing service, however, for a range of fees.

Engraving a laserdisc or a CD-ROM will also vary greatly in costs. Engraving one side of a laserdisc (30 minutes of video) costs approximately $300. A blank CD-ROM can be purchased for approximately $9, and a CD-ROM maker can cost from $800 to more than $2,000. And finally, authoring software ranges in price as well—from a low $100 for *HyperStudio* to $2,989 for the full version of *Macromind Director*.

In light of the price tags of the essential tools needed to create video-case instructional programs, it is wise to seek existing university/college media services or to write a grant to fund the production. *LEAP*, *DIVIR*, and *PPT* were subsidized by grants. *I-TECH* was the effort of a single individual.

Investigating Copyright and Other Legal Issues

Researchers are aware of the legal ramifications of using human subjects. Researchers and developers who use video images of school children must be aware that they may be entering an incredibly puzzling legal lair because laws regarding videotape are diverse and changeable. It is good practice to investigate the laws protecting video of students by visiting with legal representatives, either in private practice or through the university/college's administrative offices. Release forms must be secured from *all* persons whose images or whose children's images will appear in video-cases. In the production of *LEAP* and *I-TECH*, for example, all children and the three teachers videotaped received a form explaining that the sole purpose for the programs was to improve the education of preservice teachers. Some parents refused to allow their children to be videotaped, and those children were seated behind the cameras during the taping sessions.

Evaluating the Product

What might have been envisioned to occur when a prototype of a video-case program is used may be far different from the reality. Responsive formative evaluations conducted with stakeholders, experts in the content field, and potential users can help to insure that the purpose and goals set for the product are achieved. For example, stakeholders, the professors who would be using *LEAP*, were interviewed at the start and asked to critique the prototype of the product on two occasions during the development process. Experts on the reading/writing approach were asked to rate a number of potential *minicases* using a Likert-type scale. And two groups of students (potential users) were asked to comment on the raw footage, and later, on the prototype. The final prototype was field-tested and modified after data collected through observations, interviews, and a survey conducted were analyzed. The prototype components of *I-TECH* were also continuously revised and evaluated experts, potential users, and individuals not familiar with the topic or content. Revisions and improvements suggested by stakeholders were incorporated into the product.

Certainly, not all video *minicase* based programs need to be rigorously tested; however, creators of such programs will design a more valuable instructional tool if time is reserved for carefully thinking through and reflecting on their purpose, goals, intentions, and assumptions at the start, during, and after the program is developed.

Final Remarks

Of the four products described in this paper, one—*LEAP* —has been field-tested. *I-TECH*'s creator conducted a series of formative evaluations during all stages of design and development, and *DIVIR* and *PPT* are still in production. Results of the field test of *LEAP* show evidence of a shift in philosophy among the users—from a teacher-centered orientation to a student-centered perspective. The most valuable gain, however, was that the teachers-in-training had an opportunity to collectively explore their future professional world and to share their interpretations of it in a safe, encouraging environment. Although some aspects of designing, developing, and evaluating a video-case based instructional tool may seem daunting (cost and legal issues, for example), benefits as these are too notable to discount.

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USING A NEWTON MESSAGEPAD IN THE CLASSROOM

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The cover story of the March/April 1996 issue of *Electronic Learning* was "New Teachers: Unplugged - Why schools of education are still sending you staff you'll have to train in technology" (Barksdale, 1996). One of the reasons for this is that schools of education do not have the latest technology to use for teaching their students. To provide education students with the opportunity to use one example of the latest technology, the funds from a summer research grant were used to help purchase a Newton MessagePad 130.

Review of the Literature

An Apple Newton MessagePad is one type of hand-held, battery-operated, personal digital assistant (PDA) that organizes, transmits, and retrieves data. PDAs contain a mixture of personal-information-management tools for people on the go (Zilber, 1996). These miniature computers were first introduced in 1992, and if PDAs follow the course of PCs, by the year 1999 everyone will have to own one (Malloy, 1996). The first Newtons were plagued with poor handwriting recognition ability. This was disastrous because many people purchased them specifically for their ability transform hand written notes into text. The Newton MessagePad 120 and 130 with the 2.0 operating system have excellent handwriting recognition. Additionally, improved battery life, improved communication capabilities, and an increase in the number of third-party applications make the Newtons contenders in the PDA war (Zilber).

The Newton Message Pad 130 ships with cables for computer connections and backup software for both Windows and Macintosh platforms. By connecting the MessagePad to a printer, handwritten notes can be printed. With the addition of a software program, such as X-Port, hand written notes can be downloaded to a personal computer and opened up in a word processing program. These once hand written notes are converted to text to be formatted and printed as a word processed document. X-Port also exports information from either a Windows or Macintosh computer to the Newton.

Software programs such as Learner Profile and Grady Profile Companion for the Newton Message Pad combined with Grady Profile - Portfolio Assessment enable teachers to use the Newton to facilitate alternative assessments of student learning. These programs provide rubrics and matrixes for teachers to check off as they observe students working in their classrooms. Teachers can customize the programs to suit their needs and record anecdotal comments. The portability of the Newton makes it easy for teachers to carry with them throughout the school and on field trips. Records and information gathered on the Newton can then be downloaded to student records stored on a computer, and then used to print out student records of progress.

Johnston (1992) contends "The most powerful assessment for student learning occurs in the classroom moment-to-moment among teachers and students" (p. 60). Teachers' assess students' learning as they teach. Based on these assessments, teachers modify how and what they are teaching. Teachers intuitively assess student learning in a narrative rather than numerical manner during personal interactions with students (Johnston). A hand-held message pad allows teachers to immediately record and store their anecdotal observations for later reflection on students' learning. These anecdotal records provide a broad range of assessment data gathered over time, rather than the snapshot assessment of tests.

The purpose of this study was to provide education students with access to, a Newton MessagePad 130 and to provide data on the feasibility of using a Newton in a classroom for anecdotal record keeping. Whereas the ideal situation would have been to have the students use the Newton MessagePad 130 in their own classes, the constraints of two-three week summer courses required them to use the Newton to keep anecdotal records of their university classroom activities.

Methodology

A pretest-posttest design was used in this study as well as an analysis of anecdotal records kept by the students.

Participants

The participants were thirteen students who were enrolled in two of the courses required for computer literacy endorsement in the summer of 1996 at Louisiana Tech University. Seventeen students were enrolled in the first course. Since three students did not enroll in the second course, their responses were not included in the data analysis. One student did not attend the last day of class when the posttest was given, hence data was collected for only thirteen students. Two participants were male and eleven were female. Eight of the participants took the course for graduate credit and were practicing K - 12 teachers. Two participants were graduate students with limited prior teaching experience, one of whom planned to begin teaching in the fall. The other three participants graduated in May, had not been admitted to graduate school, and planned to begin teaching in the fall.

Instruments

Instruments used in this study were researcher designed pre- and posttests consisting of open-ended questions. The pretest contained the following three questions about the Newton: 1) What is a Newton MessagePad 130?, 2) What can you do with a Newton MessagePad 130?, and 3) How can a Newton MessagePad 130 be used in a classroom? The pretest questions about anecdotal records were: 1) Have you used anecdotal records before? If yes, when and where?, 2) What are anecdotal records?, 3) How can anecdotal records be used in a classroom?, 4) What are some of the benefits of anecdotal records to a classroom teacher?, and 5) What problems might you encounter when using anecdotal records in a classroom?

The posttest contained the same three questions about the Newton with four additional questions. These questions were: 1) How could a Newton MessagePad 130 benefit a teacher in the classroom?, 2) What problems might you encounter when using a Newton MessagePad 130 in the classroom?, 3) If a Newton MessagePad 130 was available to you, would you as a classroom teachers use it in your classroom? Why or why not?, and 4) If you answered "yes" to the previous question, how would you use it in your classroom? Please be as specific as possible.

Procedure

Prior to data collection students were given a pretest consisting of three open-ended questions to assess their knowledge of the Newton and five open-ended questions to assess their knowledge of anecdotal records.

Students were provided with information on taking anecdotal records. They were advised to describe rather than interpret the behavior they observed using positive descriptions (Wright, 1967). Students were instructed to record the entire situation including detailed, accurate descriptions of the actions and setting using adjectives and adverbs to enhance the description (Cohen & Stern, 1967).

A brief introduction was given to the students on how to use and care for the Newton. They were given the opportunity to explore the Newton and had an opportunity to examine demo programs of Grady Profile on both the Newton and a Macintosh.

Over a six week period students were required to spend two thirty minute sessions using the Newton to record classroom observations. Some students enjoyed using the Newton and worked with it for longer periods of time. Students were advised not to write down their classmates names as they recorded their observations. Since most of the class time was spent in working in groups, students simply gave each group they observed a number.

As students finished their observations, they connected the Newton to a printer and printed their observations to turn in as part of a classwork assignment. At the end of the six weeks, students took a posttest. This consisted of the original three open-ended questions about the Newton with four additional open-ended questions about potential benefits, problems and uses associated with having a Newton in the classroom. The portion of the posttest regarding anecdotal records contained the same five open-ended questions as the pretest.

Results

This section includes an analysis of pretest responses, posttest responses, and students' anecdotal records.

Pretest

Pretest responses to questions about the Newton ranged from "I don't know" to a rather informed "record credit card transactions & keep running balances; record important dates." Students' pretest responses to "What is a Newton Message Pad 130?" indicted that 2 students had no idea what it was. Eleven students responded that it was used to record messages. Six of these respondents also stated that it was plugged into a computer, or was a computer. For question two, "What can you do with a Newton MessagePad 130?, eight respondents wrote that it was used for messages. One respondent replied draw pictures, and one guessed that it could be implemented in the classroom. Another respondent wrote "record credit card transactions & keep running balances; record important dates." The other two respondents did not know what to do with a Newton. Question three asked, "How can a Newton MessagePad 130 be used in a classroom?" Seven replied that they did not know how to use it in a classroom with one student adding the comment "can't wait to find out." Two students commented on using it to take notes with one clarifying that by saying "to record what the children are doing." Three indicated that students could write notes on the Newton. One student wrote "I guess it could be used with different projects."

Pretest responses to the five questions regarding anecdotal records ranged from "I don't know" to more in-depth knowledge of them. Question one about having used anecdotal records before indicated that six students had used them before and seven had not. Students reported using them several years ago, during student teaching, and while supervising student teachers. All six had used them in a classroom. Question two asked "What are anecdotal records?" Six students responded that they did not know. The remaining seven responses pertained to taking notes about what students were doing or saying. Only one of these respondents commented that anecdotal records were gathered to obtain a total picture and analyzed.

The remaining three questions focused on using anecdotal records in the classroom. The six students who responded that they did not know what anecdotal records were did not answer the last three questions. Question three asked, "How can anecdotal records be used in a classroom?" Students responses included comments such as recording behavior, recording events as a measure of progress, to compile thoughts, and for portfolio assessment. In response to question four about the benefits of anecdotal records students had an array of answers relating to helping keep accurate records, providing more information than grades, and adjusting for individual differences. Problems with using anecdotal records were queried in question five. Here students frequently commented on the problem of finding the time to record, organize, and analyze them.

Posttest

Posttest responses to "What is a Newton MessagePad 130?" were more detailed than pretest responses with most referring to it as a computer or an electronic device used for note taking. One student referred to it as "a highly specialized computer," while another student wrote "It is a small device (I cannot call it a computer)..." The second question about what can you do with a Newton elicited a variety of responses. They included: take notes, print out, calculate, draw, import and export information, keep records, handwriting conversion, calculate loan repayments, calculate interest rates, store information, play phone numbers, calendar, and store addresses. Classroom uses of the Newton evoked ten different ideas with one student commenting that it would be a waste to use in the classroom. Students would use one in a classroom for: anecdotal records, lesson planning, making records, checklists, field trip observations, storing grades, scheduling, a clipboard, notes for student evaluations, and for children to take notes for students who are absent.

Students comments about the benefits of using a Newton in classroom were favorable except for one student who wrote "waste of money in an educational setting." Students remarked that they could use it to take notes in class, record and evaluate student progress, and record observations. Responses also indicated that the students had developed an appreciation for the convenience of the Newton and had thought about other ways to use it in a classroom as well as for their personal use. They commented that the Newton could be used to take notes during class, to write reminders, to jot down ideas for assignments, for short dictation, to write lesson plans, to schedule events, and to print out ideas for children. Some respondents included student uses such as, recording observations on a field trip and having students use it to take notes for absent students. They had ideas for using the calculator, address book, and calendar on the Newton. Students commented that it could be used it to place phone calls, calculate loan payments, draw, and "store all sorts of information." Comments included that it was "easier to use than writing on paper, handy to operate in a classroom, goes from place to place to record data, and could be taken home."

When asked about potential problems involved in using a Newton in the classroom, 9 students or 69%, commented on problems with getting it to recognize their handwriting. This can be attributed to the fact that the students used the Newton in "guest user" mode; hence, it was not individually configured for each students' handwriting. Two students were concerned about the Newton being stolen in a classroom setting. One teacher remarked that it would be difficult to take notes on the Newton in a classroom of young children. Problems with upkeep and maintenance were also mentioned. This is probably related to the fact that many school districts in the area lack technology support personnel. Students also commented on the Newton's slowness in converting handwriting to text. One respondent expressed concern about "all of the students not being able to use it at the same time." This response is similar to teachers' concerns about one computer in a classroom. Another respondent felt that given the opportunity to become more familiar with the Newton, it would be more beneficial.

Overall, students had very favorable comments about using a Newton in their classrooms. They were asked, "If a Newton MessagePad 130 was available to you, would you, as a classroom teacher, use it in your classroom?" Ten respondents or 77% circled "yes," while three respondents circled "no." They viewed it as a personal tool to "keep track of ideas to focus on later, reminders to self, print out notes, and easily accessible information." Three respondents, who indicated they would not use one if available, indicated why they would not use it. One respondent stated that it would not be practical for a physical education teacher who worked outside with students. Another respondent felt that "a sheet of paper and pen would work just as well." The third respondent commented "I can take notes faster by hand than on the Newton MessagePad." However, the respondent further commented, "Possibly, if I had more experience on the Newton, I would like it a little more."

When asked to be as specific as possible about ways to use the Newton in their classroom, student reiterated previously mentioned ideas. These included answers such as: keeping anecdotal records, writing lesson plans, student addresses, keeping track of ideas to focus on later, check lists, writing quick notes to print out, sharing with students, and preparing class assignments.

Two participants did not respond to any of the posttest questions on anecdotal records, therefore, responses for only eleven responses were analyzed for this portion of the posttest. Students described anecdotal records as "factual notes of student behavior or class activity" and "short brief notes." Responses to the use of anecdotal records in the classroom included: recording inappropriate behaviors, identifying students in need of remediation, documentation, notes to use during parent conferences, and to record observations of student teachers. For the benefits of anecdotal records in the classroom, students wrote: reminder of students' past behavior, provide a great deal of information, to keep up with student progress, documentation of student behavior, and reflection on instruction and student performance. Regarding potential problems with anecdotal records, students noted: recording of opinion rather than facts, time consuming, not being able to write everything down, and having the time to work on and read the records.

Students Anecdotal Records

Students anecdotal records captured the classroom atmosphere of periods of intense work and periods of laughter. One student wrote: "Students are not discussing very much, rather they're concentrating heavily on the projects at hand. Hesitant students are asking for help from the teacher. The atmosphere in the room continues to be quiet with students consciously keyboarding." Another one wrote "In a nutshell, the class is working very hard to complete their assignment." Humorous times were also noted: " A lot of laughter can be heard in the lab this morning" and "Group 4 - Three students are working in HyperLogo. One student humorously requests to be in another group."

The frustration of creating multimedia projects was evidenced by "Two students worked on the laser disc player. They had trouble getting the picture to show up on the screen." One student's notes contained this grim statement, "Their complete program just crashed and they must begin again." Problems with Internet searches were also sources of frustration as noted in the following record: "Some students are showing signs of great frustrations due to their searches not giving the desired information needed to complete their projects."

Students recorded observations about the group work being done in the class such as group of 4.

The members of the group seem to enjoy what they are doing but they need to work on sharing the mouse. One student has been using the mouse for 30 minutes. A second student in the group has acted as the leader to long. The last two members in the group have not spoke in 10 minutes. The last two members do seem to understand the material being covered. The group consults on all the choices to be made about the project.

Along with the frustrations encountered with technology and problems with group members, students noted the fun and excitement of learning with technology. Students' observations included statements such as, "... this is starting to be fun," "We are having fun," and "Group 4 is using the QuickCam. They are having a blast." And one statement that sums up the experience, "Now that I actually know what I'm doing, I may take (EDUC) 447 and (EDUC) 448 again just for fun."

Discussion

Students' posttest responses indicated that they had learned a great deal about the Newton MessagePad. However, one student was still uncertain as to what it was and hesitated to call it a computer. They discovered a variety of uses for the Newton as both a personal productivity tool and as a tool to use in their classrooms. Problems encountered with handwriting recognition could be over come if they had each had their own. In actual usage only two students had a great deal of difficulty getting the Newton to recognize their handwriting and this was overcome with practice. One student, a keyboarding teacher, preferred to use the pop-up keyboard on the Newton screen. She would have benefited from the Newton's optional keyboard.

Posttest responses to questions about anecdotal records indicated that providing practice in taking anecdotal records facilitated their understanding of the uses of these valuable records. Experiencing taking anecdotal records provided students with opportunities to discover how time consuming it is to record observations. However, judging by their observations of the benefits of anecdotal records, students find them valuable records to document student activities, behavior, and progress.

An analysis of the anecdotal records students wrote during class indicated that they understood the importance of describing rather than interpreting the behavior they observed. They described the setting in which the events were occurring. Students did not, however, use many adjectives or adverbs to enhance their descriptions. Their observations provided an intimate glimpse of classroom activities including the mood of the class, the frustrations, learning, and excitement taking place.

Students appreciated the fact that they had hands-on opportunities to use this new technology and enjoyed using the Newton. If made available to them, the majority of the students would incorporate it into their classrooms. The responses recorded to the open-ended questions on the posttest indicated that students would find a wide array of uses for the Newton in their class rooms. They were able to find personal uses for the Newton as well as classroom applications. This is important because teachers who use technology for their personal benefit are more likely to use technology with their students.

The short time frame of this study and the small sample size limits the generalizability of these results. However, the favorable responses to using the Newton indicate that additional research should be done in this area. Additionally, as the prices drop on these products and new PDAs are introduced, it is likely that they will be available in classrooms in the future.

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University of Maryland's Success in Using Teaching Theaters and Lectureware

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These days, word processing, e-mail, and the World Wide Web have changed the way businesses operate and people communicate, yet how students learn in the classroom seems to have been overlooked by this onslaught of new technology. The traditional teaching method of a professor lecturing to students using limited visuals such as chalkboards and overhead projectors is till the norm. But things are changing. University of Marylandís Teaching Theaters is the first step in extending technology to the lecture environment. The three Theaters - the AT&T Teaching Theater, the IBM-TQ Teaching Theater, and the AT&T Foreign Language Classroom, are unique classroom environments that provide integrated computer networks, customized presentation equipment, as well as an assortment of locally developed "Lectureware" (software specifically designed for the lecture environment).

Teaching Theaters

The University of Maryland at College Park, with the financial support of AT&T and IBM, has designed, constructed, and is using classrooms which spotlight technology to transform lectures and learning. A network of computers, highly integrated with a broad array of audio/visual equipment, is available in an effective setting to support instruction and research. The room, The AT&T Teaching Theater, is the first step in extending to the lecture environment the benefits of technology that are revolutionizing other aspects of the teaching/learning process.

The AT&T Teaching Theater is located in room 3140 of the Engineering Classroom Building. It is also available for a single class, short session, or meeting. Staff are available to assist in preparing for and running these sessions. For maximum benefit, faculty or staff are encouraged to schedule at least one month in advance of the planned dates for the class, short session or meeting. Demonstration sessions are also available. The computers in all Teaching Theaters run under Microsoft Windows on a Novell Network.

The Teaching Theaters are run by the Academic Information Technology Services at the University of Maryland. The use of them is, therefore, not restricted to any particular discipline. Previous users include instructors from Anthropology, Art History, Business, Chinese, Civil Engineering, Computer Science, Electrical Engineering, English, Government and Politics, History, Housing and Design, Library & Information Services, Math, Mechanical Engineering, Physics, Psychology, Spanish and Speech Communications. The courses range from the undergraduate to the graduate levels.

Lectureware

Lectureware is software application specifically designed for the lecture environment. Some Lectureware are designed specifically for instructor to use while some are designed for student, or for the interaction of both student and instructor. The following Lectureware applications have been developed by the Teaching Technologies staff to provide tools to enhance the collaborative learning environment available in the Teaching Theaters.

Caprina

Caprina makes high-quality color images easily accessible on many computers at the University of Maryland at College Park. Currently, access is limited to IBM and IBM-compatible computers with adequate quality video capability, running Windows, and having the Caprina access software installed. Fortunately, this includes many of the computers in public labs.

Caprina currently provides two ways of accessing images: MultiSlide and QuizSlide. In MultiSlide you are presented with a list of the images in the order in which they will appear in your course. You can view several images at one time for ease of comparison. QuizSlide is a ìflashcardî study tool to help you learn to recognize images. It presents you with images, one at time, chosen at random from a certain collection. After you have completed your identification, you can easily have it confirmed. (Kozintsev, Stenchikova, Chang & Gilbert 1996; Chang & Gilbert, 1992)

Class Directory

The Class Directory combines each student's picture, name, and a personal biographical sketch into a format searchable by picture or by name. It is particularly useful during the first few weeks of class to aid students as they get to know each other. It is also useful to the instructor for learning the names and backgrounds of the students. The instructor is also included in the directory. (Stenchikova, Chang & Gilbert, 1992)

Feedback Meter

The Feedback Meter is a simple tool which enables the instructor to get feedback from the students as to whether they need clarification during a lecture. Students can simply click on one of two buttons on their program window: "I've got it," or "Please clarify." (Figure 1) The instructor receives immediate feedback as to the number of students who need clarification. (Figure 2) It is also used for simple Yes/No class polling. (Taylor, Chang & Gilbert, 1992)

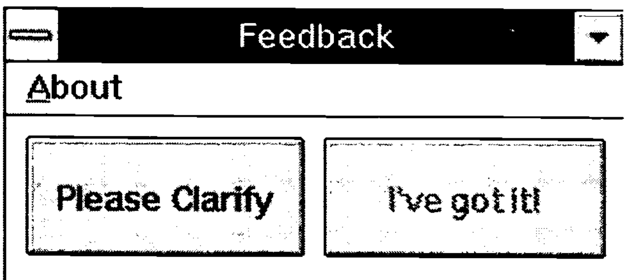

Figure 1. Feedback Meter - Student Version.

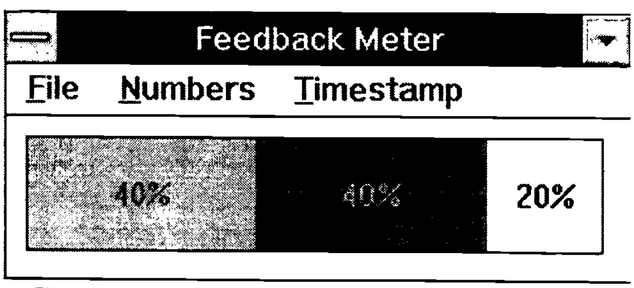

Figure 2. Feedback Meter - Faculty Version.

MultiChat

Multichat is an interactive communication package which allows students to "chat" with each other in small groups. While this will not replace conventional small-group work, it provides some useful enhancements. Multichat creates a permanent record of student transactions which enables the class to analyze student group processes as well as outcomes. Additionally, students can use the Switch Group function, which allows them to go from one small group to another. Once they enter the new group, they can read all the group transactions before participating. In addition, students do not need to enter a group at the same time. Students can participate in groups which continue all semester, synchronously. (Chu, Gilbert & Stenchikova, 1993)

These are the features of this program:

- Users have to specify the group they want to join.
- Send Identified/Send Anonymous: Users can send their messages with their name or not.
- Messages Released/Hold: Users can browse the old messages without being interrupted by new incoming messages.
- Switch Group: Users can switch groups at any time they want.
- Delete Group: (for FACULTY only) Users can delete a group.

One Minute Paper

The concept behind the One Minute Paper has been in education for some time: ask students to take out a piece of paper, but not to put their name on it. They should take one minute to answer a simple question such as

What is the most important thing they've learned today? or What should be covered next class?

The One Minute Paper program allows the instructor to ask these questions electronically. In addition, by collecting this type of information quickly, electronically and anonymously, it is possible to use this technique in various ways. In the teaching theaters, for example, the instructor has the option to look at the data alone, or to project it to the class for analysis. The One Minute Paper could be used as a kick-off for class, asking a question about the previous homework assignment. (Yoo et al, 1994)

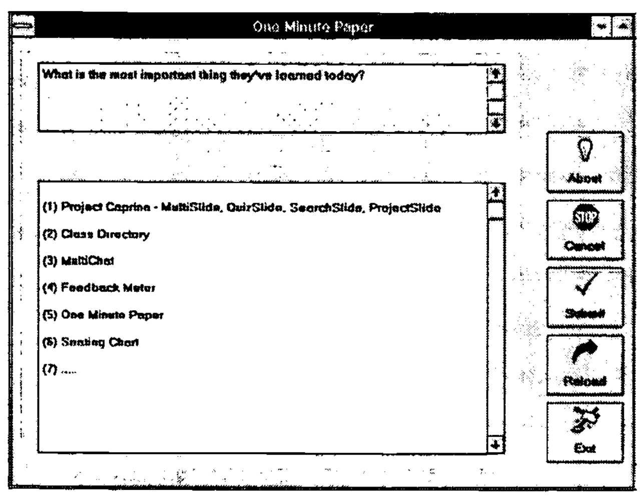

Figure 3. One Minute Paper - Student Version.

Random Number Generator

The Random Number Generator is another simple tool which will pick a random number. The user starts the numbers counting (in random order) and then clicks on stop to pick a number. (Elvove & Chang, 1994)

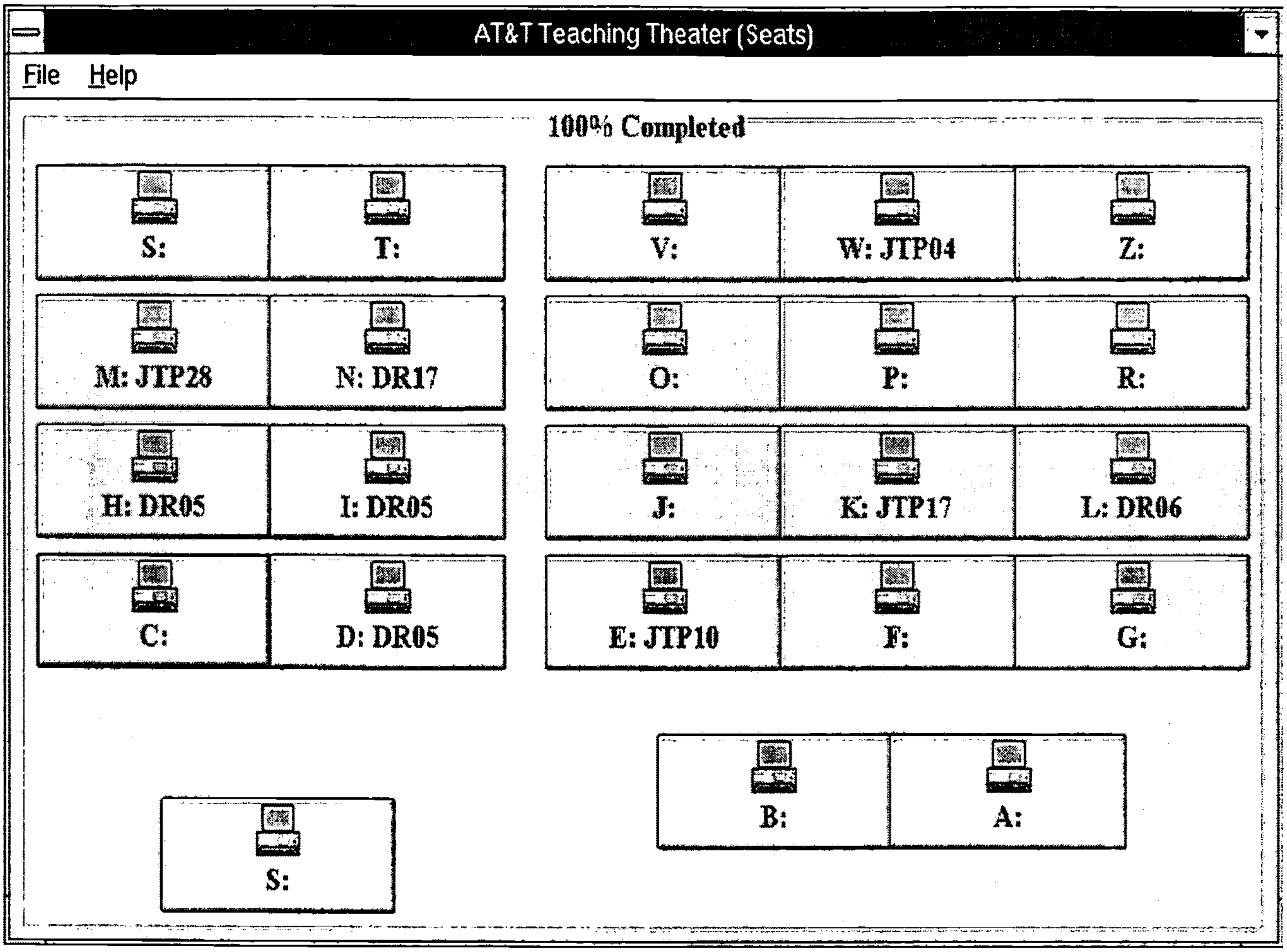

Figure 4. WinSeat (DR** and JTP** are students from two different class sessions.)

WinQuiz

WinQuiz is a program that allows the instructor to create a quiz on-line and the students to take the quiz on-line. The instructor has the ability to create the following types of questions:

Multiple Choice, True/False, Short Answer, Essay. When the student is taking the quiz, they are allowed to move back and forth between questions and change their answers. However, once they have submitted a quiz, they are not allowed to submit the quiz a second time. The instructor is able to view all the studentís answers together in a table for quick grading and individual student answers may be viewed for further examination. (Olien, Chu, Chang & Gilbert, 1994)

WinSeat

WinSeat provides the instructor with the current seating chart for the Teaching Theater. The layout of the screen is identical to the physical layout of the Teaching Theater. The login id of the student who is currently logged in at each station is displayed. The instructor has the ability to print the list of students logged in. (Dan, Chang & Borkowski, 1995)

WinTimer

WinTimer is a simple application that allows the instructor to enter a set amount of time and to start ìthe clockî. The timer counts down the entered time. The user can pause the clock if desired. (Wu, Do & Chang, 1994)

Implications for Teacher Education

The desire to enhance the classroom experience with new and changing technology is growing among campus faculty; the demand for resources and support is also mushrooming. However, with the proliferation of networks, computing platforms and software, authoring systems, and experimental teaching environments, the kinds of instructional support needed is changing dramatically. The goal then is to offer a powerful, interactive educational environment in which it is actually easier to teach than it is in the traditional classroom. The design, implementation and operation of the Teaching Theaters and Lectureware are successful examples of incorporating information technology into teacher education.

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Collaborative Computer Education for Preservice and Inservice Teachers

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One of the great challenges facing today's education system is the computer revolution in education. The same technological advances schools are supposed to prepare students to use are not being utilized in the classrooms. Former U.S. Secretary of Education Terrel H. Bell (Bell & Elmquist, 1992) points out that U.S. teaching practices are outdated and that students and teachers need to be provided access to the same technological tools which have revolutionized American industry. He draws the analogy that "technologically, American education is wobbling down Electronic Avenue in an oxcart" (p. 22). However, merely providing access to computer technology is not sufficient. Efforts to place high powered hardware and software in schools will do little to increase computer support of curriculum in the classroom without a concomitant effort at inservice and preservice computer education.

A lack of preservice education on the integration of computers in the curriculum is one of the most common obstacles new teachers face when beginning their careers. Several researchers have stressed the need for preservice education programs which emphasize integration of computer use in subject content areas and individual curriculum units (Dugdale, 1994; see also Robinson, 1993; Novak & Berger, 1991; Nuccio, 1990; Diem, 1989). The primary need is to structure computer education so student teachers will be enabled to use computers to support their curriculum most effectively.

Though preservice education on the integration of computers into curriculum is lacking, productive inservice education on this topic is practically non-existent (Main & Roberts, 1990). Main & Roberts go on to say that computer education for experienced teachers is most often limited to short seminars the week before school begins or perhaps on Career Ladder Day. Other efforts by experienced teachers at computer integration into curriculum must be undertaken by the individual teacher, usually on their own time.

While computers have become more accessible to the teacher in the classroom and computer capabilities have increased dramatically, efforts to provide more effective computer education for student teachers have not kept pace. Early efforts to meet the need focused on either creation of stand alone core curriculum courses in computer use or addition of computer instruction modules in teaching methods courses for all student teachers. Many of these programs encountered problems in that every student received the same instruction and completed the same assignments. These assignments, however, were not necessarily related to the individual student's curricular interests or teaching disciplines (Dugdale, 1994; Robinson, 1993).

The next generation of preservice education is exemplified at the University of California (UC) at Davis (Dugdale, 1994). UC Davis discontinued the computer core course in favor of a classroom-based experience. Student teachers in both the elementary and secondary education programs were assigned to complete a computer project which was used to support classroom lessons. These projects were prepared and presented by the student teachers and were supervised by the mentor teacher at the school and the supervising professor at the college of education.

Dugdale (1994) reports that student teachers participating in the computer instruction program were enthusiastic about using computers to support their curriculum. Student teachers reported feeling confident that they would be able to use computers effectively and were eager to continue working with computers in their classrooms. Additionally, the mentor teachers in the schools were supportive of the student teacher's work and saw the assignment as an opportunity to broaden their own expertise.

Foundations for Collaborative Computer Education

Collaborative computer education expands the work of Dugdale (1994) at UC Davis and builds upon previous efforts at technology integration in the teacher education program of a large private university. During the 1994-1995 academic year, a computer-based instructional module was developed and integrated into selected sections of the course *Teaching Methods in Secondary Education*

(Secondary Education 375R) (see Wentworth & Breithaupt, 1995; Breithaupt & Wentworth, 1996). This module was centered around a computerized tutorial program that demonstrated several computer-based instructional techniques. Students were taught to program with the HyperStudio authoring system and completed the activities contained in the computer demonstration program. The heart of these assignments required students to write a computer program which would support one of the lesson plans they prepared as part of their term curriculum project. The lesson plans and supporting computer programs were collaborative efforts by interdisciplinary groups of students. The computer programming assignment was made discipline-specific by requiring student groups to incorporate elements of each student's specific teaching discipline.

By retaining the core computer courses, students are given a background in basic computer programming and software selection. Additional computer instruction which is discipline-specific for each student to the teaching methods course provides each student the basic background needed to use computers to support their own secondary education curriculum. The results of research on the effects of this computer instruction module show that the core computer courses have minimal effect on whether the students do or do not use computers to support their curriculum. However, students who received discipline-specific computer integration instruction in their *Teaching Methods in Secondary Education* course are significantly more likely to integrate computers into their curriculum than those who did not receive the computer integration module (Breithaupt, 1996).

Collaborative computer education extends preservice computer integration education into actual classrooms. It is designed to simultaneously teach student and mentor teachers to support their curriculum with computer technology. The student and mentor teacher team identifies problem areas in their curriculum which might be resolved by integrating computer technology into that part of the course. To assist the student-mentor teacher team, a support team is organized consisting of a teacher educator, an arts and sciences faculty member, and an instructional designer from the university. Also included in the support team is the media specialist from the student-mentor teacher team's school. The support team is available to collaborate as needed in the revision of existing curriculum or development of new curriculum based upon the latest pedagogy, instructional technology, and teaching discipline content.

Method

Participants

Student teachers participating in collaborative computer education have already received background knowledge and experience in software selection and evaluation, as well as having participated in a computer programming project to support lesson plans they have made in their own teaching discipline. The mentor teacher will not necessarily have a strong background or education in computer use, only an interest in learning to develop computer support for his or her curriculum. The mentor teachers have the primary responsibility for the curriculum taught in their classrooms. They direct the curriculum development effort and approve all revisions. Mentor teachers have final approval on the curriculum development effort, and will decide whether or not the new or revised curriculum is actually presented to their students.

Support team members fill a variety of roles based upon the requests of the student and mentor teaching team. The support teams are made up of the following members: (a) teacher educators, who are supervising professors from the Department of Teacher Education assigned to supervise the student teachers; (b) arts and science faculty members from the university departments which teach the preservice education courses in the student teachers' various disciplines; (c) instructional designers, professors and graduate students in instructional design and technology; and (d) media specialists, media/computer lab supervisors from the mentor teacher's school or district.

The student and mentor teachers will, of necessity, be in the same teaching discipline. Likewise, the teacher educators and arts and sciences faculty members participating in collaborative computer education will be in the same teaching disciplines as the student-mentor teaching teams.

Procedure

During the student teacher's teaching practicum, student-mentor teaching teams are asked to develop computer support for at least one lesson plan in their regular curriculum. The computer-based instruction may be either presented to their students in the classroom or assigned as homework. This computer support may be selected from appropriate commercially available software, or prepared by the teachers using any authoring system or programming language available. The teachers are given wide latitude in the format and methodology used. This is a collaborative development effort: the teaching teams have access to all members of the support team listed above. The support teams provide guidance, ideas, suggestions, and editorial and formative evaluation services. At the teacher team's request, the development effort may be made available to an instructional design graduate student as an internship or project. In all cases, the collaborative effort is to be under the control of the mentor teacher. It is this teacher's curriculum that is being developed or revised, and his or her students who will receive the computer supported curriculum. This teacher is the individual responsible for the outcome of the collaborative curriculum development effort.

Discussion

Collaborative computer education is currently undergoing pilot testing and revision. The primary contribution of collaborative computer education is to extend teacher education and professional development beyond the bounds of colleges of education to include members of the arts and sciences faculty from throughout the university. This extension connects teachers to university resources in addition to that currently available from colleges of education.

Collaborative computer education also combines development of computer supported curriculum with teacher education and professional development. Previous efforts have separated the education of student teachers and professional development of experienced teachers. Often, both efforts have yielded marginal results. Simultaneous teacher education and professional development streamlines the process and should yield improved results.

However, the real contribution of this work may not be realized until the participants have participated in collaborative computer education for a period of time. This suggests that a longitudinal study of the participants in collaborative computer education covering the next two or three years may yield additional useful data. Further study may also help strengthen curriculum and improve instructional delivery throughout the educational system.

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DESIGNING VIRTUAL PRACTICUMS FOR PRE-SERVICE TEACHERS: THREE PROJECT ITERATIONS

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This paper reviews the development of three Virtual Practicums for pre-service teachers over a 12 month period. The first iteration of the project involved matching more than 20 pre-service teachers at Massey University (Palmerston North, New Zealand) with 40 students drawn from the Nechako Electronic Busing Program and Sinkutview Elementary School (Vanderhoof, B.C.). This electronic project was delivered over a period of six weeks. A second pilot project explored the potential of Virtual Practicums connecting pre-service teachers from the University of Calgary with On-line Teachers from the Nechako Electronic Busing Program for a six week on-line teaching /learning experience with E-Bus families. Recommendations arising from this experience were incorporated into a full practicum project offered during the 1997 winter term, connecting student teachers at the University of Calgary with On-Line teachers from the Nechako Electronic Busing Program.

Literature Review

While there is a growing research base that supports the notion of providing technology training for pre-service teachers [Levin, (1995), Duckett (1995), McClintock (1994), Maddux, Johnson, and Harlow (1994), Kester and Beacham (1994)], and also a growing body of research that describes some of the necessary features of on-line learning environments [Hiltz (1995)], there is almost no research that describes how pre-service teachers might acquire the skills necessary to create, foster and evaluate on-line learning activities for direct use with students.

Levin, Waugh, Clift and Brown's (1995) Teleapprenticeship Model developed at University of Illinois, looks at support systems for pre-service and beginning teachers. His model does not look at using technology to develop on-line teaching skills or to assist in the design, delivery and support of computer mediated learning activities.

The models developed by Makurat, (1994), Gunn, (1994) Kester and Beacham, (1994) look at teaching pre-service teachers how to use electronic mail and then try to extend these skills into collaborative learning activities. These models and projects do not explore the skills, knowledge and attitudes important in preparing teachers to use telecommunication technologies to actually teach distant students. This project is an attempt to gather that information.

Project One: Massey University Students

The purpose of the project was to explore the skills needed to develop, deliver and support educational activities electronically to elementary students and to provide opportunities to integrate technical skills in teaching practice. The student teacher pairs created 3-6 learning activities to achieve stated learning outcomes supported by Internet resources and delivered these via electronic mail over a 3-4 week period. Learning how to use electronic mail and Internet tool skills were vital.

Data. Messages between all parties were collected and archived. Transcripts totaled approximately 135 pages. Student teachers were also asked to record comments, observations, and insights weekly in a reflective electronic journal. Message and journal texts were examined for the emergence of factors and themes significant to participants.

Identified Themes and Discussion

1. Significant Organizational Factors included:

- Roles and responsibilities
- Clarifying expectations
- Establishing timelines
- Assumptions/cultural backgrounds and differences.

Future projects could be improved by sharing class schedules, assignment dates, and holiday times. Clarifying expectations about the amount of electronic communication necessary during the start -up period between student teacher pairs and the facilitator would also be helpful.

Creating an archive of projects to which new student teacher pairs can refer will be extremely useful in future efforts.

2. Management Factors included:

- Managing volume of communications
- Updates - keeping all parties in the picture
- Adjusting to change; making modifications.

In retrospect, handling ten groups of communicating partners amounted to more traffic than should have been attempted in an exploratory project. Reducing the number of groups or sharing the mentorship task would reduce this load. Involving classroom teachers in providing feedback directly to student teachers in the planning stage would be very helpful.

3. Project Factors: Planning, Preparation, Delivering, Supporting and Evaluating:

- Partner selection and group process
- Topic selection
- Identifying resources
- Setting goals/learning outcomes
- Background knowledge
- Time
- Instructions and referencing resources
- Expectations for students and student work
- Feedback.

Project activities need to be blended into an integrated series of steps towards a specific goal; these steps need to reflect more clearly the important aspects of good pedagogy.

The provision of superior Internet resources to support projects is very important. Unfortunately groups who provided an insufficient number of supporting resources, or used inappropriate resources for the specific task had real problems with the completion rate of tasks or lessons. The task of locating resources cannot be passed on to the students unless adequate guided practice is provided first.

Formatting of messages needs to become much more important. Being able to draw the student's attention to important information within a text based medium is an art form. The biggest formatting error was to include too much text in each message. Students need instructions broken into manageable chunks — perhaps outlining what can be accomplished in one 30 minute session. Consistency in referring to activities as lessons, or tasks was also helpful, but a feature that many groups overlooked. Preservice teachers with a higher degree of Internet literacy might be able to take advantage of posting materials on the Internet.

Feedback and how it is provided to students is also important. Personal messages from both partners making specific references to earlier communications were valued by the participating students and their parents. Both students and parents requested that answers be provided so that self checking could occur. Evaluation of student work requires further exploration.

Student teacher partners working with students from elementary classrooms, experienced different problems than those working with students from the Electronic Busing Program. Students in classroom settings operated in a largely independent context where there were competing demands on their time and energy, assistance was not always readily available, and access to computer networks and Internet resources needed to be shared. Students from the E-Bus program had more guidance and supervision from parents at all times, and were able to concentrate their energies on completing the task at hand.

4. Communication Factors:

- Learning to use electronic mail / e-mail etiquette
- Security
- Frustration at amount of feedback provided by students.

This collaboration hinged on the ability of the student teacher pairs to use electronic mail as their fundamental communication tool. Quick and effective communication was particularly crucial at the beginning of the project when the greatest number of concerns arose.

The early pattern of once a week communication was not sufficient to support the kind of collaboration required to get all of the groups off to a productive start. The initial lag on message turnaround was a significant factor in successful completion. As the project progressed, the number of contacts per group per week increased and this allowed for more efficient feedback and problem solving.

It was very important that expectations surrounding the frequency, and the format for messages be established early in the process. More time needed to be devoted to the less formal exchanges of information that occurred at the beginning when curiosity was high. The immediacy of communication between parties was what excited and captured the interest of elementary students. Teaching all parties to check their mail regularly and to respond to each new messages was an extremely important task.

Many of the elementary students had minimal keyboarding skills, thus responding to information requests took time away from completing the "job". Students tended to respond with generalities instead of specific information, and time lags between receiving the request and answering it varied according to other pressures in the classroom. If students come to expect new "mail" each time they check, then they will quickly learn that checking is important. If they receive quick answers to their questions, then asking for clarification via e-mail becomes an option for them. When no communication occurs the parties involved assumed that no work was being done. This was often incorrect. Students were so busy "working" they didn't have time for e-mail (which was not seen as part of the work!) Student teacher pairs should communicate in future directly with classroom teachers who can provide valuable feedback that the children are unable to articulate.

This project was a very time consuming undertaking requiring many more hours of preparation than the average classroom lesson. Student teachers simply ran out of time. Students who could tolerate high levels of ambiguity, decided to proceed with a course and action that could be modified as needed. Others, faced with indecision, had difficulty completing the project. It is important to recognize that in addition to this undertaking, Massey University students were involved in many other class activities that demanded their time and attention.

5. Technical

- Hardware/ software
- Access to lab facilitates
- Basic computer literacy
- Learning /applying skills simultaneously.

If this kind of project is used as a vehicle for teaching pre-service teachers how to use electronic mail and Internet tools in educational practice, two distinct phases should occur. In the first phase, student teachers acquire and practice the skills needed; in the second phase, they can concentrate on applying the skills to the task of creating, delivering and supporting on-line activities. If additional access to lab facilities cannot be provided, then groups will need to organise themselves to make sure that regular e-mail contact is maintained with students, and with the facilitator.

Recommendations

1. Require that participating student teachers have basic skills in using electronic mail and Internet tools OR develop the project in two stages.
   - Stage One would focus on learning how to use e-mail and Internet tools,
   - Stage Two would explore how these can be used to support electronic learning activities and collaborative exchanges between partners.
2. Share complete time table information in advance so that timelines are more appropriate.
3. Create a complete archive of papers, and projects from this year's participating student teachers to be provided to the next group of student teachers.
4. Limit the number of groups participating in the project, or share mentorship tasks.
5. Involve classroom teachers and parents in the planning of projects and in providing feedback and mentoring.
6. Emphasize the connections between good pedagogical practice in a classroom and good pedagogical practice in preparing learning activities for electronic delivery.
7. Pay special attention to resources provided to support activities, and to how activities are formatted for use with elementary students.
8. Increase the volume, frequency and quick response of communications between participants at all levels.
9. Concentrate on creating an electronic communication "process" which articulates the expectations with students. Invest time in the initial stages of the project establishing with students what good electronic communications look like and what kinds of information must be shared .

Project 2: Calgary Students

Two student teachers from the University of Calgary were paired with teachers from the Nechako Electronic Busing Program in May, 1996. The first tasks of these students were to set up the computer, become familiar with the software, arrange for Internet connections, and to prepare an electronic letter of introduction to forward to all clientele. These letters were then electronically circulated to parents. At the same time, e-mail correspondences were begun between the student teachers and the cooperating teachers to establish a rapport and a common understanding of the practicum.

Several tasks were required of the student teachers over this short, six week practicum. Initially, Internet searches were conducted to identify resources that could be utilized in a variety of instructional settings. The student teachers then constructed discrete units of study that employed some of the strengths of electronic communication. These units evolved through several iterations in order to have them not resemble correspondence courses with a directive teacher approach.

The intent at this point was to have volunteer E-Bus families work with the student teachers to implement the unit and then offer feedback on its effectiveness. Due to time limitations and the fact that many families were winding up their academic activities for the year, the student teachers did not have an opportunity to completely implement their work. Evaluations of the process proved to be quite positive. student teacher or parents? Initial responsive journal entries focused on the paradigm shift required for on-line work, and later moved to a more comprehensive discussion of the trials and benefits of the process.

Project Three: University of Calgary Students

Another Virtual Practicum Project was proposed for the winter 1997 semester at the University of Calgary that followed the model of delivering curricular support online. Student teacher tasks would include clarification of BC Learning Outcomes Identify for parents, identifying Internet resources to meet learning outcomes, writing tutorials of pedagogical techniques, the development of on-line projects for specific groups of students and expansion of the e-bus.com web page.

Student teachers will also explore the Internet as a source of on-line professional development to challenge their own thinking about teaching and to encourage them to develop new ideas and skills. Other responsibilities will also include communicating and negotiating with parents on when, what and how to assess student growth and report this information.

Drawing on the experiences of the previous virtual practicums several prerequisite skills were identified as well as the development of a profile of a student teacher who would benefit from such an experience.

Prerequisites skills tended to focus on tools skills, electronic resource and communication skills and pedagogical skills. Tool skills included a basic computer literacy and comfort with at least one operating system and a knowledge of basic applications such as word processing. Electronic communication prerequisite skills that would benefit a student teacher in a virtual practicum include a knowledge of e-mail and the ability to search the world wide web. Students with a wide range of teaching and subject experience will find the practicum experience more rewarding and gratifying considering the diversified nature of the clientele; specialists might not get the opportunity to draw upon their particular area of expertise.

Further, successful participants in previous virtual practicums include a willingness to be a problem solver, the ability to tolerate change and ambiguity, a degree of creativity and flexibility and the willingness to relinquish instructional control to parents and value them as full partners.

A number of ongoing expectations for student teachers participating in the Winter 1997 virtual practicum were articulated:

- weekly scheduled meetings online
- entries in a reflective journal
- participation in an educational listserv.
- correspondence between student and a number of volunteer E-Bus families
- connection of student teacher with a classroom teacher for development of a specific classroom-based project.

A number of specific projects were to be completed over the 13 week practicum:

- develop a simple web page and resource page
- work with a specific web resources and develop several ways to integrate the resource into curriculum (learning outcomes) through multilevel learning activities
- collect Internet resources to support a specific theme, topic or cluster of learning outcomes with very general descriptions of how they might be used
- develop an e-mail based project such as a writing or editing activity, letter exchange, or data exchange
- develop an integrated thematic unit equal to about 5 hours of student time. This would involve the student teacher in planning, delivering, managing, and assessing student learning for the project they design.

Conclusion

The format for the Winter 1997 practicum and the Virtual Practicum Project in general has enormous potential as a vehicle for accomplishing a series of diverse aims within any teacher preparation program. It provides a meaningful reason for learning Internet skills and offers an application of these skills into classroom settings. Student teachers are also encouraged to integrate curriculum across traditional subject and age boundaries as they integrate technology into practice. Opportunities to connect pre-service teachers with experienced classroom teachers for a mutually beneficial experience are presented. Such collaborations have enormous potential not only to further our knowledge of the processes and skills involved in on-line teaching, but also in providing an application of technology skills into teaching practice that require a high degree of integration.

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Preservice Teachers Connect Theory with Practice in a Fifth Dimension Project

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Preservice teachers have the opportunity to mesh theory with practice in an introductory course linked to the Fifth Dimension Project. This paper reveals the theoretical underpinnings of an early field experience as well as its value to a future educator. The Fifth Dimension Project is an international distributed literacy consortium located in after school programs under the auspices of Boys and Girls Clubs, YMCA/YWCA's, recreation centers and public schools. This project includes a cultural system with rules, artifacts, and a division of labor that combines play, education, and peer interaction (Cole, 1995). At Appalachian State University preservice teachers enrolled in an introduction to teaching course have an opportunity to participate in The Fifth Dimension during their laboratory experience. This project provides an opportunity for undergraduates to connect theory with practice while providing a rich technological context for children to acquire knowledge and literacies mediating cognitive and social development.

The goals for the introduction to teaching course include developing an understanding of the teaching and learning process, identifying the various tasks and responsibilities of a teacher, becoming knowledgeable of the diversity in today's classroom, gaining experience with technology, using reflection as a tool for professional development, and making decisions about teaching as a career. Initially, students complete a preassessment instrument which surveys current definitions of teaching, learning, technology, etc. Course readings provide theoretical knowledge of teaching, learning, and schools. Classes are held twice weekly on the university campus and a two-hour lab is scheduled on alternating days in a technology lab in a public school. Students are engaged in conversations and reflections throughout the semester during class meeting dates, along with notes conferencing and electronic field notes written immediately after each lab experience. A post-assessment instrument gathers personal reactions to the class and field components with regard to the cultural and intellectual development of each individual participating in the Fifth Dimension community.

Purpose of the Study

The purpose of this study was to determine if undergraduates could connect the theoretical underpinnings of cultural-historical activity theory (CHAT) with cultural practices in the Fifth Dimension laboratory experience. Findings from two semesters of class discussions, field notes, assessment instruments, and course evaluations were analyzed. There were 35 university students involved in the study. Each one was a prospective teacher and was an applicant for admission into the College of Education.

Approximately 70% of the students were pursuing a degree in elementary education and the remaining students were seeking degrees in either secondary education or a K-12 program such as special education, speech pathology, or physical education. These students were enrolled for either the spring or fall semester of 1996. The majority of the students were sophomore, female, and Anglo-American.

Merging Theory with Practice

Former psychology and foundations courses provide a schema for educational theories for the preservice teacher. Prior knowledge of Piaget, Skinner, Vygotsky, etc. is discussed and elaborated upon to create a base for extending theory into practice. One activity assigned to students is to describe how an activity such as learning to tie a shoe would occur according to one's theoretical orientation. The responses give insight into students' understanding of behaviorist, cognitivist, and social constructivists views of learning. Although most students have had previous experiences with these theories, they lack concrete examples of the principles guiding theories such as CHAT. Insight is gained on all theories while the lab experiences target furthering the learner's knowledge base for CHAT. Within the context of the Fifth Dimension, practice does not mean action to be repeated to a level of automaticity. Students are not practicing a teaching skill to achieve perfection. Rather, students are actively engaged in technological activities such as computer games and electronic mail, and practice is viewed as a social activity.

Preservice teachers learn about technology, teaching, and learning simultaneously. Throughout the semester, conversations bridging field experiences with pedagogy are encouraged.

Roles of Preservice Teachers

Defining the role of the preservice teacher in the Fifth Dimension setting is problematic initially as a result of the influence of their prior and multiple experiences as pupils in school. The confusion is theoretical in nature and comments such as "I don't see what I'm learning about teaching here" were made by preservice teachers early in the practicum. Most defined teaching as information giving or guiding. Therefore, when children were teaching them or when play occurred, their traditional role of teacher was questioned. With increased understanding of the theoretical underpinnings of Fifth Dimension, students began to accept their role in the community and gained more confidence when they were not always the information giver in the lab. This shift in how one defines teaching and learning is a major thrust in their preservice training.When the preservice teachers ceased to worry about being the authority on games and activities, reflections regarding the quality of their relationships and affiliations with the students increased. Students began to see themselves as partners in learning and also began to take a different direction with assigned children in the lab. Possible roles played by preservice teachers were expanded. A peership evolved in some situations where the university student felt a need to explain the special characteristics and needs of his partner as topics of diversity arose in the university classroom.

At the present time, some children enrolled in the Fifth Dimension program have reached the expert level in technology - referred to as Young Golem Assistant. When preservice teachers are linked with an expert child, it quickly becomes clear that the "teacher authority" role does not work. The child knows much more about the program of games than his partner and therefore assumes the role of the more knowledgeable member of the community. It is here that the concept of the zone of proximal development becomes clear. Each member of the community brings a level of performance and understanding to the setting. What is easily comprehended by one member may be a high level of frustration to another. Socialization occurs as the more knowledgeable one attempts to share what is known. Evidence that learning is a social activity before it is a cognitive one is affirmed. Preservice teachers observe firsthand how one's thinking develops through language mediated social interactions.

Results of the Study

When interns begin to draw conclusions about the validity of the theory which drives practice in the Fifth Dimension experience, other dilemmas arise. Interns soon see themselves as active participants in a classroom rather than former passive recipients of teacher directed learning. They express a sense of accomplishment from total immersion into a practice that was driven by a theoretical base. Future learning was projected to be influenced by the conclusion that a community setting can be of tremendous value - especially when the more accomplished members strive to bring group members from a level of frustration to one of understanding and independence. In many instances, teaching and learning are redefined in the post assessment instruments. Interns are no longer operating under the assumption that they are solely responsible for all the learning that should occur in a classroom. Each member can assume some responsibility.

Future Projections

University students pursuing a career in teaching are well served by a practicum with the Fifth Dimension. It offers an opportunity to have an early clinical experience with children, to merge theory with practice, to learn about technology, and to make important career decisions. Follow-up studies of these preservice teachers to determine paradigm shifts about teaching, confidence with technology, and attitudes towards children would be beneficial. Insight could be given into the validity of meshing theory and practice during the pivotal years of teacher training. These studies could also assist in reshaping how teaching and learning are defined inside and outside school.

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PARADIGMS FOR PRESERVICE TEACHERS: EMPHASIS ON TECHNOLOGICAL INTEGRATION

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The continuous advances in technology over the past two decades have radically altered our access to information, facilitating prospects for a truly world-wide community of learners. The growing number of computers in the schools and rapid proliferation of instructional software, coupled with the rich educational content being added to the Internet daily, have the potential to provide an effective and exciting environment for teachers and students alike - one where technology can help teachers to teach, and in helping students to learn.Unfortunately, all too often we must think of these opportunities in terms of potential, not reality. We are still at a point where we can only imagine a world in which the successes of our students are eloquent testimony to the ways in which we have employed technology in the classroom. We know, through a myriad of research done over the past twenty years, that the wise use of technology can lead to improved student achievement, motivation, self concept, attendance, and enhanced instruction. The question still facing all of us in education is how transform our schools so that they will reflect this knowledge. One way is through recruiting and training preservice teacher who might be predisposed to this philosophy, even before they begin formal teacher training.

Collaborative Training Paradigm

In 1992, a collaborative effort began in San Antonio, Texas involving all the teacher education programs from throughout the metropolitan area. Representatives from these entities, several independent school districts, the community college district, and the local business community came together to draft a mission statement and set of goals for a collaborative organization that would have far-reaching impacts on a variety of educational environments in San Antonio. As a result of these meetings, a proposal was sent to the Texas Education Agency that led to an initial grant award of almost two million dollars for the 1992-1993 school year for the establishment of a Center for Professional Development and Technology (CPDT). One of the original eight Professional Development Centers funded across the State of Texas, the San Antonio Center for Education Development and Excellence / Centro Educacional para el Desarrollo y Excelencia, or CEDE, was the only award recipient from a major metropolitan area during the first year of CPDT funding.

The CEDE signatories included five universities; six independent school districts; three private schools; a community college; an education service center and representatives from the local business community. Through its first four years, CEDE partnerships have expanded to include twenty five (25) Professional Development School Sites.

CEDE's ongoing mission was, and is, that of a collaborative community that can serve as a center of inquiry dedicated to the continuous life-long development of teachers as learners in a culturally diverse, technologically enriched environment. It was dedicated to serving the teachers of the greater San Antonio and South Central Texas areas with innovative teacher education programs that would be field based and technology oriented. Two unique features of CEDE were that it represented an unparalleled collaboration among local educational and community institutions and that it was designed to cultivate classroom teachers, school administrators and teacher educators who could meet the educational needs of the multicultural populations in South Texas' schools.

Developmental Background - Training

As the collaborative began to take form, its partners recognized that one of the greatest challenges facing their teacher education programs was how to adequately prepare potential teachers to respond appropriately to the linguistically and culturally diverse student populations found in the professional development settings they were forming, while developing a technologically rich environment. Research noted that the problem the collaborative was facing was of one of the factors that caused disproportionately high failure rates among minority students; namely, a failure of the learning setting to accommodate cultural diversity (Marshall, 1993).

The collaborative partners felt that one possible answer to the problem of the lack of the cultural responsiveness in educational environments might be to increase the number of minority teachers who knew how to use and integrate technology in those schools. To meet this challenge CEDE's teacher preparation programs needed to find a way to increase the number of minority education students participating in their programs.

The CEDE collaborative understood that recognizing this need and doing providing a solution for it would be difficult, at best. Indeed studies reveal that 92% of all preservice education students are white and have minimal exposure to technology (Goodlad, 1990). Based on this data, increasing the number of technologically oriented minority students going into the teaching profession would also require dramatic changes and increased minority recruitment projects designed by the CEDE teacher education programs.

Addressing the problems of minority recruitment in teacher preparation programs had also become one of the most important educational issues in the State of Texas during this time period. A policy research report produced by the Texas Education Agency (T.E.A.), related that the Texas teaching force was far from matching the diversity of its student body. For example, in 1992-93, 52% of Texas students were minorities while 77% of the teaching force was white (Texas Education Agency, May, 1994).

This discrepancy prompted T.E.A. to suggest that teacher education programs throughout Texas develop minority recruitment projects in teacher preparation programs through a model of professional, school, and community partnerships which would link colleges of education, schools, and perspective teacher education students. As Arthur Greenberg (1992) has noted, a significant push towards this an interest in collaboration in these efforts is an awareness that recruitment of minorities to become professional educators will require a community wide effort in which institutions of higher education will be asked to play a much larger role than was previously reserved for them. These partnerships will serve to prepare preservice teachers, induct novice teachers, and support experienced teachers as well as to experiment with new ideas and conduct research in the study of teaching (McIntyre, 1994).

From its inception, CEDE partners recognized that, in addition to providing professional development opportunities for preservice and continuing professional educators, they also had a responsibility to recruit prospective teachers. With San Antonio's distinctive multicultural mix, especially its Mexican American population which constitutes over half of the community, one of the specific objectives of CEDE was to recruit and increase substantially the number of minority teachers in San Antonio area schools (San Antonio Center for Educational Development and Excellence, 1992). This goal is congruent with nation wide developmental efforts that call for imaginative recruitment programs developed through private and public resources to attract minority students to professional education programs (Donnelly, 1988).

As part of CEDE's commitment to enlisting new teacher educators, especially from minority populations, two summer institutes for prospective educational professionals were developed. These institutes, for students who might choose teaching as a career, were designed for different age groups. One institute was for high school students, who had completed at least the ninth grade, and the other was for college students who had completed their freshman or sophomore years. As per CEDE's overall goals, both institutes actively sought minority participants.

The High School Institute

The first CEDE High School Summer Institute was held in the summer of 1993. The program's focus, then and now, was to recruit primarily minority students who had expressed an interest in the teaching profession and to further their pursuit of teaching by providing a variety of educational professional and technological experiences that would expose them to a variety of occupational endeavors available to them as professional educators.

Students were actively recruited from seventeen Bexar County (San Antonio) Independent School Districts and private schools. Interested participants were required to submit an application with two letters of reference, current G.P.A. standings and a letter of purpose. In its three years, one hundred and eighty five (185) students have applied for admission to this program. Of these, one hundred and fifteen (115) high school students have participated in this Institute. Sixty two percent (62%) of these youngsters have been minorities; of whom ninety two percent (92%) were female.

A significant focus of each of the institutes has been the discussion, demonstration and use of educational technology. Efforts were made to incorporate current and future technological advances in the curriculum. Students have produced their own newspapers and evaluation portfolios using the most up to date computer laboratories. They have visited university computer centers, have been instructed in the use of interactive television and had opportunities for hands-on application of a variety of other interactive technologies. They have also been trained on the use and function of the Internet.

Students also visited innovative PDS sites at the early childhood, elementary, middle, and secondary levels, that incorporated technology into their learning environments. Sea World Education Center, the Fiesta Texas Education Center, the Southwest Research Institute, and a visit to one of the CEDE business partners have also been on the agenda.

The two most enthusiastically received trips have been to the YO Ranch near Kerrville, Texas and to the Children's Association for Maximum Potential (Camp CAMP). The YO Ranch adventure consisted of a ropes challenge course and a team-building experiences course. Camp CAMP is a summer program for children who are so medically, emotionally or physically challenged that they would be unable to attend other camp programs. The CEDE students were particularly drawn to this population and were encouraged to have hands-on experiences with the campers while there. CEDE students have taken this challenge and as a result in the summer of 1994, for example, six CEDE high school student volunteered their time at camp after the completion of the CEDE program.

In addition to the "field trips," seminars were held to provide information on financial aid, college admission procedures, SAT and ACT review procedures. Sessions on innovative classroom technology, programs for the future in a "fair" format, and a discussion on gangs and violence in the schools sponsored by the Bexar County Probation's Department have also been held.

The College Institute

As with the High School Institute, the College Institute has been held since 1993. College and university students apply for the CEDE college program through their own respective schools. They are given a scholarship to attend and three hours of credit through each college and university participating in the program.

The agenda is primarily the same for both the university and high school cohorts; however, the university format deletes college information and provides instead teacher certification information. Additionally, students have an opportunity to meet with a panel of teachers representing various grade levels and areas of specialization. This panel of teachers provides the college students with insights into the challenges of a teaching career.

In addition to preparing and editing a newspaper of their experiences, as the high school group does, the collegiate cohort must also develop an individual portfolio. The portfolio includes a daily journal, a review of at least five current education articles, a resume and a personal, autobiographical, section. These portfolios are presented orally to the entire group on the final day of the program and then given to respective professors from each of the universities for further evaluation.

As with the high school institute, one of the primary goals of the college institute is to recruit minority groups into teacher education programs. Over the its first three years, the CEDE College Institute has attracted 40 college students, of whom seventy (70%) percent were minority; ninety five percent (92%) of whom were female.

Evaluation

In an effort to evaluate the Summer Institute program a ten item questionnaire that focused on programmatic and affective queries was mailed to all of the students who had enrolled in either the CEDE High School or College Institute in 1993, 1994, or 1995. One hundred and twenty (120), of one hundred and fifty (155) participants current addresses were available. Of the 120, twenty five were returned as undeliverable. Thirty one (31) questionnaires (40%) were returned in completed form. Of the thirty one, 25 had attended the High School Institute and six had attended the College Institute. Since the numbers were small, responses were analyzed in aggregate form and were not broken out by High School or College responses. Completed forms from minorities constituted 82%. Over 90% of the respondents were female.

Twenty nine of the respondents indicated that they still intended to pursue a career in education. Fifteen of this group indicated that the CEDE Summer Institute influenced or strengthened their decision to go into teaching.

The students noted that "CEDE helped me to confirm my decision to teach and remove any doubts I had." Another stated that " I've always known that I wanted to teach but wasn't sure I had "what it takes." CEDE showed me that there isn't just one way to define a teacher and that YES I do have "what it takes."

The participants indicated that the most meaningful parts of the institute were related to: (1). interaction and visits with teachers and students in school site settings that used technology; here a student noted that " it was the actual times we went to schools and interacted with children that affected me the most." (2). working with children; especially during CAMP Camp trip; a youngster stated that " these visits encouraged my decision to teach." (3). bonding activities including the ropes course at the YO Ranch; commentary here noted that " The most meaningful part of the program was the bond, the oneness, the unity we all had as aspiring potential teachers. We all shared a belief. Strangers became friends." and (4). use of technology in educational oriented activities; " CEDE taught me that there is more than one way to teach and that education doesn't always occur in a school."

Commentary

The CEDE Summer Institute experience has been a success from its inception. The goal to encourage minority students to enter the teaching profession has been met and constantly reinforced through the institutes determination to attract a full spectrum of students to become professional educators.

The use of school sites as teaching laboratories has helped strengthen CEDE's ties to the teaching community and made the program as realistic as possible. The notion that one can learn best through actual observation and interaction rather than from mere abstractions is a constant part of these efforts.

Further, CEDE has helped students understand their particular academic and interpersonal skills that can contribute to the teaching profession. It has done this through activities that bring students together showing them that they have the ability to work with groups and as individuals in problem solving situations. These are the very skills that all classroom teachers need if they are to be successful.

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Better Prepared Teachers Through Technology and Cognitive Coaching

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The call for reform in public education and teacher education has been directed toward both public education and teacher education programs (Commeyras, Rienking, Heuback, Pangucco, 1993; Dixson, and Ishler, 1992; Goodlad; 1984, Holmes Group, 1986, 1990). The Holmes Group (1986, p. 56) advocated that a design for improvement in tomorrow's schools is found in the structure of the professional school, as a collaboration between universities and public schools. These professional schools would bring practicing teachers and administrators together with university faculty in a partnership to improve teaching and learning by students at both institutions. Various approaches, both traditional and innovative, have been used to support this venture, in a search to find the most effective and efficient way to provide educational experiences for all involved. This paper describes how one university and it's surrounding public schools have addressed this issue by joining forces to enhance the learning of both the public school students and the university's preservice teachers. The team has joined together to use a combination of technology and both new and traditional teaching methods to improve the skills and abilities of preservice teachers. One approach to this issue combines the concept of cognitive coaching with the infusion of technology into both the professional teacher education courses and the public school classrooms into which these preservice teachers have been placed.

Using technology as a widely recognized and necessary tool and cognitive coaching as a valuable technique, the collaborative team received greater insight into what an ideal teacher education program should contain and offer its preservice teachers. Technology and cognitive coaching added a new dimension to the professional course sequence and the students' field experiences, supporting the instructional decision-making processes of preservice teachers.

Cognitive Coaching

Cognitive coaching, one of the new buzz words in education, is a supervisory/peer coaching model that supports informed teacher decision-making. It is a nonjudgemental process that is built around a planning conference, observation, and a reflecting conference. Anyone in the educational setting can become a cognitive coach—teacher, administrator, department chair, or support personnel. In this program, though, it is the student teacher supervisor who becomes the coach who propels the preservice teacher into making decisions about teaching.

Cognitive coaching is organized around three major goals:

1. establishing and maintaining trust, an assured reliance on the character, ability, or strength of someone or something;
2. facilitating mutual learning, which is the engagement and transformation of mental processes and perceptions; and
3. enhancing growth toward holonomy, which is defined in two parts: individuals acting autonomously while simultaneously acting interdependently with the group. (Costa and Garmston, 1994 p. 3)

These three goals help to develop and maintain a fundamental trust which creates a safe environment for learning and change in a preservice teacher. This learning by the preservice teacher and the coaches (both the university supervisor and the public school faculty) encourages all partners to move beyond their present capacities into new behaviors and skills. The entire process is based on incorporating the following:

> ... [the basic] principles of knowledge construction by Jerome Bruner, Jean Piaget, and Hilda Taba; the adult learning theories of Malcolm Knowles; human development sequences based upon the work of Jean Piaget, Lawrence Kohlberg, Frances Fuller, and Eric Erickson; the neurolinguistic studies of

Richard Bandler and John Grinder; and the mediational theories of Reuven Feuerstein. (Costa and Garmston, 1994 p. 3)

When the preservice teacher becomes an autonomous individual the person becomes self-asserting, self-perpetuating, and self-modifying. Then the preservice teacher becomes a member of the school community and begins to function interdependently, recognizing the capacity to both self-regulate and be regulated by the norms, values, and concerns of the larger system. The preservice teacher begins to realize the capacity that influences the values, norms and practices of the entire system. (Costa and Garmston, 1994).

Integrating Technology and Cognitive Coaching

Technology is a tool that assists preservice teachers in becoming self-assertive, self-perpetuating, and self-modifying. In the year-long program, preservice teachers participate in an internship during the first semester, and are residents during the second semester. Fifty to sixty secondary and all-level preservice teachers begin the program by becoming familiar with basic computer skills before or during the internship semester. The students move to advanced computer skills in the resident semester. Students start with discovering why they should learn to use the computer and what it has to offer, and then move through assignments that include sending messages by e-mail, doing research on the internet, and making slide presentations for their classes,—as well as the traditional word processing database and spreadsheet educational applications. By the end of the year many are amazed at what they have accomplished and how valuable the knowledge and skills they have gained will be used in their classrooms.

At the same time, in their seminars they are introduced to cognitive coaching and its purpose. Students work with the same mentor teachers for both semesters, which gives an air of continuity to their year in the field, allowing them to explore and then more fully develop specific areas throughout the year. This continuity is important as the preservice teachers first think and write down their goals in the internship phase, and then clarify, change, or add to these goals during the resident semester. The goals are centered around student achievement, teacher cognitive development and teacher professional development. By the resident semester the preservice teachers, mentor teachers, and university faculty have built a mutual trust and understanding. The university faculty and the public school teacher (mentor) become a team and act as coaches for the preservice teacher. Both coaches conference with the preservice teacher on a weekly basis.

Goal One: Student Achievement

The entire procedure of cognitive coaching is coupled with the use of technology to enhance performance. In accomplishing the first goal, the area of student achievement, preservice teachers develop a database to keep student records, and actually chart and graph student progress. The preservice teachers also show these charts to their students so that the students, themselves, can monitor their own progress as they prepare for the future. For example one preservice teacher charted the progress of her students in a weightlifting program. By the end of the teacher's term, the students, for the first time, could see that they were making progress and they continued the program instead of becoming discouraged and transferring out of the program.

Goal Two: Cognitive Development

For the second goal, the area of cognitive development, preservice teachers find instructional strategies that support their specific subject areas, and materials that will help them improve their skills in classroom organization and management. They modify their instruction in the classroom as they begin to visit different Web sites that show sample lesson plans. For the example, they use search engines to find and then visit sites relevant to their teaching fields, and explore the links found at these sites. Two favorite sites have been the Armadillo WWW server (http://chico.rice.edu/armadillo) and SEARCH—the Cisco Educational Archive (http://sunsite.unc.edu/cisco/schoolhouse.html). The preservice service teachers are coached into integrating what they find into their daily lessons. For example one preservice teacher shared how he had asked his students about fish and their sleeping habits. He did not know the answer to his questions himself, but because he had learned how to get online to get up-to-date information about the science questions, he was able to retrieve his information and start his class the next day with the answer and photos he found online. Another example comes from an art class. A preservice teacher had downloaded, with the help of his mentor teacher, artwork that refined a lesson on drawing lines in a particular way to develop a picture. Students watched as the mentor teacher and the preservice teacher team taught the lesson from the monitor. Students in both of these instances enjoyed and learned the latest information from the Web.

Preservice teachers visit their university supervisor's web page (http://www.tamu-commerce.edu/coe/shed/justice) to look at multicultural lessons and to visit other sites that help them understand and work with special students. In addition to visiting these sites, preservice service teachers are encouraged to produce their own activities that can be added to some of the sites or share what they have done by sending responses to certain home pages. These activities give preservice teachers a chance to really think and evaluate what they see others do and what they actually do in their classrooms.

Goal Three: Professional Growth

For the final goal, professional growth, the teachers visit premiere educational organizational sites, and also look at job opportunities on TENET, the Texas Educational NETwork. From the TENET web site (http://www.tenet.edu), preservice teachers are able to access information about each district in the state. They get a chance to decide upon the district in which they would like to teach and began to learn about the districts before they interview with prospective personnel directors at the job fair that is held each year on the university campus. Students are also able to look at the professional organizations in the state and begin to decide on which ones will be an asset to them.

Online Communication

After the initial development of their goals, the preservice teachers communicate with the supervising teacher through e-mail. Coaching takes place online and in person. They share their experiences based on the three goals and evaluate their teaching experiences by sending journal reflections to the coaches (university faculty, public school teacher, and peers). Some of these personal reflections have included asking for advice when conferencing with parents; asking questions about seminar assignments and student classroom behavior; and discussing the ups and downs of their experiences. In addition, they communicate with their peers online to get support about some of their ideas, and they share and ask for advice about what they have learned. The computer facilitates this sharing and coaching.

Students also communicate with other professionals who teach in their subject area. This helps them understand the process of what other professionals go through when they are planning lessons. These professionals (other teachers) give them tips that assist them in organizing their classroom and in the how-to-skill of applying instructional strategies and management techniques. Since textbooks cannot be replaced every year, the information that is given by these professionals is more up-to-date material than they are apt to find in their schools. This online contact has richly added to the improvement of their lessons, especially when they are also able to get tips on student motivation, learning styles, multicultural materials, government documents, biographies of scientist or authors, and news magazine articles. Preservice teachers have included some of this information in the presentations that they have made in their classes. These preservice teachers have discovered that the Web has actually added personality, depth, and breath to their original information. A favorite site for these types of information is the Classroom Connect web site, at http://www.classroom.net/.

The Portfolio

The preservice teacher ends the semester with a portfolio that demonstrates personal and professional growth. The portfolio is an appropriate vehicle for metacognitive awareness. All of the coaches can see a term's work through the goals performed and reflected upon through the use of technology. The goals that are included grow out of interactive experiences and are not imposed from the outside. The specifics are important to the author because of the reflective change that could not be foreseen in the area of both personal and professional growth.

The portfolios contain students' vita, philosophy of teaching, and the three goals that they have achieved throughout the semester. This portfolio can assist them is seeking employment, but most of all, it helps them measure *their* students' growth under their supervision and their own growth and development as a teacher. In addition, they are able to move on to advanced technological skills that include building their own web pages, using other technology in the classroom, and helping their students communicate with other students electronically.

Summary

Research indicates that teaching is a complex intellectual activity and that preservice teachers who think at a higher level produce students who are higher achieving, more cooperative, and better problem solvers. Using technology enables preservice teachers to arrange their environment not only to enhance intellectual capacities but also to modify themselves.

If teaching is an art, the selection and identification of creative talents and abilities may be at the core of changing the kind of students that are training to become teachers; however if teaching is a science, then tested and verifiable training experience may be the answer. If, as Gage (1972) states, teaching is an instrumental art, then one may need a combined approach to producing good teachers. The cognitive coaching model used in conjunction with a variety of technologies, assist pre-service teachers in cognitive development that promotes a deep understanding that may not be present in programs that do not combine a theoretical frame for developing and interpreting practice. Combining cognitive coaching with the use of technology is one such innovative approach, and anyone who is involved with it can understand that it is definitely producing a new breed of teachers.

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TECHNOLOGY AND CHANGE IN SCHOOLS: THE ROLES OF STUDENT TEACHERS

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I think it's energizing to have a student teacher. I think they keep you current. I was very impressed. Jackie knew her word processor very well. She had the Powerbook since the very beginning. She was very comfortable with email. She was very comfortable with using any of the programs. It didn't scare her to go in, pop in a program, and to play around with it. That, from a technological standpoint, I think is a real breakthrough. As compared to last year, while I had a terrific student teacher, technology was not a real strong suit. She just hadn't been exposed to it. And the year before that even less.... The young people always keep me really thinking, "Am I doing what I need to be doing?" (Sarah, interview, May 5, 1994)

We do not often think of student teachers as change agents. Their role is that of apprentice and student, learning to be good teachers. Change agents come into situations as experts ready to transform a situation.

The nature of school is such that it is slow to change. From an organizational standpoint, it is almost a closed system with few avenues of input from the outside. Student teachers can be one of the few sources of input and new ideas for a school. This exaggerates their role as change agents and places them in the conflicting position of students and change agents at the same time.

Because of this conflict, student teachers can have a wide range of functions in supporting technology and change in the schools. Sometimes they initiate change and bring in new ideas; sometimes they directly support the efforts of teachers to change their classrooms with technology; and sometimes they indirectly support teachers' change efforts.

I spent several months at Burnham Elementary School (this and all other names in this paper are pseudonyms to protect the anonymity of the participants) as part of a qualitative study of support for technology and innovation. In this paper, I discuss a continuum on which student teachers live: from student to teacher, and I discuss the kinds of things I observed student teachers doing to support technology and how these things fit on the continuum. I tie student teacher support into a theoretical context of organizational theory, situated-evaluation, and a theory of support for innovation.

Research Methodology: Ethnography, Case Study and Situated-Evaluation

This study combines methods of ethnography, case study, and situated-evaluation. I combine my experience and my interpretations of the experiences of the participants to build an understanding of what I observed and how it relates to support for innovation.

In parts of the 1992-93 and 1993-94 school years, I spent several hours each week at Burnham Elementary School observing classes, talking informally to teachers, interviewing teachers, and attending school and district Technology Committee meetings.

Situated-Evaluation and Support for Technology

Situated-evaluation is an important theoretical basis for my approach to this research. Bruce (1993) contrasts traditional views of an innovation as the chief actor in a situation with the situated-evaluation view:

> In reality, the innovation is but one small addition to a complex social system. Instead of seeing it as the primary instrument of change, it is better to see it as a tool that is incorporated into ongoing processes of change.
>
> We are thus led to a different model for implementation of innovations. In this model, the active agents are not innovations, but the participants in the setting in which the innovation is placed. Participants interpret the innovation and then re-create it as they adapt it to fit with institutional and physical constraints, and with their own goals and practices. (p. 17)

750

In this view of innovation:

1. The participants in the setting are the chief actors.
2. The innovation is an idealization that will be achieved more or less when brought into the real situation.
3. This idealization is interpreted and recreated by the participants in the setting to adapt it to fit the context and constraints of the setting.
4. Every situation is different, so the innovation-in-context will be different for every context.

Situated-evaluation is an important way to look at support because it helps us understand why support does not always meet its objectives. A situated-evaluation approach might find that the support was inadequate because the designers of the support did not account for the contexts and constraints of the situation, or it might bring about a better understanding of how the situation and the support interact to provide different, not necessarily better or worse, support than what was originally intended.

Research Procedures

In this ethnographic study (Marcovitz, 1996), I developed new models for support and innovation by looking closely at support for technology and the use of technology in three 3rd and 4th grade classes at Burnham Elementary School. I spent most of my time with these three classes and their teachers: Sarah, Jennifer, and Cindy. I also looked more broadly at the 3rd/4th grade of Burnham Elementary School, the school in general, and the district.

I began my study by looking at the impact of changes in the school, especially the change in principal and the change in computer coordinator. Those changes were rich sources of information and comparison data, but they were not the primary focus of the study. Even the three teachers who were the primary participants in the study became the context of the study, rather than the primary focus. By the end, the study focused on models of support and innovation as they applied to the situations in the three classes and at the school and district more generally.

The Roles of Student Teachers

Student Teaching Programs

Burnham Elementary School is near a major university that provides most of the student teachers. The university has three student teaching programs: the junior practicum, the standard semester-long placement, and the Full Year Program.

The junior practicum provides juniors with a limited exposure, a few hours per week for a few weeks, to a classroom.

The standard semester-long placement is a one semester assignment in one classroom that culminates at the end of the semester in a three week take-over period during which time the student teacher is almost completely in charge of the class.

The Full Year Program is a two semester assignment in which the student teacher spends time in three different classrooms. The Full Year students are loaned Powerbook Macintosh computers for the year to facilitate communication among the students and their university supervisors.

The Student to Teacher Continuum

Student teachers' primary function is to learn. They are students. They are not in schools to act as direct or indirect supporters of change.

> First of all, that is not a criteria that they are for support. That is not at all. In fact, people who say, "I want a student teacher because I'm going to have an extra pair of hands in the room," is one of the first indicators that you don't want a student teacher for the right reasons, the reasons that you can model and teach a student. So I really disagree with that. They can be support. Daniel [Cindy's student teacher in the spring] was support, but there are many student teachers out there that are of no support; they're more work for a teacher. (Cindy, interview, May 16, 1994)

Student teachers never completely escape their student role; their function is to learn to teach and practice being teachers. But at times, they are teachers. The roles of student and teacher form the ends of a continuum of roles. At Burnham, I observed four somewhat distinct roles for student teachers that lie along the continuum: student; adult; adult plus; teacher.

These roles are not completely distinct in two ways. First, any given action can be interpreted in different ways and be interpreted, for example, as more or less like the action of a teacher. Second, the student teacher is usually acting in multiple ways, and at any one time could be in several different roles.

Student Role. In the student role, the purpose of the student's actions is to learn about teaching. This can take the form of observing and talking to the teacher. In some cases, it can interfere:

> Cindy told a story about a student teacher who used to constantly take notes. She found the practice a little disturbing, especially at a parent-teacher conference. She said that parents are already uncomfortable about having a student teacher at a the conference, and it was inappropriate for him to be taking notes. (fieldnotes, informal conversation with Cindy, September 30, 1993)

Adult Role. In the adult role, the student teacher is acting like any adult volunteer would in the classroom. The student teacher's role does not require any special training or status.

Sarah [the teacher] decided that Ken [3rd grade student] should write down the directions for what he did so he could remember. Sarah got Ken to tell Anne [the student teacher] what he did so she could write it down. (fieldnotes, Sarah's after-school program, October 26, 1993)

In this example, Anne is doing something that any adult volunteer could have done.

Adult Plus Role. In the adult plus role, the student teacher is doing something special that most adult volunteers would not do. Volunteers might perform these tasks, but the tasks would generally require some training or status. The adult plus role includes disciplining students for misbehavior, spending time alone with the class (a privilege reserved exclusively for certified teachers, substitutes, and student teachers), working on special projects with students, and providing special expertise. Jennifer had a difficult class, and she spoke about how someone, such as a student teacher, could be very helpful to her.

[Jennifer] said that her class is unmanageable. She can't spend time with one student because if she turns her back, the rest of the students will be out of control. She said that if she had a student teacher or someone else who could be involved with the rest of the students, she could work with one student on the computer to show them some of the advanced features of ClarisWorks. While she is by herself, she can't work with one or a few students on the computer. (fieldnotes, interview with Jennifer, December 16, 1993)

Teacher Role. In the teacher role, the student teacher does things that are generally done by teachers. This is most evident during take-over when the student teacher has primary responsibility for the class. This also can be seen when student teachers give instructions and permission to students.

Renee and Terri finished. Connie [the student teacher] showed them how to save and told them they could go around and help others. (fieldnotes, Cindy's class at the university computer lab, October 5, 1993)

The four levels on the continuum are merely marking places, not absolutes. In most cases, student teachers are working in multiple roles, and any given role falls somewhere between the marking places listed here.

Support for Technology

Student teachers support the use of technology in different ways, some of which provide direct support to the teacher's use of technology, and others indirect support.

I observed nine functions of student teachers that support the use of technology in the classroom, and that can be classified along the student to teacher continuum. These functions and their categories are:

1. take-over, teacher
2. teamwork, teacher
3. projects, teacher
4. future, teacher
5. alone with class, teacher or adult plus
6. university resources, adult plus
7. discipline, adult plus
8. expertise, adult plus
9. general help, adult

Take-Over. During take-over student teachers provide indirect support for technology. The purpose of take-over is to provide student teachers with a practice teaching experience. But if take-over goes well, the student teacher is in charge of the class for three weeks, giving the teacher a three-week period to spend time away from the classroom or working on special projects, including technology projects, with a few students at a time.

Sarah had several computer applications she wanted to teach her students during the school year. She said she plans to concentrate on Hypercard, Hyperstudio, Lego Logo, and ClarisWorks-in-the-Classroom.... She said she is going to pull students out to work on these things while the student teacher is in take-over. (fieldnotes, interview with Sarah, March 10, 1994)

While the three-week take-over period did not provide Sarah enough time to do everything she wanted to do with technology, it did serve as a time to take steps toward her goal of integrating technology throughout her curriculum.

Teamwork. "What's nice about having them [student teachers] is the teamwork. You feel like there is a lot of brainstorming that goes on when you're creating units" (Sarah, interview, May 5, 1994). Sarah reported a sense of teamwork from her student teachers that allows her and her student teacher to bounce new ideas off of each other and exposes her to new ideas. Cindy warned that some student teachers never reach a point where they are helpful, but others are "naturals:"

It works out lovely if you do [have a good student teacher], and many of us have very good teachers. These are the naturals, that I call them, so we didn't have to spend as much time training them, but we were able to immediately draw them into co-teaching with us, this teacher associate idea. (Cindy, interview, May 16, 1994)

Graham (1993) discusses the potential for conflict and uncertainty as well as the potential for teamwork and growth:

But this shared situation also creates an opportunity for genuine collaboration—a dynamic which engages and alters both teacher and student teacher as they explore each other's intentions and reflect upon their shared work and teaching context. Faced with such a task, their relationship has the potential to become "joint work," the kind of collaboration most likely to lead to sustained professional growth and change. (pp. 213-214)

Projects. Cindy's class participated in the TeleOlympics, a project in which students compete in athletic competitions and email the results to other schools to be tabulated. As part of the TeleOlympics project, Daniel (Cindy's student teacher) organized the results in a spreadsheet. Cindy would have had difficulty doing this without Daniel. He offered computer expertise: while Cindy was comfortable with word processing, her experience with spreadsheets was limited. He offered an extra helper: this was a labor intensive project because the students could not do most of the computer work themselves—they had not learned spreadsheets, and the email was set up so that Daniel had to send the messages for the students—so Cindy would not have been able to spend the time on this project without her student teacher.

Future. With networking technology, schools across the country and around the world have more of an opportunity than in the past to communicate with one another and participate in joint projects. One implication for this is that student teachers can maintain a relationship with their cooperating teachers once they move to their own classrooms in other schools. For example, Daniel expressed an interest in continuing his contact with Cindy, "Daniel wants to get involved in TeleOlympics and do email with my class wherever he is."

Alone With Class. At Burnham Elementary School, only certified teachers are allowed to spend time alone with the class. The exception to this is student teachers. This issue was most prominent in Jennifer's class because she had an aide who was not certified, and Jennifer could not leave the class alone with her for extended periods of time. In take-over, student teachers provide long periods of time that the teacher is free to leave the room. At other times, when the student teacher is ready, the teacher can leave the class alone with the student teacher in order to attend meetings or prepare for the class.

University Resources. As part of the Full Year Program, the student teachers are provided with Powerbook Macintoshes. Cindy suggested that the student teachers be encouraged to bring their Powerbooks to the classroom to use as an extra computer. Both Daniel (Cindy's student teacher) and Jackie (Sarah's student teacher) brought their Powerbooks into the classroom regularly. "It was great, as far as the technology goes, to have these people because they were specifically trained [with technology]" (Cindy, interview, May 16, 1994).

The Powerbooks were brought into existing situations: classrooms that are trying to use computers and finding that they could use more. The support was being altered in two ways. First, the teachers were asking the students to bring their Powerbooks into the classroom to use as an extra computer. Second, some teachers were asking if they could use the Powerbooks outside of school. What started as support for student teachers was altered to become support for teachers and classrooms.

Discipline. In my observations, parent volunteers rarely disciplined students for misbehaving, but student teachers did regularly. This provided indirect support for technology by allowing teachers to work with small groups of students while student teachers maintained order in the rest of the class.

Expertise. Some student teachers, especially those in the Full Year Program had training and expertise with technology. This allowed them to work on additional projects and offer support for the teacher's projects. For example, when Cindy was showing her class some of the basics of Microsoft Word, Connie (her student teacher) helped her with some of the things she was not sure about.

In Connie's case, Cindy was fairly new to word processing, and Connie was more advanced, so she was able to help Cindy with some of the basic features of the word processor. In Daniel's case, he was fairly proficient with several aspects of the computer, such as email and word processing, so he was able to do computer projects with the class.

General Help. Although the purpose of student teachers is not to provide an extra pair of hands for the teacher, they often serve this purpose. For technology, this was especially evident when the teacher took classes to the university computer laboratory. In this lab, the students worked on computers to learn educational games and computer applications. As the students played the games, or worked on the word processing activities, they asked many questions, including: asking permission to go to the bathroom; asking basic technical questions such as "Where is the delete key;" asking questions about the assignment; asking for reading help. When student teachers or other adults were present, they answered these questions. In many cases the questions were simple enough that any adult could answer them, but this helped relieve the burden for the teacher.

Discussion

Student Teachers and the Organization of Schools

Scott (1987) discusses organizations in terms of open systems. The way an organization interacts with its environment can have a major impact on the organization—the more open the organization, the more significant the role of the environment.

Structurally, schools' organizations are set up in such a way that contact with the environment is limited. Other than contact with their students and students' parents, teachers get a great deal of information filtered down to them through principals. This limitation on the interaction with outside limits the information which teachers can receive.

Teachers do have contacts with the environment. One of the significant contacts can be through student teachers. As Sarah said, "The young people always keep me really, 'Am I doing what I need to be doing?'" (Sarah, interview, May 5, 1994). Firestone (1989) suggests that district-level policies filtering down to the schools are the main influence on school change. But he also discusses support: "Sometimes a school lacks the knowledge or skills to do what is required to use reform. Sometimes it lacks the personnel, time, and materials" (p. 161). While Firestone (1989) discusses what the district should do to target support to the needs of the school, in some cases, support exists from factors in the environment, such as student teachers.

Rising Credibility and Rising Proximity

Marcovitz (1996) extends models of innovation and support (e.g., Hall & Hord, 1987; Strudler, 1991) by creating a model of support for technology in which the goals of support are support-received and inspiration. These goals are influenced by credibility of the supporter, proximity of the support, and relevance of the support.

In addition to support teachers receive from student teachers, student teachers provide inspiration. Sarah spoke about the student teacher as "energizing," giving her the opportunity to discuss ideas and reflect on her practice. In a way, the student teacher provides the opportunity for the teacher to inspire herself by reflecting on her practice, validating some of her old ideas and challenging others.

In terms of support-received, student teachers have high proximity: they are in the classroom on a daily basis. Credibility and relevance vary based on the student teacher's different roles.

In the *adult* role credibility and relevance are not an issue because the student teacher is generally being directed by the teacher to what the teacher feels is relevant. However, both credibility and relevance can be a factor based on the teacher's trust in the student teacher (credibility) and the student teacher's abilities. Anyone can monitor students at the computer, but the teacher might not rely on someone with no computer background to be of any assistance.

As credibility and relevance increase, the teacher can place the student teacher into more of an *adult plus* role, relying on the student teacher for expertise and discipline.

With enough credibility and relevance, the student teacher can take the *teacher* role. All student teachers are placed in the *teacher* role for the take-over period, but the amount of support that is to the teacher varies based on relevance and credibility. The class remains the responsibility of the teacher, who must feel comfortable leaving the student teacher alone with the class to go work on other projects.

The amount of support-received from the student teacher varies as the teacher can use the student teacher in roles of increasing responsibility along the student to teacher continuum. This generally follows how relevant the ideas of the student teacher are perceived to be and how much credibility the student teacher has.

Summary

Although student teachers are not placed in classrooms to provide support to the teachers, they often do provide support at various levels in roles ranging from student to teacher.

Technologically knowledgeable student teachers can provide direct support by being technical consultants, working on projects with students, and bringing teachers up-to-date information about the use of technology in classrooms.

Student teachers can provide indirect support for technology by taking care of students (teaching large or small segments of the class, disciplining students, providing an extra pair of adult hands), allowing the teacher to do technology projects with the whole class, small groups, or individuals.

Student teachers can bring new ideas to teachers, energize teachers, and provide a sense of teamwork for teachers.

Regardless of the intention of student teacher programs, student teachers can provide support to teachers. For at least a short time, student teachers are part of the classroom, not isolated from the teachers, and in some cases, are able to help implement projects on a day-to-day basis. Due to a need for day-to-day help with technology, some teachers have partially recreated the role of the student teacher to be an integral part of support for technology.

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PRESERVICE TEACHERS AS MENTORS DURING AN EARLY FIELD EXPERIENCE THROUGH ELECTRONIC COMMUNICATION (E-MAIL)

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In 1989, Paese wrote, "The field experience component has always been a vital part of teacher education programs" (Paese, 1989, p. 18). With a national emphasis on educational reform both The Holmes Group (1986) and The Carnegie Task Force (1986) agree that field experiences should be an integral part of teacher education programs. Because field experiences function as a critical link between formal teacher training and apprenticeships researchers should study what happens to students in the field (Dodds, 1989). These early field experiences provide information to students so they can determine their suitability for the teaching profession, orient preservice teachers to schools, and begin the socialization process for potential teachers (Dueck, Altmann, Haslett, & Latimer, 1984).

Mentoring might be one way to develop more effective field experiences for preservice teachers. Bey (1990) noted that mentoring in education has developed along with the growth of support programs for preservice and inservice teachers. Mentoring traditionally refers to a relationship where experienced teachers work with new teachers to strengthen their teaching skills and assist them in the ongoing process of becoming a teacher.

Encouraging peer support during teacher training has been investigated (Dodds, 1975; Verabioff, 1983). A peer assessment model became a viable way for preservice teachers to support one another in the student teaching environment. Peer tutoring is another strategy designed to allow a student to teach another student of approximately the same age and skill level (Cooke, Heron, & Heward, 1983). While providing useful information these investigations have focused on traditional methods of conducting preservice teaching field experiences or traditional mentoring relationships. Future investigations should include other innovative training methods as well as examining the role of technology and electronic communication in the process of educating preservice teachers.

Telecommunications, and specifically electronic mail (e-mail) systems are available on most academic campuses. These systems transmit messages in seconds and it has been suggested that they could become the arena for teachers to share ideas, teaching plans, and problems without having to leave the classroom (Bull, Harris, Lloyd, & Short, 1989; D'Souza, 1992; Eiser, 1990). E-mail has been studied to determine its function and usefulness (Durham & Sunal, 1991), its role as a supplement to classroom communications (D'Souza, 1991; Poling, 1994; Schrum, 1988, 1991), and its usefulness in facilitating collaborative opportunities (Buchanan, Rush, Krockover, & Lehman, 1993; Rush, 1993).

"Every day hundreds of thousands of people are communicating through the Internet" allowing individuals to become friends without ever having met (LaQuey, 1993, p. 41). "Handicaps and disabilities make no difference" when people are communicating through e-mail and online communication (LaQuey, 1993, p. 41). E-mail "eliminates barriers" and prevents communicators from "making judgments" about those with whom they are communicating with based on appearance or voice (LaQuey, 1993, p. 41). The advantages of e-mail are several. It is a cheaper way of communicating especially if the communication requires long distance phone charges. Messages can be delivered in seconds with no waiting for a written message to be delivered to colleagues in another country (Kent, 1994). Since the connection is asynchronous (not at the same time) e-mail is also convenient to use. Users can send and exchange messages at their own convenience rather than having to worry about time zones or opportunities to connect through telephone (Kent, 1994; LaQuey, 1993). E-mail does have some limitations. Messages are in text form and cannot contain special formatting such as italics or underlining as is used in word processing. A limitation for many is the lack of interpersonal face to face communication. E-mail is a form of conversation, but it is less formal than written letters and lacks inflections found in verbal conversations (Kent, 1994). While there are some ways to communicate emotions using e-mail (symbols) messages can also be misinterpreted more easily due to the casual form of this communication (LaQuey, 1993). Aside from these limitations, "electronic mail is the most popular application in use on the Internet today" (LaQuey, 1993, p. 42).

Teacher preparation programs have utilized e-mail as a way to establish and maintain communication between new teachers, experienced teachers, and university professors (Eskridge & Langer, 1992, 1993), and as support for student teachers (Casey & Vogt, 1994; Hoover, 1994; Lowe, 1993; Thompson & Hamilton, 1991). The potential impact of telecommunications on communication during preservice teachers' field experiences and other aspects of teacher education requires further investigation. Establishing a communication link between cohort groups of preservice teachers would seem to be a valuable part of their preservice educational process (Eskridge & Langer, 1992 ;1993). As yet, there are no studies that have looked at the use of e-mail in a physical education preservice teacher training program.

Purpose

The purposes of this study were to determine if field experience students' could provide one another with support, guidance, and pedagogical feedback concerning classroom issues using e-mail, and to gain the students' perspective on the use of electronic communication in the field experience process.

Subjects

Subjects were 23 juniors in the methods year of a Physical Education Teacher Education program. Selection of this population was determined by the following criteria: access to computers and electronic mail (e-mail) accounts, basic computer knowledge, involvement in a teaching experience, and researcher access. All subjects were enrolled in a secondary teaching methods course and had previously been taught introductory managerial techniques and teaching strategies. These preservice teachers had taken a basic computer skills course prior to the study and utilized e-mail in another course. These subjects were members of a teacher education physical education cohort group and had been in classes together for a period of two and a half years. They had a well established social system and were considered both a social and academic group. Technologically, these subjects were novices with no established communication network, academically or socially. These characteristics were specific to these subjects.

Data Collection

E-mail reflector lists, were established for subject use during this project and were monitored by the researcher. Messages posted to reflector lists were sent to subjects on the list for their access and reading.

Six major sources of data were collected for five weeks and included subject participation in e-mail tasks such as posting teaching questions, responding to peers' questions, and maintaining weekly journals. Subjects also completed pretest and posttest surveys, one week e-mail logs, and participated in group interviews.

Subjects were asked to reflect upon their teaching and utilized their e-mail accounts to post queries to their peers on the reflector list. In addition to posting a query, subjects were asked to react to at least two other posted queries. Peer reactions took the form of ideas, suggestions, and other pedagogical feedback to their peers concerning their queries. Both queries and peer reactions went to all reflector list participants and the researcher.

Weekly journals were also submitted and followed an established question format intended to probe and encourage subject responses concerning this study. During the five week data collection a one week e-mail log was also completed by the subjects. E-mail logs were used to determine types and frequency of messages send by participants.

A small group interview was conducted with each of the three reflector list groups at the end of the five weeks. All interviews utilized a semi-structured format which included questions concerning positive aspects of e-mail communication, drawbacks to e-mail, comparison of identified benefits and drawbacks, and hypothetical future situations in which the subjects would use e-mail for communication.

Upon completion of the field experience subjects were administered the Delcourt and Kinzie (1993) Attitudes Toward Computer Technologies and modified Self-Efficacy for Computer Technology survey for preservice teacher educators. This survey was administered in a pretest and posttest methodology.

Data Analysis

Queries were read and reread until primary foci emerged (Patton, 1990). Focus categories were inductively derived and included five categories; instruction, management, student behavior, and other. All queries were coded into one of the categories.

Peer responses were read in the same manner and categories emerged. These categories were determined by their agreement or disagreement with the query and whether they provided alternative suggestions or strategies. This categorization was confirmed by a colleague who read all of the subjects' peer responses and categorized them in the same manner as the researcher. The categories included agreement, agreement plus strategy, strategy only, disagreement plus strategy, disagreement.

Journals were read to ascertain subjects' perceptions of whether or not their field experience peers could provide assistance concerning classroom issues using e-mail communication. They were also examined for subjects' perceptions of the usefulness of peer feedback, ideas, or alternative strategies provided in peer responses. Since journals followed a question format, each question was analyzed individually by the researcher.

Analysis of questionnaires was conducted through a comparison between changes in individual item mean scores and shifts in individual item responses (Gravetter & Wallnau, 1992). A simple t-test was utilized to further evaluate the surveys. A t-test is "used to test for significant differences between statistical measures of two samples" (Burns & Grove, 1995).

E-mail logs were examined to determine types of messages sent and possible changes in e-mail use by participants. Data were used to determine the number of connections, average connection time per use, and the preferred day of the week to use e-mail for all participants.

Three small group interviews were used to determine subjects' perceptions and attitudes concerning this project and the use of e-mail. Participants were asked to identify benefits and disadvantages of e-mail communication as well as their perceptions on future potential uses in their careers and lives. Each question had an individual categorization of patterns or themes depending on the question focus and the types of responses received.

Queries, peer responses, journal responses, and group interview categories were confirmed by a colleague who read all of the entries and categorized them in the same manner as the researcher with 100% agreement.

Results

After reflecting upon their teaching these subjects were able to describe their lessons and pose questions to their peers using e-mail. The lesson descriptions were detailed enough so that their teaching colleagues who had not observed the lesson were able to interpret what had occurred and develop ideas and strategies concerning the lesson. In addition to merely posing questions, subjects sought the advice of their peers in their postings. Preservice teachers focused on instructional aspects of teaching most often in their queries.

These subjects were able to read their peers' questions, interpret them, and respond by posting feedback using e-mail. Additionally, they were able to be positive in their responses. While a few subjects were able to provide some criticism to their peers concerning their teaching, the negative comments were always accompanied by strategies.

Journals provided the subjects' perceptions concerning the use of e-mail and this mentoring study. Information from the journals indicates that subjects were able to read their peers' responses and interpret the pedagogical feedback that was given. Also, they were able to determine if this feedback could be useful if applied to future teaching episodes and if it was supportive in nature. Subjects reported feeling more confident in their teaching as a result of peer feedback. As a result of being able to understand the feedback many subjects indicated that changes in their upcoming lesson plans would occur.

E-mail logs revealed that most of the messages sent were a requirement of the study. While there was a small percent of messages sent concerning other academic issues, e-mail clearly was not something these subjects used to accomplish communication with professors or instructors. Requiring the e-mail messages from the subjects was viewed as a motivating factor for those who had difficulty with the e-mail system during the study.

There was no significant change in subjects attitudes toward computer technology during this study. Subjects did have a significant change toward increased self-efficacy in this study.

Subjects were able to verbalize their thoughts and perceptions concerning e-mail during the interviews. Answers to the questions posed were similar among all participants during the group interviews. These subjects seemed to value the use of e-mail, specifically noting the ease of communication. The subjects also liked the aspect of being able to send messages and communicate without the other individual necessarily being at home. The greatest complaint that these subjects had revolved around the issue of difficulty with access. Typically the subjects who had e-mail access at home were more positive about using this type of communication. Overall the subjects did believe that the benefits of e-mail outweighed the drawbacks they identified.

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Online Teaching Experiences for Preservice Teachers

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The world of education is caught in a bittersweet dilemma. On one hand, we are very excited about the innovations of the modern technological age and the promise technology holds for the field of education. On the other hand, we are perplexed as to how to utilize these technologies to their fullest potential. Many schools are coming online with their own direct connections to the Internet; yet, their teachers are sometimes ill-equipped with good ideas of how to integrate these new technologies into the curriculum (Bernauer, 1996).

This paper focuses on how the Internet is being used to connect students in two small school districts, Central Heights Independent School District (CHISD) and Arp Independent School District (AISD) with preservice teachers at Stephen F. Austin State University (SFASU). Through the Partners for Success project, students in grades 6-12 are gaining a resource to help them academically, while the preservice teachers are gaining telecommunications and teaching experience as "Online Tutors".

Over the past four years, teacher preparation programs in Texas have placed a major emphasis on field-basing their education programs. Stephen F. Austin State University has participated in this effort of putting preservice teachers into the school setting early in their programs. This effort has yielded outstanding results in both teacher preparation and student achievement.

The Partners for Success project took advantage of telecommunications to bring the preservice teachers and secondary students together sooner in the preservice preparation program than ever before. Many of the preservice teachers participating in the project were in their first semester of professional development coursework. Each was assigned as an "Online Tutor" to a student in a secondary school. This gave them an authentic teaching experience at the very beginning of their teacher preparation program. This project was the first implementation of a project of this type at this university.

Project Concept and Objectives

This project consisted of electronic tutoring activities between one hundred twenty (120) preservice Secondary Education preservice teachers at SFASU in Nacogodoches, Texas and one hundred twenty (120) Junior High and High School students at CHISD, in Central Heights, Texas. Both of these institutions have direct Internet connections which they used to facilitate the project. A small number of students from AISD also participated via dial-up connections. University students in the preservice program were paired one-to-one with secondary students (grades 6-12) in an online guiding/tutoring relationship. The project took place over an eight week period during the Fall 1996 semester.

The objectives of the project were:

1. To introduce preservice teachers to the experience of teaching.
2. To provide Junior and Senior High School students an opportunity to interact with a college student.
3. To provide academic help to students in areas of need.
4. To create in the student a greater interest in attending college.
5. To improve the telecommunications skills of participants at all levels.

Project Details and Definitions

Through weekly electronic mail interactions, preservice teachers worked as online tutors to provide assistance in an academic area to their assigned student. The online tutors and the students were each assigned their own individual email addresses and were given the opportunity to check their email and write messages every few days during the project. Each student identified an academic area in which they wanted to improve. The online tutor provided resources which they thought might be of help to the student. These resources included the tutor's own knowledge, references to library materials or textbooks, references to Internet sites, Web pages, hints on study techniques, etc. The students were expected to attempt to use any of the suggestions that seemed appropriate and give feedback to the tutor. In addition, the tutors created World Wide Web pages which acted as a collection of resources for their students or any other student studying similar topics. In addition, another group of preservice teachers who interned on the school campus through the University's field based program were also involved. Their role was to work with the students to help them utilize any instructions or resources received from the online tutor.

Project Results

At the end of the eight week period, the project concluded with the sending of a final message from the online tutor to the student, stating that they had enjoyed working with them and wishing them continued success in school. An informal survey of students, teachers, and online tutors who participated in the project was conducted. The responses from each group of participants are reported below.

Student Responses

1. The CHISD student's telecommunication skills improved from having participated in this project. Sixty-three (63) percent of the students indicated that their telecommunication skills improved somewhat; whereas, twenty-one (21) percent of the students reported experiencing great improvement.
2. The majority of students (80 percent) responded that teachers allowed them to check their email about once per week; however, seventeen (17) percent checked their email every two weeks and two (2) percent check their email less that once every two weeks.
3. Thirty-eight (38) percent of the students indicated that their online tutor was of no help to them; however, thirty-four (34) percent responded that their online tutor was of some help, and twenty-seven (27) showed that their online tutor was a lot of help by providing information for their project or subject area, providing them with Web page addresses, and helping with their telecommunications skills and in other ways.
4. Thirty-two (32) percent indicated that the project positively affected their interest in attending college in that after having corresponded with a college student they are were more interested in attending college that then were when the project began.
5. Eighty-six (86) percent of the students responded that they would participate in this type of project again. Only thirteen (13) percent indicated that they would not participate in this type of project again.

Teacher Responses

Responses from the teachers indicated that students benefited from participating in the program by improving their technology skills and gaining additional knowledge in the academic areas they had identified. Reflections from teachers involved in the project revealed the need for more effective communication among all participants. It should be noted that this project was planned and implemented totally through the use email. In coming semester, face to face visits between the university and school personnel both during the planning and implementation of the project.

Online Tutors' Responses

Ninety-six (96) percent of the SFA online tutors indicated that their telecommunication skills improved as a result of participating in this project however fifty-seven (57) percent of the tutors felt that they were of little or no help to their students. Thirty-nine (39) percent reported that they were of help to their student primarily by providing information for their students to use in a class project and by providing references to web pages that were of interest to the students. Reasons given by those who felt that they were of no help to their online students included that their students never wrote them or wrote them rarely, and that longer periods of time were needed to interact with their students. Online tutors should expect different levels of success in actually being able to help their student in a given area through such a project (O'Neill, Wagner, and Gomez, 1996).

When asked if they felt that future preservice teachers should be required to participate in a project like this, the ninety-one (91) percent of the online tutors said "yes." They went on to say that the experience gives them an opportunity to interact with students and to discover how technology can be used to supplement instruction.

Also, when preservice teachers were asked "What did they learn about being a teacher from having participated in this project?", the responses included the following: Teaching is a two-way process, teachers must be knowledgeable about the nature of the learner, they must possess effective organizational skills, they must have self confidence and patience because they will not have all the answers, and I can help a student more that I thought.

Play It Again

Plans are underway to repeat the project in the Spring semester of 1997. Specific action items have been targeted for improvement of the project during its second implementation. Instead of trying to make all arrangements online, face to face meetings between the university project coordinator and all participating teachers will be held at the beginning, middle, and end of the project. Steps will be taken to monitor the writing activities of both preservice teachers and their online students more closely to insure prompt and meaningful responses to message received. Duration of the project will extended from eight weeks to ten weeks in order to give more time for groups to utilize limited facilities. Teaching interns will play an increased role in helping students to identify their academic area in need of improvement and in the utilization of messages from their online tutor.

Conclusions

Many preservice teachers enter their programs never having experienced the opportunity to teach a child. Although at the beginning of their program they may be unprepared for the classroom experience, modern telecommunications technology makes possible for preservice teachers the experience of interacting with students in remote schools without ever having to leave the university campus.

Online projects require considerable time and effort of all involved. Planning is crucial to prevent any delays in communication. Everyone involved in the project including the project coordinator, university professors, school administrators and teachers, university students, and school students must not only have the technological support and resources for such a project but also have a clear understanding of the project guidelines and an enthusiastic determination to see the project succeed. When these are in place, all participants will benefit.

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Teaching Thinking and Problem Solving with Technology

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The need to teach students to think is not a new idea in American education. Early in this century Dewey (1910) along with other educators called for making the teaching of thinking a goal of formal education. In 1982, the Education Commission of the States concluded that higher order thinking processes should be the "basics" of education (Education Commission of the States, 1982). Robert Sternberg, a leading educator, has asserted that the teaching of thinking should be . . . "the first order of business for school" (Quimby, 1985, p. 53).

Thinking Skills and Strategies

When we discuss the need for schools to teach thinking some people respond that this has always been done. Of course thinking has occurred in schools, however, the quality of thinking has been questionable. Schools have emphasized rote memorization and the accumulation of basic knowledge while putting little emphasis on processes such as problem solving and decision making. Students often make such comments as "Outside school I have to figure things out, but in school I don't have to really think. I just have to remember what the teacher or the textbook said." Because of a concern about the life-long relevancy of much of school learning, the teaching of thinking has become a major focus in education. Information may become outdated. Thinking skills and strategies don't become outdated. They remain constant and useful across content, context, and time (Allen, Hutchinson & Wood, 1995). As Sternberg suggested, the ability to engage in skillful thinking is an important survival skill for society and individuals (Sternberg, 1984).

Thinking can be defined as a search for meaning and at some level is a natural human process. However, quality reflective thinking, like other skills we develop, takes guidance and much practice. Effective skillful thinking does not seem to occur naturally for most people. David Perkins, a Harvard researcher in education, asserts that everyday thinking is as natural as walking. It happens without any formal training. However, to become a skillful effective thinker able to deal with the complicated reality of today requires specialized and specific training. Perkins believes that good thinking is, in fact, often contrary to natural thinking. For example, he states that while we know that good decision making requires that we look at all sides of an issue, this is not a naturally occurring process (Perkins, 1985).

Like the learning of other skills, the process of becoming a good thinker is very much an individual experience. All of the principles of learning and development apply to the learning of thinking. For example, students learn in a variety of ways. What works with one student won't necessarily work with another. Students learn at their own individual pace; they don't all learn at the same rate. However, there is evidence that students at all levels can benefit from strategy training (Allen, 1990).

There are numerous variables which contribute to the swelling tide of educators who believe that the teaching of thinking must become the focal point of education. It is not within the scope of this writing to address all of these variables. However, I will mention briefly three major variables. These include research related to learning and instruction, information issues, and the inability of students to engage in effective higher order thinking processes.

Research

Communications research, the development of technology, and the theoretical approach of the information processing framework have all contributed to a new understanding of instruction and learning. We now know more about how the brain functions, how people process information, and better ways to facilitate learning. Specifically, there is research on which to base the teaching of thinking skills and strategies.

Information Issues

In the past, the role of school was thought to be the dispenser of information. This role is being challenged for at least two reasons. First, the amount of information is increasing at an unbelievable rate. Second, there is a serious lack of agreement on what "information" should be taught in school. Information and knowing are important. However, what is known is constantly changing and therefore information becomes outdated. Thinking skills never become outdated (Sternberg, 1984).

School Learning

The inability of American students to engage in the processes associated with higher order thinking and problem solving has been cited as a major concern

(Altbach, Kelly & Weis, 1985; Glaser, 1984). Also, the lack of transfer of school learning to "real life" has been observed by students, educators, and employers.

According to Beyer (1987), there is more emphasis on improving the thinking of American students today than ever before. This message should be loudly resounding through the halls of the Colleges of Education because unless teacher education programs focus on this approach to teaching, students will be unprepared for the reality of this kind of classroom.

Technology

Another critical aspect of education today relates to the rapid changes occurring in the world. These changes, especially those related to technology, have created challenges which must be addressed in our teacher education programs.

Computers are already in the homes of about one third of the American population and in middle class neighborhoods, up to 75% of families own computers. The prediction is that 80% of all families will have home computers by the year 2000 (Debeham & Smith, 1994; Friedman, 1994). Therefore, it is essential that teachers be at the forefront of those in our society who have access to, and proficiency with technology. And in this regard, teacher education programs should be leaders, not laggards.

Once we have addressed the need for teachers to be aware of and prepared to integrate technology into their classes, the next issue becomes ways in which the technology is to be used. In "Automating the Past or the Future", Van Hom (1994) states that ". . .many of today's applications of technology simply automate the past" (p.336). He elaborates on the topic and suggests that the basic skills of the past are not the basic skills of the future. The basic skills of the future are the use of powerful technologies. One primary use of these powerful technologies is to engage in effective thinking and problem solving.

The traditional textbook can no longer keep a breast of the rapidly changing world conditions and the knowledge explosion that is a part of our daily experiences. The traditional teacher-directed classroom is no longer an effective delivery system to prepare students for the realities which they face.

Pre-service teachers must be prepared to do things differently than most of them encountered in their schooling experiences. As teacher educators, we have a responsibility to provide the tools and experiences that will prepare them for using technology to do research and solve problems.

This paper will focus on a model for having pre-service teachers engage in the activities of reflective, critical, and creative thinking. The model uses technology to provide a research based approach to problem solving.

The Process

The first step of the process involves introducing students to on-line work and providing them with the vocabulary that will facilitate their searching. This is accomplished through modeling and hands-on practice. The students observe while the teacher demonstrates the process. During the demonstration, the teacher is engaging in a "think aloud" protocol The process is:

- Identifying an area of interest for research
- Developing a problem statement
- Analyzing the problem statement to identify key concepts for on-line searches.
- Identifying appropriate search resources
- Engaging in the search
- Critiquing the outcomes
- Using critical thinking skills to review the findings
- Weighing the evidence related to the problem statement
- Making a decision related to the problem statement
- Sharing the decision making process with other class members

After the demonstration, there is a discussion of the process, the internet, and related concepts. At this point, the preservice teachers engage in a series of simulations to reinforce their understanding of the vocabulary and computer functions associated with using the internet. During this phase of the procedure, the more technologically experienced and confident students become teachers for their peers.

Students then spend some time reflecting on areas of interest they would like to research. They identify a partner based on mutual areas of interest. The students are provided a worksheet, that when completed will aid in the pursuit of the information needed. At this point, the partners begin the proces by developing a problem statement. In analyzing the problem statement, creative thinking strategies such as brainstorming are suggested to assist in their eloborating on the key concepts and related synonyms.

At this point, students work with their partners in a technology lab. The goal is both to familiarize then with the search process and locate sources which will provide a basis for addressing the problem statement. An important part of this process is to have them experience the vast amount of information and engage in appropriate "narrowing" strategies or deductive thinking. This means that while the students are gathering information and afterward, they are encouraged to engage in a critical thinking process that questions the validity of the information, including the source. This is crucial part of the operation, particularly when working with material gathered from the internet.

When the information has been gathered, critiqued, and sorted, the problem statement is again addressed. At this point, students present their findings to a group of peers.

They share their best judgment and provide justification for their position.

Having pre-service teachers engage in a research based approach to problem solving provides them both tools and experience for guiding their future students into an exciting and realistic approach to learning. Technology learned in isolation becomes pointless. Technology that is nothing more than automation for the past lacks creativity and wisdom. When teacher educators provide the opportunity for pre-service teachers to practice meaningful integration of technology while gaining the insights necessary for effective thinking and problem solving, we have made a giant leap toward better schools for the future.

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Changes in Teacher Attitudes During Information Technology Training

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A compendium of 14 previously-published instruments for assessing teachers' attitudes toward information technology was used to measure pre-post changes among nine groups of K-12 educators completing six weekly training sessions in a southern Texas public school district during 1995-96. Teachers were introduced to the significance of information technology in society and instructed in Macintosh computer applications focusing primarily on teacher productivity. One-hundred eighteen educators completed both pretest and post test questionnaires. This paper contains a description of the attitudinal changes that occurred in teachers during their technology training sessions.

Description of Trainees

Each of the schools in the district was given the opportunity to send teachers with little or no background in information technology to receive training. Each school could send one teacher for a morning session and a second teacher for the afternoon session. 1995-96 was the third year of training, and by this time, several schools sent teachers who had not necessarily volunteered to receive the training. Some of the trainees were very adept at using the keyboard, while others had little or no keyboarding skills. While the majority of the trainees were predominantly elementary school teachers, there was representation of secondary school teachers along with a few secretaries, librarians, and classroom aides.

Description of Training

The training consisted of 2 1/2 hour sessions each held over a period of six weeks for up to 20 trainees at one time. When the trainees came to the media center training room on the first day, they were introduced to the world of technology and the changes that were currently taking place. They were told that the school district had made a commitment to their educational personnel to train them personally as individuals, and that they were under no obligation to have to use any of this for their teaching. This approach was used to take the pressure off the teachers so that they did not feel they were being forced to learn something that was not going to benefit them directly. During this first session they were also introduced to the Macintosh computers (660 A-Vs) and were taught to navigate using the mouse, change desktop patterns, use the calculator, change time, and eventually to play music CDs.

Sessions 2-4 were devoted to learning word processing skills. Session 5 was devoted to learning how to set up a database and print labels, and now to merge a database into a word processing document. The final session focused on setting up a gradebook using the spreadsheet.

Trainees were advised to try to use the computers at their schools or at home to review the skills that they were learning so that they would not forget skills learned each session. While some had immediate access to computers, the majority of the participants rarely practiced their skills prior to the following sessions.

Instrumentation

The Teachers Attitudes Toward Computers Questionnaire (TAC) was used to assess attitudinal change among the teachers participating in the training sessions. A total of 284 items falling on 32 Likert and Semantic Differential subscales were included from the following 14 sources (Christensen & Knezek, 1996a):

1. Computer Attitude Scale (CAS) (Gressard and Loyd, 1986)
   •confidence (CASC), liking (CASL), anxiety (CASA), and usefulness (CASU)
2. The Computer Use Questionnaire (CUQ) (Griswold, 1983)
   •awareness
3. Attitudes Toward Computers Scale (ATCS) (Reece & Gable, 1982)
   •general attitudes toward computers
4. The Computer Survey Scale (CSS) (Stevens, 1982)
   •efficacy and anxiety
5. Computer Anxiety Rating Scale (CARS) (Heinssen, et al., 1987)

•technical capability (CARSA), appeal of learning and using computers (CARSB), being controlled by computers (CARSC), learning computer skills (CARSD), traits to overcome anxiety (CARSE)

6. Attitudes Toward Computers (Raub, 1981)
   •computer usage, computer appreciation, societal impact
7. Computer Anxiety Index (Maurer & Simonson, 1984)
   •examines avoidance of, negative attitudes toward, caution with, and disinterest in computers (anxiety and comfort)
8. Blombert-Erickson-Lowery Computer Attitude Task (Erickson, 1987)
   •attitudes toward learning about computers and towards computers themselves
9. Attitude Toward Computer Scale (ATC) (Francis, 1993)
   •affective domain
10. Computer Attitude Measure (Kay, 1993)
    •cognitive (student (KS), personal (KT), general), affective (CAM), behavioral (classroom and home), and perceived control components of computer attitudes
11. Computer Attitude Questionnaire (CAQ) (Knezek & Miyashita, 1993, 1994)
    •computer importance (I), computer enjoyment (J), computer anxiety (Anxiety), computer seclusion
12. Computer Attitude Items (Pelgrum & Plomp, 1991)
    •computer relevance (REL), computer enjoyment (ENJ)
13. Computer Attitudes Scale for Secondary Students (CASS) (Jones & Clarke, 1994)
    •cognitive (CASSC), affective (CASSA) and behavioral (CASSB) attitudes
14. Electronic Mail Items (E-Mail) (D'Souza, 1992)
    •attitudes toward classroom use of E-mail.

Gardner, Discenza, and Dukes (1993) carried out a combined-item factor analytic comparison of the Blombert-Erickson-Lowery Computer Attitude Task (Erickson, 1987), the Gressard and Loyd (1986) Computer Attitude Scale, the Raub (1981) Attitudes Toward Computers questionnaire, and the Maurer (1983) Computer Anxiety Index. Their analysis of data gathered from 244 undergraduates identified the existence of eight factors, one of which was Computer Liking (CASL) from Gressard and Loyd. Christensen and Knezek (1996a) selected the strongest items from the other seven factors to form the following subscales for inclusion on the TAC: Computer Anxiety (CA, 20 items), Utility (U, 7 items), Male Domain (MD, 6 items), Success (S, 4 items), Negative Impact (NI, 6 items), Motivation (MOT, 4 items), and Productivity Importance (PI, 4 items). These and other subscales listed in parentheses in this section can serve as identifiers to the item sources for the measurement indices listed in the tables and figures to follow.

Reliability of the TAC for Inservice Trainees

Table 1 contains a listing of the data analysis classification labels for each of the 32 Likert and Semantic Differential subscales, along with the internal consistency reliability for each subscale based on the data gathered from the teachers. The distribution of the internal consistency reliabilities for the 32 subscales was:

.90 and above	8
.80-.89	13
.70-.79	6
.60-.69	2
.50-.59	1
.40-.49	2
Below .40	0

According to the guidelines provided by DeVellis (1991, p.5), 27 of the 32 are at least "respectable" ($r >= .70$), and 21 of the 32 are "very good" ($r >= .80$). Only 3 of the subscales are "unacceptable" ($r <= .60$). A more detailed description of the indices and how their 1995-96 measurement accuracies compare with comparable indices from the times of the subscales' origins, is provided in a companion paper in this issue (see Christensen and Knezek, 1996b).

Major Areas Measured

A cluster analysis and factor analysis (SPSS, 1984) were carried out on the data in an attempt to group the subscales into larger categories. Summed indices for each of the 32 subscales were used as variables in the analyses. Four major areas were identified (Christensen and Knezek, 1996a). As shown in Table 2, 14 subscales appeared to be most closely associated with the Perceived Utility of Computers, while 11 were mainly concerned with various kinds of Computer Anxieties. Five subscales seemed to be measuring Accommodating Outlook, and 2 were associated with the broader Perception of Email and other Information Technologies for activities other than professional productivity, such as classroom learning.

Results

Results are based on returns from 118 teachers (approximately 75%) who: a) were participants for the entire six-week training session in which they were enrolled, b) completed both pretest and post test questionnaires, and c) provided sufficient identifying information to match pretest with post test responses. As shown in Table 2 and illustrated in Figure 1, indices for 20 of the 32 subscales drawn from previously published instruments changed in a positive direction ($p < .025$) over the course of technology training.

Table 1.
Internal consistency reliabilities for 32 TAC subscales

Subscale	No. Items	Reliability (Cron. Alpha)
I (Knezek & Miyashita Importance)	7	.80
J (Knezek & Miyashita Enjoyment)	9	.85
Anxiety (Knezek & Miyashita)	8	.91
CAM (Computer Attitude Measure)	10	.93
CASA(Loyd & Gressard Anxiety)	9	.90
CASC(Loyd & Gressard Conf.)	10	.72
CASL(Loyd & Gressard Liking)	10	.89
CASU (Loyd & Gress. Usefulness)	10	.84
REL (Pelgrum & Plomp Relevance)	7	.78
ENJ (Pelgrum & Plomp Enjoyment)	9	.81
CA (Computer Anxiety)	20	.95
U (Utility)	7	.86
MD (Male Domain)	6	.83
S (Success)	4	.76
NI (Negative Impact)	6	.40
MOT (Motivation)	4	.80
PI (Productivity Importance)	4	.82
CUQ (Computer Use Questionnaire)	14	.67
CSS (Computer Survey Scale)	8	.70
ATC (Francis Att. Toward Comp.)	16	.91
KS (Kay CAM Student)	5	.88
KT(Kay CAM Teacher)	5	.90
CARSA (Technical Capability)	6	.81
CARSB(Appeal-learning computers)	4	.84
CARSC (Controlled by computers)	3	.58
CARSD (Learning computer skills)	3	.72
CARSE (Traits to overcome anxiety)	2	.41
CASSA (Affective)	15	.94
CASSB (Behavioral)	10	.71
CASSC (Cognitive)	14	.66
ATCS (Raub Att. Toward Comp.)	8	.89
EMAIL (D'Souza Classroom Email)	11	.96

Note: n = *118*

Groupings resulting from a factor analysis of the 32 subscales indicated that the teachers involved in these training activities changed primarily in the areas of reducing their anxieties about computers (Factor 2) and increasing their estimation of the usefulness of information technology (especially Email) for classroom learning (Factor 4). Several measures related to enjoyment or liking became more positive as well, as is indicated by significant changes in several of the indices listed in the latter half of Factor 1.

Discussion

Positive teacher attitudes toward computers are widely recognized as a necessary condition for effective use of information technology in the classroom (Woodrow, 1992). Among the teachers completing six-week technology training sessions at a southern Texas school district in 1995-96, reduced anxiety, increased enjoyment, and increased recognition that

Table 2.
Pretest - Post test changes on 32 attitudinal subscales

Subscale	Pretest Mean	Post Test Mean	Difference	Prob.
Factor 1 - Perceived Utility				
CASU	4.1773	4.2152	0.04	ns
PI	4.1306	4.2313	0.10	ns
CUQ	3.6509	3.7857	0.13	0.002
REL	4.2623	4.3348	0.07	ns
KT	4.3303	4.3758	0.05	ns
KS	3.9758	4.1545	0.18	0.017
U	4.0737	4.0576	-0.02	ns
CARSB	4.2537	4.3358	0.08	ns
I	3.1797	3.394	0.21	0.0005
ATC	3.8472	4.0407	0.19	0.0005
ATCS	4.006	4.2242	0.22	0.0005
CASL	3.7062	3.8477	0.14	0.018
ENJ	3.159	3.4274	0.27	0.0005
NI*	3.2273	3.601	0.37	0.0005
Factor 2 - Computer Anxieties				
CA*	3.1843	3.5321	0.35	0.0005
CASSA	3.5075	3.8796	0.37	0.0005
CASA*	3.5949	3.8923	0.30	0.0005
CARSA	3.2139	3.5647	0.35	0.0005
CASC	3.5365	3.7	0.16	0.004
Anxiety*	2.7802	3.1048	0.32	0.0005
CARSC*	3.6219	3.7512	0.13	ns
J	3.0229	3.2575	0.23	0.0005
CASSC	3.5024	3.6792	0.18	0.001
CSS	3.6604	3.8153	0.15	0.005
CASSB	3.5238	3.7984	0.27	0.0005
Factor 3 - Accommodating Outlook				
CARSE	4.0373	4.1642	0.13	ns
CARSD	4.1768	4.1919	0.02	ns
MOT	4.3396	4.3731	0.03	ns
S	3.9627	3.9701	0.00	ns
MD*	4.5846	4.5498	-0.03	ns
Factor 4 - Perception of Email and Other Information Technologies				
CAM	5.3721	5.836	0.46	0.0060
E-MAIL	3.3204	3.6468	0.33	0.0005

Note: ** = Coding reversed — larger value represents less of attribute;* n = *118*

Email and related information technologies can help in classroom learning, can be viewed as positive outcomes. The latter is especially encouraging since the teachers did not receive explicit training in the use of information technology to promote classroom learning. On the other hand, the lack of any apparent change in the area of Accommodating Outlook, combined with sparse evidence of any movement toward perceived usefulness of information technology for teacher productivity, would seem to indicate that these teachers, who came to the training sessions often as the last from their schools to sign up, did not drastically alter their views on how willing they were to embrace new information technologies. Perhaps, as much of the literature in this area indicates, anxiety reduction and recognition of potential usefulness are just beginning points. True acceptance may take longer than just six weeks (15 contact hours) of exposure, or perhaps an incubation period is needed after the initial training, to enable the ambivalent trainee to accommodate this new perspective.

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769

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Using Hypertext to Enrich an Initial Teacher Education Course

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Initial teacher education in the UK has become increasingly school-based. Less and less time is now available in college or University to cover content or 'theory' in the space of a 36 week postgraduate certificate in education (PGCE) course. As a result of this trend, a decision was made in 1994 to support the coursework of our quota of 50 PGCE science students at the University of Sheffield by providing a range of material on science education in a form known as "hypertext".

The history of hypertext is long and winding but the coining of the term is usually attributed to Vannevar Bush in 1945 whose paper 'As We may think' (Bush, 1945) is seen as the starting point. Fifty years later the term still eludes a concise definition but like the proverbial elephant people can recognise hypertext when they see it. It involves putting text (and other media such as photos, drawings, sound and video in the more general version called "hypermedia") into an information system so that students can learn, read view or listen as they wish. Thus they learn at their own pace, in their own order and in their own style. Terms associated with hypertext include non-sequential or non-linear reading, which are fairly accurate but more fanciful ideas of the reader as an 'explorer', a navigator' on an unguided tour also abound. Accounts of hypertext talk in terms of readers not only "traversing established links to pre-existing nodes but also venturing forth into uncharted realms" (but see Nielsen, 1990, for a more sober description). Similarly, in the small number of evaluations of hypertext in teacher education (Lacey and Merseth, 1993; Higham and Morris, 1993) there has perhaps been some research through a rose-coloured lens, as so often happens with new technology. Thus Lacey and Merseth (1993, p. 545) report in their study of hypermedia in teacher education that "students can gain access to data immediately their questions emerge: therefore, their intellectual curiosity guides the use of the technology, not the other way around". My reaction on reading this: it may have happened in Harvard but can it happen here?

Developing the Project/System

Hence the aim of my own project was two-fold: to produce and develop course material for initial teacher education students (which might also be of value to school-based mentors in the partnership scheme); and secondly to evaluate the use of the system with an open, critical mind but some healthy scepticism. To include details of the hypertext material would not be appropriate here but it is relevant to say that the eight "modules" are all generally central to most UK PGCE courses covering topics such as *Planning and Managing Learning, Scientific Investigation, The National Curriculum, Language in Science Teaching, Practical Work* and the *Use of IT in Teaching and Learning*. These areas were presented as modules on the screen, each containing text, figures and tables, and all giving lists of references and further reading at the end. It can be seen that the material was concerned more with what is now commonly termed pedagogical and curricular knowledge rather than subject knowledge (Shulman, 1986)

The text, table and figures were all mine, hence there were no copyright problems in putting the material into hypertext as there can be with other courseware in this form on a computer system (the material itself has since been developed, added to and published as a book: Wellington, 1994). Technical problems were eased for me thanks to a grant from the *National Council For Educational Technology (NCET)* who supported the project and paid for technical assistance in transferring the material from Word for Windows files into a hypertext form on the University network using a system called Guide. I was also assisted in the design of the screen, the format, the colours and the ways of moving around the system - the "user-interface" was designed so that everything could be done by moving and clicking a mouse i.e. moving from one page to another, turning the pages, moving from one book or module to another, looking at references and so on. We were also able to provide two extra facilities: an easy way of calling up the library catalogue so that students could see if books referred to were actually there; and an icon which students could click on to get them straight into electronic mail and send messages and feedback to me.

The hypertext system used was chosen mainly for three reasons: first, its availability on the University campus network, free of charge; second, its ease of use, although many other hypercard/hypertext systems are also easy for the learner; thirdly, its ability to handle large amounts of text which was an essential requirement in this case with about 40,000 words involved.

Evaluation of the Project

There seems to be a paucity of useful frameworks for evaluating multimedia in general and hypertext in particular. My own reading led me to perhaps two lists, or frameworks if they can be so called, of value in this context. The first is in the form of a list provide by Nielsen (1990) who suggested five points that should be met by a hypertext system:

1. Easy to learn: the user can quickly get some work done with the system.
2. Efficient to use: once the user has learnt the system, a high level of productivity is possible.
3. Easy to remember: the casual user is able to return to using the system after some period of not having used it, without having to learn everything again.
4. Few errors: users do not make many errors during the use of the system, or if they do make errors they can easily recover from them. Also, no catastrophic errors must occur.
5. Pleasant to use: users are subjectively satisfied by using the system: they like it.

These helped to guide my own evaluation and I would add a sixth point essential in any course involving students and finite resources: ease of access.

A much less simple but probably more valuable framework was discussed at length by Barker and King (1993) who put forward a whole methodology for evaluating "multimedia courseware" and included a useful checklist for evaluators.

Both lists or frameworks proved useful for my own evaluation and, I would suggest, can be of value in studying the use of IT in teacher education generally. They helped to shape my own interviewing and questionnaire design. A decision was made to personally interview a 20% random sample of each year of students (a total of 10) and then to ask all other students to complete a questionnaire based on the evaluation frameworks above and on points emerging from the interviews. Each interview lasted about half an hour and was taped and transcribed. The interview was semi-structured but plenty of time and space was allowed for open comment, judgement and personal remarks! One of the aims of the interview (and to a lesser extent the questionnaire) was to encourage students to reflect upon their own learning using this medium, in order to add a meta-cognitive aspect to their use of hypertext in the course i.e. to promote their own reflection and self-evaluation on the learning process.

Results Emerging from the Evaluation

The system has now been used with 2 cohorts of students and is in progress with a third group. The results from the interview tapes and questionnaires cannot be presented in full here so the summary below represents a distillation of the main points emerging. Responses from the interviews were many and varied and also the questionnaire provided some fairly open-ended questions which brought a range of answers. For the sake of brevity, I have summarised the main findings using just the three headings below:

1. Quality of the user interface, engagement and interactivity

Generally, students did find hypertext easy to use with comments like "simple and convenient to use" and "not very much text on each page", "easily readable". Some found it an interesting, novel and attractive way of reading and studying, illustrated by the following comments:

"I found it a much more accessible way of reading."

"I liked it a lot better than reading a book...because I don't have to hold it...I found it less effort...and maybe because of the novelty value. And also because there's not very much on each page. I did find it easier to read."

A clear majority however were critical of the idea of reading from a screen especially in the environment of a computer room. A few short quotes from the tapes suffice to make this point:

"I just don't feel comfortable reading from a screen."

"I can't concentrate with other people around."

"Reading from a screen is very tiresome...I mean you could only do an hour at a time (sic!). I needed several sessions just to go through one module."

There were mixed feelings about other aspects of the user interface, such as the diagrams and tables:

"I don't like flicking from a table to text and back again."

On the other hand some students found the break from text useful, for example:

"The tables and figures in it help to break it up."

On the issue of access and availability views were again split:

"It's not always possible to get on to a terminal - I've been up there with spare time and not been able to get on it."

"It's the fact that it's just on the University system that's the problem - if we could have it on disc to take home...that's when it could be really valuable."

"The only times it was difficult in getting to the hypertext immediately was when deadlines were approaching for assignments - other than that, if you chose your times, it was all right...late afternoons or early morning..."

I speculate that the view on access to systems such as this depends on the circumstances, working patterns and other commitments e.g. family, of the particular student involved.

2. Learning Styles and 'Collaborative Reading'

Did the system allow for a variety of learning styles, collaborative use and links to other ways of learning ?

Styles seemed to vary, from the habitual "serialist note-taker" to the students (a clear majority judging from the questionnaire) who used the system as a "primer":

"As a starting point, then I'd go off to the library...so I'd used it to get some ideas and some references and then go and follow them up. A lot of the hypertext stuff pointed me in the right direction and gave me a start...which was a great help."

However, the main factor determining learning style appeared to be the limitation of reading and studying from a screen:

"I didn't read it in chunks of longer than about 20 minutes because I got a headache. It's probably the lights in the room more than the computer."

As for collaborative reading with hypertext, the attitude of many was "perish the thought". A small selection of comments make the point clearly:

"I can't imagine why people should want to read together."

"People read at different speeds don't they...and then you'd start talking about the football. I'd soon get distracted."

"When I'm reading I'm oblivious to anything that's going on round me...so my partner might find it very irritating. I like flicking backwards and forwards too."

"I think my partner would be bored waiting for me because I'm a slow reader. They'd be wanting to flick to the next screen and I'd still be reading."

Some students had obviously thought about the possibility of consenting adults reading together from a screen but even these showed (in the interviews) an air of incredulity:

"There probably are reasons why people might want to read together - but I can't think what they are...I suppose you're bound to be more critical about what you're reading if there's someone else there - you're bound to question it more aren't you?"

"It would be easier to read off a screen together than to try and read a book together - partly because the pages are shorter, and partly because you can both look at a screen together."

3. Fitting Into The Curriculum And The Course

A vital part of the evaluation of any use of new media is the context, the course and more generally the curriculum in which the innovation is situated. This aspect featured in both the interviews and questionnaires. There were many positive comments as well as some very salutary, pragmatic reminders from students who are nothing if not realistic.

"I found them excellent overviews of the topics and a good source of reference, a good back-up to course sessions".

"If a topic is appropriate for an assignment it saves you having to get books out which aren't always available. It's always in".

But many positive comments were tempered with a general feeling that use of this type of material is a very "seasonal" activity:

"I used it a lot when it was first mentioned...and then on and off for assignments during the course, for a quick look at references and things ....not so much recently though". (the last term of this one year course)

"Right at the beginning of the course a lot of people went and used it because we weren't quite sure what to do...but what we needed during the course were weekly reminders, especially on the day a week when we were back in the department." (during the first long school experience)

"After Christmas it would be better to read about more theoretical things on the hypertext, you can appreciate it then after you've been in the classroom - it becomes more relevant. The course should be more practically based in the first term and gradually more theoretical after that. I don't think the theoretical stuff's relevant to you until you've actually been in the classroom."

In a course which is largely school-based, students cannot use a system such as this is during their periods of extended school experience. Many of the students felt that this is a time when access to a hypertext system of this kind would be especially valuable, not just for them but for the teacher mentors working with them in our partnership scheme. I should point out that the comments on mentors below were spontaneous and not prompted during the interview:

> "The hypertext would be a great system for schools that are networked, so you could access it then while you're out at school - which is a lot of the time."

> "Teachers who have been out of education for a time...it would do them an awful lot of good just to sit down...because they're very readable, just a couple of pages on each topic. I think they would benefit greatly from having it in schools. They could sit down, with nobody else there and use it without being seen...especially the older teachers."

> "A lot of them ask what we've been doing in the University - this would give them a chance to see...a lot of them are quite open to new ideas."

> "It would be an interesting, accessible way for teachers to keep up to date"...

The Use of New Technology In Teacher Education

The summary above gives a flavour of the main points emerging from this on-going evaluation, whilst not including a large part of the data. Some clear lessons were learnt in the formative evaluation which helped to improve each version in time for the next cohort of students.

However, there is an inherent difficulty in any innovation and on-going evaluation of this kind: a "measurement" or assessment of the impact or effect of any educational intervention, not least one involving IT, is extremely problematic. How can we know with any certainty what the "added-value" of an innovation has been? How can we be sure that any "gain" was unique to this innovation i.e. not achievable by other means; or that the very presence and novelty of a project did not in itself create added interest motivation etc.? (A version of the Hawthorne effect). How can we generalise from our own context to others?

Some studies feel confident enough to assert that their own innovation did bring about a gain or added-value. Thus, in Goldman and Baron's(1990) hypermedia project with primary teachers they assert that:

> "We feel that these technologies, when integrated into courses that have as goals the development of pedagogical content knowledge (Shulman, 1986), can make a major contribution to the reform of teacher education."

In concluding their article they even suggest that new technology of this kind can bring about a shift in approach in teacher education:

> "We believe that hypermedia technology has the potential for creating a new type of teacher education program - one that moves traditional college and university courses away from a teacher-directed lecture format and into a problem-solving/analytical mode."

I would not feel confident enough, on the basis of the project outlined above, to support either of these assertions. I cannot believe that new technology alone can bring about "a reform of teacher education", for better or for worse. There are other, far more powerful, forces at work in the current maelstrom.

What light can my own small evaluation shed on possible ways in which new technology might play a part in teacher education ? (Bright and Waxman, 1993). Firstly, there is some evidence from my experience that it can enrich teacher education courses, not least by introducing students (as learners) to the technology they are likely to meet as teachers. This will be enhanced by encouraging them to reflect on their own learning in a critical way. However, this will only happen if the new technology is built into the course. My evaluation showed me that students need constant reminding about it, especially if it involves going to another room or even another building to use it. The material needs to be built into the course structure, the lectures and workshops themselves and the assignments. Careful attention also needs to be paid to the rhythm of the course and the evolving needs of students through it.

Finally, how does new technology of this kind relate to the debate over school-based versus higher education based courses? I cannot do justice to this huge and complex debate on the two poles and positions between, but I am prepared to assert that the increased use of IT in teacher education could never compensate for the weaknesses in a totally school-based course. The role of the higher education institution will still be essential for three reasons: in providing a base for the technology, including the staffing required to monitor it, to up-date it and to support it; in providing a forum for students and tutors to share critically the use of the new technology, and to encourage the kind of meta-learning and reflection referred to above; and in monitoring and up-dating the content of the material. My evaluation showed one thing clearly and I would hazard a guess that it can be generalised from: students do not trust their school mentors to keep up-to-date on new developments and new approaches, hence their suggestion in the interviews that mentors themselves should use the hypertext.

There may be ways of dispensing with the higher education institution in teacher education (though I seriously doubt this) - but the introduction of more and newer educational technology is not one of them.

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Technology and Content Integration to Enhance Preservice Teacher Preparation

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During the mid 1980's, Kansas State University's College of Education developed a common core of professional education experiences required for all students who sought certification at the secondary or middle school levels through the Secondary Education Preservice Program. Although the next several years saw a variety of adjustments in the composition of this required core, significant changes occurred in the Fall Semester of 1993. In response to feedback from students, we took advantage of emerging technological opportunities and significantly altered the learning environment and increased the depth and breadth of the preservice experience. This effort involved the first sequence of professional education courses known as Block One. The major features of the Block include: 1) collaborating on integration of three courses into one experience, 2) integrating and restructuring the content of the three courses into a series of thematic units, 3) structuring students into cooperative teams, and 4) integrating selected computer technologies throughout the experience.

Soon after the original implementation of the required Secondary Education Preservice Core, faculty began receiving complaints about duplication of content among various courses. The initial response to such concerns included a philosophical belief that a certain amount of repetition added emphasis and was beneficial for students. However as students continued to voice concerns, it became increasingly evident that an analysis of these concerns needed to be conducted. As the Fall Semester of 1993 began, faculty from Secondary Education, Special Education and Educational Psychology met to examine possible overlap in content among the three courses in Block One. The results of this analysis provided concrete evidence that excessive overlap existed among the courses and that additional depth and breadth could be developed through scheduling an extended block of time and through collaborative planning and team teaching.

During this same time period, the College of Education made the move from an Apple IIe and Apple IIgs environment to an all Macintosh environment. The first steps in this transition were taken in 1990 as each faculty office and a student laboratory were equipped with Macintosh computers. Each computer was then connected to an Apple Talk network and subsequently to the University's Ethemet network. The stage was now set for faculty and students to explore opportunities beyond traditional instruction and learning.

Although the authors would like to report rapid and extensive progress from faculty and students, applications of technology to enhance student learning opportunities has been slow. The College moved quickly to identify and train a Technology Support Group. At that point the trouble shooting and service needs of the College were adequately addressed. In contrast, the development of visions related to using technology to enhance student learning experiences and significant changes in the delivery of instructional programming progressed more slowly.

Integration of Content

The three courses involved in Block One include, Educational Psychology from the Department of Counseling and Educational Psychology, Core Teaching Skills from the Department of Secondary Education, and The Exceptional Student in Secondary Schools from the Department of Special Education. Each department is relatively large with undergraduate and graduate programming at the master's and doctoral levels. With the departments heavily involved in programming at all levels and the Block One instructors involved in teaching undergraduate and graduate courses, time for collaborative planning as well as team teaching was scarce. However, with encouragement from the administrator of each department, each instructor was able to establish a calendar which included Block One activities as a major focus.

As the first plans to integrate the content from the three courses were developed, each instructor expressed concern about having to give up significant portions of content. However, as the semester unfolded, all instructors reported significant efficiency in the amount of content addressed as well as substantial increases in the depth of student experiences. Implementation of the integrated Block initiated the use of one syllabus with five integrated thematic units as a replacement for individual syllabi for each of the three collaborating courses.

The nature of the teaching and learning experiences also changed significantly. Rather than a traditional "stand and deliver" teaching model or a "sit and listen" learning model, the integration of content, the extended time periods, and the establishment of collaborative student teams led the Block instructors to implement a substantial number of problem solving projects. These projects required students to make use of traditional and technological research methods.

Student reliance on traditional searching within the main campus archives became more challenging during the past two years as an extensive library renovation project moved forward. As interactions in the library became more challenging, students exhibited growing interest in the Internet and World Wide Web. Thus, the curriculum integration and technology integration efforts received sizable encouragement from an unplanned source.

Integration of Technology

During the early planning phases which led to the development of the integrated Block, the elimination of needless repetition in content was the overriding focus. As content contributions from each course were refined, the need for different teaching and learning models became readily apparent. The movement away from "stand and deliver" teaching models, implementation of extended time periods, and evolution of problem based projects led to the development of collaborative teams. Each team was composed of four to six students representing different teaching fields.

After the first two semesters, the development of the Block reached a point where the integration of technology became more systematic with more uniform experiences provided for all students.

Although much of the enhanced learning climate could have been achieved without the use of technology, teacher and student uses of technology clearly speeded progress as well as acceptance among students. The technologies selected for integration into Block One included: electronic mail or e-mail, teacher presentation and student interpretation technologies or interactive multimedia, electronic research, and network or Web technologies.

Electronic Mail

The use of e-mail was the first technology integrated into the newly configured Block. The climate for successful integration of e-mail was firmly established as all faculty in the College of Education and the student lab were connected to an internal network as well as the world-wide electronic communication system when the Macintosh equipment was installed. The faculty and many students have been using e-mail to enhance communications for several years. Based upon these successful experiences, we required all students to obtain e-mail addresses. Subsequently, students have been able to engage in follow-up conversations with instructors, conduct team planning from on and off-campus sites, and behave in a more professional manner.

Interactive Multimedia

As previously mentioned, the nature of learning experiences has undergone significant changes. The presence of collaborative teams has facilitated opportunities for larger projects which are more strongly connected to emerging practices in middle schools and high schools. Students have opportunities to construct multimedia course wear to support class experiences as well as lessons which they direct in the Micro-Teaching Laboratory.

Even though the College of Education is an all Macintosh unit, the selection of multimedia development software has focused attention on products which have PC as well as Macintosh versions. With the initial selection of multimedia development software accomplished, the instructional team began engaging in a variety of activities to enhance their technology talents. Once the faculty reached an initial level of comfort in developing and using multimedia, students began incorporating multimedia applications into their individual and team orchestrated lessons.

Subsequently, problems arose because enrollments in the Block averaged 50 to 60 students who competed with students from other courses to access the 25 computers in the Student Lab. Potential solutions included sequencing projects to provide additional work time, providing computer stations in the classroom, and facilitating student access to computers in other areas of the campus.

A proposal for a technology enhanced classroom with movable, networked computer stations to support the activities of each collaborative team is currently under consideration.

Electronic Research and World Wide Web

The classroom in which the three-and-a-half hour sessions of Block One are conducted on Tuesdays and Thursdays, was connected to the internal and external networks through Ethernet during the early developmental stages of the Block. With one and then two Ethernet connections, additional opportunities emerged for faculty and students to access resources across the World Wide Web, and for faculty and students to develop multimedia presentations and to move such learning materials from any location they could access.

A recent addition to the technology integration agenda provided an opportunity for student teams to extend their understanding and use of the World Wide Web. During Fall Semester 1996, student teams were required to design and develop a Web page which described an integrated thematic unit developed for the Block's Teaching and Learning Unit. The Web page established and described links to Web sites which supported the various content strands incorporated into their project. It also established and described links to Web sites that addressed effective uses of strategies similar to those utilized to orchestrate student involvement in the team project and/or effective uses of technology in classrooms in general. The results of efforts by these student teams may be located at http://www.educ.ksu.edu/Faculty/ParmleyJohn/Block%20One%20Web%20Project%20F96/ProjectOverview.html

During the implementation of the Web page project, faculty and students encountered obstacles which were the same or very similar to those encountered during development of multimedia applications. The solutions were also very similar to those associated with efforts to develop multimedia as faculty provided access to additional computers in various locations across the College.

Technological accommodations for students with special needs

Students also have had the opportunities to explore technological accommodations for students with special needs. The presence of technology throughout the Block One experience has created an environment in which the impact of such technological accommodations is accepted with serious thoughts toward possible application in students' future classrooms rather than as technological toys intended for someone else's classroom.

The faculty involved with the development of the integrated Block have placed a consistent focus on developing students' decision making abilities and talents related to orchestrating learning experiences for all students. The role of technology has been to facilitate and enhance this focus or mission.

Basis for Integrating Technology?

Each of the faculty members involved in development and growth of Block One has reported this as their first experience with such an extensive effort to collaborate on curriculum development and orchestration of instruction. Based upon this relative lack of experience as well as the desire to provide the highest quality experiences for students, faculty invested substantial time reflecting upon proposed changes.

When decisions about selection and integration of technology were being made, faculty examined such works as Sivin-Kachala and Bialo (1994-95) who wrote:

Technology makes a difference when the teacher has a clear vision of what students are to learn and how technology can help. Success also requires that the teacher include in his or her instructional plan ways to give students guidance in the processes and thinking strategies that make up the skill. Finally, the teacher needs to be actively involved in a variety of roles- sometimes a lecturer, sometimes a coach; one day a consultant, the next day an editor.

What role should the technology play? Research suggests that technology works best as a supporting tool-making complex processes or creative experiences either possible or easier to accomplish. Technology offers new ways to provide meaningful, real-life contexts for learning. And telecommunications technology allows students to collaborate with peers and experts across the country and around the world. (http://glef.org/glhttp/newsletter/2.2/research.html, October 10, 1996)

Maloy's (1993)Toward a New Science of Instruction provided a significant contribution as the Block instructors developed a conceptual frame for making decisions related to organization and instruction. In this work she states,

To meet the challenges of an increasingly complex world and workplace, students must become what NRCSL (National Research Center on Student Learning) Director Robert Glaser calls "mindful architects of their own knowledge"— thinkers who know a great deal and continually adapt, refine, and use their knowledge. The basic skills of an earlier time—a fundamental competency in reading, arithmetic, and the tasks of citizenship—are no longer enough by themselves. Success today requires new basics: the ability to reason, analyze, plan, and act effectively in a climate of pervasive change.

In order to engage in such fluid knowledge "architecture," learners must eventually attain intellectual independence. Once they have become full-fledged workers, citizens, and consumers, most will have little access to direct instruction. (http://www.ed.gov/pubs/InstScience/index.html, October 16, 1996)

The work of Singh and Means (1995) provided additional insight as the conceptual frame was reviewed. These authors wrote:

> There are many different kinds of technology, technology applications, and technology uses. ... Our classification scheme encompasses tutorial, exploratory, tool, and communications uses of technology.

We reason that tutorial uses of technologies (e.g., drill and practice programs, tutoring systems, satellite transmission of lectures) may be useful but are unlikely to transform education. These uses in essence use technology to do the same things that schools have traditionally done for more students—albeit perhaps more systematically and efficiently.

Exploratory programs can be exciting adjuncts to an instructional program, but rarely carry a major part of the core curriculum....

If our goal is really to provide students with a different kind of education—structured around the provision of challenging tasks that can prepare them for a technology-laden world—the most relevant uses of technology are as tools and communication channels . Giving students experiences in selecting appropriate technology tools and in applying technologies such as word processors, spreadsheets, hypermedia, and network search tools to their work supports the performance of complex, authentic tasks and provides experiences that prepare students for the world outside of school.

The concept of preservice teachers and developing professionals as mindful architects of their own knowledge is consistent with the College's mission to develop "knowledgeable, ethical, caring decision makers" who direct learning experiences in tomorrow's schools.

The faculty also considered the work of Means, Blando, Olson, and Middleton (1993) who stated:

The primary motivation for using technologies in education is the belief that they will support superior forms of learning. For this reason, theory and research in learning provide an extremely important source of ideas. Advances in cognitive psychology have sharpened our understanding of the nature of skilled intellectual performance and provide a basis for designing environments conducive to learning. There is now a widespread agreement among educators and psychologists ... that advanced skills of comprehension, reasoning, composition, and experimentation are acquired not through the transmission of facts but through the learner's interaction with content. This constructivist view of learning, with its call for teaching basic skills within authentic contexts (hence more complex problems), for modeling expert thought processes, and for providing for collaboration and external supports to permit students to achieve intellectual accomplishments they could not do on their own, provides the wellspring of ideas for many of this decade's curriculum and instruction reform efforts.

In an effort to help students view instructional strategies from a teacher's perspective, the faculty shared the work of such scholars as Knapp and Glenn (1996) who reported:

Teachers teaching with technology say they:

- Expect more from their students and expect their students to take more care in preparing their work
- Can present more complex material
- Believe students understand more difficult concepts
- Can meet the needs of individual students better
- Can be more student-centered in their teaching
- Are more open to multiple perspectives on problems
- Are more willing to experiment
- Feel more professional because, among other things, they spend less time dispensing information and more time helping students learn (p. 17)

The integration of technology along with integration of the content has had a profound effect on the learning environment experienced by K-State's Secondary Education students. Students are constantly involved in activities which enhance skills in comprehension, reasoning, composition, and experimentation. Their projects and other assessment activities reflect greater creativity, they are more enthusiastic about collaborating with other professionals, they exhibit a greater commitment to teaching students rather than totally focusing on content, and they exhibit a greater degree of confidence and professionalism. Faculty and students who are involved with Block One are enthusiastic about the present and excited about the future.

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Training Preservice Teachers in Technology: A Portfolio Approach

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Beginning teachers are often ill prepared for the varied applications of technology in their classroom. The Teacher Technology Portfolio Program is a unique preservice program that combines the infusion of technology throughout the curriculum with the development of a reflective portfolio on technology in education. The program was initially tested with student teachers. Subsequently, every student in the department was required to begin a portfolio to be completed by the end of their student teaching semester. Based on initial evaluation results, a long range plan for continued revision and implementation of the project, training and support for faculty, and acquisition of necessary materials was developed.

It is apparent in the field of education that the preparation of teachers to effectively use and apply technology is lacking. Many local, state and national agencies have indicated a need for teachers, both at the preservice and inservice levels, who are better prepared in the area of technology (Lee, 1996; Northrup & Little, 1996; U.S. Congress, 1995). This viewpoint has been supported by accrediting agencies such as the National Council for the Accreditation of Teacher Education (NCATE) which has implemented new guidelines for teacher preparation including standards for technology (Thomas, 1994). There is continued discussion in the field on the best method for preparing teachers, such as using stand alone courses on technology versus the integration of technology into education courses, using a constructivist perspective versus a behaviorist perspective, or incorporating experiences in student teaching or clinical settings (Bosch & Cardinale, 1993; Thurston, Secaras, & Levin, 1996; White, 1995; Willis & Mehlinger, 1996). The Teacher Technology Portfolio Program was developed in response to these issues raised by cooperating satellite school districts, department graduates, students, and the field of education about teacher preparation and competence with technology.

Elmhurst College is a small, 4-year liberal arts college in the Chicago land area. The Department of Education includes programs in Early Childhood Education, Elementary Education, Secondary Education and Special Education. The Teacher Technology Portfolio Program integrates instruction on technology and modeling of instruction with technology throughout the course work in each of the teacher training programs. Preservice teachers begin their portfolios in their introductory courses or their first education course in the department with opportunities in methods courses to build technological competence; investigate curriculum and technology connections; and develop and implement activities that integrate technology. The Teacher Technology Portfolios are finalized during the professional, student teaching semester.

Development of the Program

Initially, faculty in the Department of Education determined the need for a method of infusing instruction on technology throughout the major courses. The idea of using a portfolio approach that would reflect a student's growth in knowledge and application of technology was proposed and approved. A three person departmental committee was formed to develop and monitor initial implementation of a portfolio approach.

Input requested from several departmental advisory councils, composed of administrators and teachers from surrounding local districts, indicated a strong need for new teachers, as well as veteran teachers, to have both basic and advanced technological competence and the ability to apply that competence in the classroom. Based on this input, the technology committee decided to survey students, assess their current knowledge, and then plan a course of action.

Using the text, Instructional Media Technologies for Learning (Heinich, Molenda, & Russell, 1989), the technology committee formulated a survey which was administered to both those students just entering the department's sequence of courses and those students about to student teach. (That text has since been revised and a 5th edition, 1996, is available). Students were asked to rate their skill proficiency in each of a number of areas by indicating previous acquisition of the task, ability to learn the task in the current clinical setting, or the need for an opportunity to learn the task on campus. The survey was strictly competency based and did not ask the students to assess their ability to integrate their technological competence into the curriculum.

At this time, guidelines for the portfolio were developed. Portfolio requirements included the development of a reflective statement regarding technology and education, the development and implementation of lesson and unit plans with artifacts integrating technology, and the documentation of mastery of basic and advanced competencies with a variety of instructional technologies. Using the results of the survey a list of basic and advanced competencies, as well as forms for documenting the acquisition of the competencies, were formulated and included. Also at this time, an advisory council specific to the Teacher Technology Portfolio Program was formed with the specific function of providing evaluative feedback and advice for the continued implementation of the program. The council is comprised of members of the college community, department alumni, students, and practitioners.

Time lines were also developed for an initial pilot test of the program in the spring of 1996 with students entering their professional student teaching semester. A series of on campus workshops were planned using the data from the survey to support the student teachers in their attempts to build competencies and complete the portfolio. Workshops were planned primarily in areas relating to computer use, telecommunications, and multimedia. Faculty were asked at this time to begin including technology activities within their course syllabi and to list the Heinich text as an optional text for students to purchase. In order to begin supporting faculty members in their endeavors, the technology committee proposed and received a small mini-grant to provide a series of full and half day workshops for full time and adjunct faculty with a focus on training in areas of technology and steps for integrating that technology into their courses.

Implementation of the program for all students in the Department of Education was scheduled for Fall, 1996. Plans for the fall included continued workshops supporting those students entering their professional student teaching semester and expected to complete a portfolio. A series of mini-courses was developed and offered to both student teachers and all other students. Education faculty were required to include the Teacher Technology Portfolio in their syllabus with opportunities for students to build competencies, to develop and field test activities with technology integration, and to reflect upon their experiences.

Evaluation, Revision, and Future Plans

During the pilot test of the program in the Spring of 1996, the student teachers were asked to complete seminar/workshop evaluations and a survey at the end of the semester about the portfolio process. Completed portfolios were assessed for number of competencies attained, number of lessons utilizing technology with artifacts, and the completion of a reflective statement on technology and education. Overall, the student teachers indicated a sense of the importance of learning to use and apply technology in the classroom. Although a variety of workshops at beginning and advanced levels were offered during student teaching seminars, many of the student teachers felt a lack of preparation to complete the portfolio satisfactorily. As well, a number of the students commented on the lack of technology in their field placements and therefore, the inability to implement the required lesson or unit plans.

Also during the spring, steps for preparing faculty to begin integrating technology into course work and supporting documentation of the student portfolios were begun. Results from a needs assessment, attitude survey, and the all-day workshop evaluation were compiled and indicated the same sense as the students regarding the importance of using technology as well as an equal need by the faculty for more adequate training on a variety of issues in order to be better prepared to infuse technology into their courses.

Based on the results from the pilot test and faculty evaluations, several revisions were made in preparation for the implementation of the program with all students in the fall, 1996. The portfolio guidelines were the first to be revised. Despite the fact that the student teachers were submitting *technology* portfolios, many completed portfolios were handwritten or typewritten. Specific instructions (with the requirement that all items must be completed on a word processor) and sample elements were developed. A bibliography of available library resources, procedures for documenting competencies from previous clinical or work experiences, and an evaluation checklist for the students to compete prior to final submission were also developed and included. Next, the supporting workshops for student teachers were revised to include a more specific focus on integrating technology into the curriculum, more hands-on, and some sessions for those students who were still fearful of technology. Additional stand alone mini-courses were developed and offered on basic instructional technology and using ClarisWorks for teacher productivity. Finally, plans were made for follow-up training for the faculty at the end of the semester and in the spring, 1997; improving the system for access and use of existing instructional software; and the printing of the portfolio guidelines and placement of them in the campus bookstore for purchase by the students.

Despite the fact that the faculty in the department have indicated the importance of and supported the need for this initiative, many still feel lacking in their preparation to actually implement technology in their courses. Others have expressed the desire to have the program more focused with clearer direction on what competencies and activities are expected in what courses. Stepping back and evaluating what has been completed so far, the realization that perhaps the program has attempted too much too soon seems clear. A long range plan with phases of implementation has been developed with start up in the fall, 1997. The phases of implementation in the plan build upon a growing level of expertise in varying areas of technology by the faculty (and subsequently the students) with opportunities for training and the acquisition of necessary resources, materials and hardware to support the phase. Each phase focuses on a specific area of technology, such as productivity software, telecommunications, or presentation software, and includes objectives and competencies synthesized from several sources (ISTE, 1996; Northrup & Little, 1996; Todd, 1993).

Conclusion

The Teacher Technology Portfolio program represents a major initiative with the Department of Education at Elmhurst College to infuse technology throughout the course work of the preservice teacher and to provide an opportunity for continued reflection about the integration and application of technology into the curriculum. The program is designed to produce teachers who can use the technology available in the schools and effectively integrate that technology into their units, lessons, and activities. The program is attempting to achieve the goal of preparing new teachers to effectively use technology. "Technology is the catalyst, but the chemical starters for such fundamental changes are teachers highly skilled in technology, with a deep understanding of curriculum and a knowledge of how children learn" (Lee, 1996, p.12).

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Reading, Language Arts and Literacy

Section Editors:
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We enthusiastically read a dozen papers from professors and graduate students through out the United States who have incorporated technology into literacy classes. As more and more of our preservice and inservice teachers are challenged by a variety of changes in literacy education, it is exciting that technology continues to play a critical role in the evolvement of reading, language arts, and literature in elementary, secondary, and college classrooms. The papers in this section range from theory to practice, and from ways technology can assist teachers to work with elementary students, to ways college professors can use telecommunications to better meet the changing needs of university teaching.

Crawford highlights the advantages of multimedia hypertext software for reading/language arts instruction. Multimedia enables teachers to individualize instruction as they address each student's preferred learning style. She discusses two instructional systems design models that developers of multimedia hypertext software can use to guide the development of multimedia software.

Caron cautions about the potential misuse of technology as literacy experts continue to debate critical issues in reading, and offers suggestions for improving dialog in the literacy classroom community through technology. Through his experiences teaching "audio" classes at his university, we are provided with options for distance learning at our own universities. Baines also discusses the success of technology in his English methods course. Through the establishment of a Web-site, students and professor were able to share course information and communicate their responses. He describes student response to reading and writing through this medium and offers solutions to some of the difficulties.

Zibikowski and Pan explore the unlimited possibilities for reading and writing on the Internet. They investigate the resources available on the Internet for research, the possibilities afforded by e-mail for communications across the globe, and the Internet as a means of publishing student work. Practical suggestions for teachers and a checklist for planning reading and writing activities on the Internet provide useful ideas for teachers as they embark on Internet explorations.

Using computers to enhance writing was the topic of several papers. Radar draws upon her own victories using the Language Experience Approach (LEA) when she was a classroom teacher and incorporates the concept into her college classroom. An updated version which includes theories from the process approach to writing and computer technology was a successful and authentic context for both preservice and inservice teachers. Ferris, Rogers, and Skolinkoff reflect on their experiences integrating technology into the writing process in a graduate level writing course. The excitement, motivation, and frustrations of using technology to enhance the writing process are described. Sometimes this medium can be so motivating that the objective of improving writing can be dwarfed by the computer itself. Smith-Gratto and Blackburn describe ways to prevent students from becoming so involved in the options of a writing program that they forget about writing while experimenting with a wide variety of graphics and sounds.

The issue of using technology to motivate and remediate the reluctant readers was the topic of two papers. Reehm and Long illustrate their work with teaching reading specialists during a summer reading and writing program. Through a variety of software programs, both the elementary students and teachers gained information about computers and software. The elementary students also improved in reading and writing. In a similar study, Gipe and Lamare also describe the implementation of technology in a corrective reading summer class for preservice teachers. They also report student responses to the incorporation of technology.

Williams, Tyson, Hilton, Kimbell-Lopez, and Granger write about their experiences of including technology in a field-based literacy course. Each section of the class had different technological outcomes based upon the availability of computers and software at the various elementary schools, and the technological experiences and comfort levels of the preservice teachers.

Two papers focus on ways that teachers of English as a Second Language (ESL) can also incorporate technology into methods courses for preservice and inservice teachers. Henrichsen's study recounts her experiences using the Internet with her ESL methods students. She discusses the trial and tribulations of both students and professor as they explored the Web and learned to use it with competence and confidence. Zhang and Feng report on software they have developed to help ESL/EFL teachers teach and access the reading strategies used by their students. A copy of their program is on the CD version of the annual.

We hope that you enjoy reading these articles as much as we did and that they motivate you to continue using technology within your educational milieu. We believe, that as literacy educators, it is essential that we allow our teacher preparation programs to evolve to better meet the literacy needs of our children. Technology must be a part!

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Developing a Multimedia Program for Reading/ Language Arts Instruction

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The world of Reading/Language Arts is a domain in which the beauty of the written word has the ability to create new, imaginary realms for its readers. The development of multimedia has introduced the educational environment to a vast expanse of intriguing, useful environments through which learners can fully develop a critical understanding of literary masterpieces through multiple learning styles. Through multimedia technology, the blending of visual, textual and auditory information enhances the environment for the learner and aids in the understanding of information and as stated by Elliot Eisner, "in so doing to help provide our children with a balanced educational program that does justice to the capacities of their minds, and that helps them access meanings that transcend the limits of the literal" (Getty Center for Education in the Arts, 1996, p. 10).

"As teachers are given the appropriate tools to incorporate these media into classroom practice they will be using these tools to structure information into a format that allow it to become, for the student, knowledge" (Buck, 1995, p. 12). One way of integrating Reading/Language Arts is the use of hypertext within a multimedia program that integrates the strengths of each student's learning style within a classroom situation.

Teaching towards the strengths of each student's learning style, whether it is visual, auditory or kinesthetic, has traditionally been problematic. It is difficult to offer a classroom of students each of these learning situations within a short time each day. However, with the arrival of multimedia technology, the education of each student is personalized to emphasize the learning style strengths, while also offering a variety of learning situations on the same topic (Toh, 1996). The term multimedia describes computer assisted instruction (CAI) which is computer controlled access to multiple medias, including text, sound, animation, pictures and video within an interactive environment while, at the same time, integrating the slides, overhead transparencies and lectures of the instructor in the traditional classroom (Helms and Helms, 1992; Barker, 1996). Multimedia technology can incorporate separate learning styles within the identical learning situation. The integration of hypertext, the examination of linear versus non-linear structural software arrangement, the aesthetic experience of the user, the creation of a multimedia product and the inclusion of instructional principles in multimedia software packages is integral to the development of a sound multimedia hypertext software program.

Multimedia has multiple meanings within the instructional environment. A multimedia program "can be anything from an electronic book to an interactive course, from an interactive slide presentation to a multimedia newspaper or an orientation tool, from an interactive auto manual to a clinical record." (Makedon, Rebelsky, Cheyney, Owen & Gloor, 1994, p. 38) The incorporation of the multimedia elements into traditional instruction enriches the experience of the user (Toh, 1996) and has the ability to aide in the rejuvenation of even the most staid of curriculums by rebuilding the classroom environment into one of excitement and cooperative, open learning (D'Ignazio, 1993). Kommers and Lanzing state, "Learning is mediated by thinking (mental processes). Thinking is activated by learning and activities, and learning activities are mediated by instructional inventions, including those mediated by technologies" (1996, p. 156). Technology invites the instructional environment to develop useful multimedia hypertext software programs that formulate a creative, effective learning atmosphere for the user.

One aspect of multimedia, which is considered to be the strength behind multimedia, is hypertext. Hypertext is the ability to move in a non-linear fashion throughout subject matter content. It is seen as a positive tool through which a user can develop connections within a body of text, commonly described as context (Paul, 1996). This significant aspect invites the user to develop and thoroughly organize the knowledge being attained in a thorough manner (Murray, 1996). This organizational development helps the user to structure the knowledge into a personalized, workable model that will aide in knowledge retention and information gain.

The internal structural arrangement of a multimedia hypertext software program is of primary importance to the users' comprehension. An understandable navigational system must be in place for the users so that they will focus upon the knowledge to be gained from the software program, rather than the structural arrangement of the multimedia hypertext software program. Multimedia can be used to develop software that follows a linear arrangement such as Grandma and Me by Brøderbund Software (1994), meaning that the only choice of the users is to move from one frame to the next in a book's page-turning fashion. Multimedia also offers the ability to move in a non-linear (or hypertext) arrangement, which describes the ability to follow multiple paths and allows the user to make choices within the software program. However, disorientation may occur when using non-linear software due to the large structure through which the users must navigate. Disorientation may occur when the users cannot decipher:

1. where they are within the navigational structure,
2. how to move forward within the software program,
3. how to return to their previous point within the software program,
4. what information is available to them from a point within the navigational structure (Conklin, 1987; Rivlin, Botafogo & Shneiderman, 1994; Nemetz et al, 1996).

Due to the problems of disorientation, it is important for the users to understand the structure of the software program (Nemetz et al, 1996). As noted by Kommers and Lanzing, "The advantage of carefully arranged dyads in an early stage of the design process is that several matching criteria like prior knowledge, actual interest, cognitive style or problem approach, can be obeyed" (1996, p. 155). Therefore, although software structured in a linear manner may be easily followed by the users, a well-structured internal navigational system within a multimedia hypertext software program may be advantageous in a non-linear fashion.

Not only is the structure of the software program important, the aesthetic experience presented to the user is also important. The aesthetic experience is the subjective perceival of the software by its audience. The aesthetics of a software program have "increased learner attention, content relevancy, student assurance, and program satisfaction" (Ent, 1996, p. 764). Ent continues by describing the four areas of aesthetic importance that software designers should consider when developing a software program: a continuous artistic theme should be developed, high-quality moving video and sound files, the aesthetic experience should parallel the informational content of the program, the use of aesthetics to parallel the emotive as well as cognitive responses of the user. The aesthetic experience presented to the user must be of primary consideration to the multimedia hypertext software program developer.

The creation of a multimedia hypertext software program is a rigorous journey through which the developers must proceed. To create a multimedia product, there are several inherent components that occur and this development process is described as the instructional systems design (ISD) model. The ISD model defines the formative structure and order required by a developer to produce a final instructional product. Two well-known models are Dick and Carey's Systems Approach Model, which is so named since the model "is made up of interacting components, each having its own input and output, which together produce predetermined products" (Dick and Carey, 1978, p. 11), and Thiagarajan, Semmel and Semmel's Four-D Model (1974) which is a linear model, also described as a behavioral model, that was originally developed for use as an ISD model for special education modules. The Four-D Model was developed and named due to the four stages of development: define, design, develop, and disseminate. The Systems Approach Model as well as the Four-D Model are two well-known ISD models within the developmental arena; however, numerous other models are available to developers.

Another instructional systems design (ISD) model is Makedon, Rebelsky, Cheyney, Owen and Gloor (1994) which delineates several inherent components that occur to create a multimedia product. The following is a graphic explanation of the previous textual description of the inherent components involved in multimedia software development:

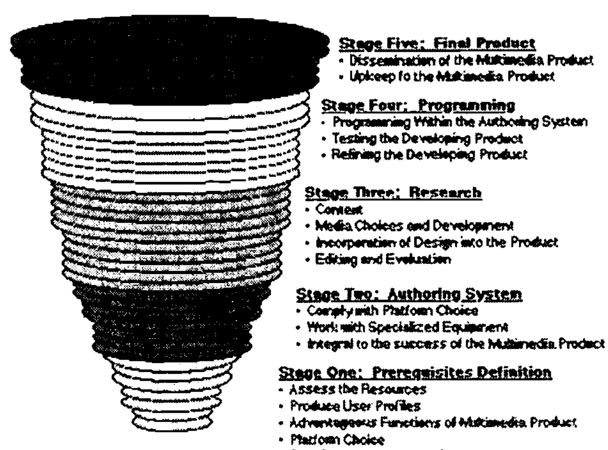

Figure 1. Components of Multimedia Software Development as Described by Makedon, Rebelsky, Cheyney, Owen and Gloor (1994).

The five stated inherent components to multimedia software development are vital to the successful completion and usage of the multimedia software package. Although stage five is not of primary importance to the development of the software package, it is essentially associated with the final, existing end product. Once the multimedia software package is complete its next step, stage five, is dissemination. Dissemination may attract many different areas within the consumer market, such as individual, corporate or educational usage.

The classroom environment takes on a life of its own within each learning situation. Once multimedia software is added to the environment, the instructional principles of the multimedia hypertext software program may become uncertain, if the developer is unaccustomed to the integration of instructional principles with technological aspects. Suprise and Mitchell (1994) articulate instructional principles to guide the user of multimedia software within a classroom environment. Six relevant aspects of instructional principles are stated that, although prevalent within the traditional classroom environment, may be lacking in a multimedia software package:

1. prepare the learner,
2. attract and direct the learner's attention,
3. guide the learner through successive steps of complexity,
4. present the material repeatedly in a variety of contexts,
5. provide a vehicle for practice with immediate feedback, and
6. make connections between new information and old information, showing how it fits into the 'big picture.'(Suprise & Mitchell, 1994, p. 532)

Although these are common instructional principles used within a classroom environment, these six principles may be lacking within a multimedia software package, perhaps due to lack of forethought or theoretical background on the part of the multimedia development team.

Teaching towards each student's learning style and strengths has traditionally been problematic within what is considered to be an established classroom situation. Although these learning styles prefer individual, or perhaps a combination, of instructional situations, the short time allotted for classroom instruction makes teaching towards each distinct student's learning style unfeasible. However, the advent of multimedia technology has presented the educational community with the ability to seamlessly integrate the visual, auditory and kinesthetic learning styles into a multimedia hypertext software program, which was previously inaccessible to the instructional situation. This style of software can integrate multiple medias, including text, sound, animation, pictures and video within an interactive environment while also integrating the slides, overhead transparencies and lectures of the traditional classroom instructor (Barker, 1996). The integration of the multiplicity of multimedia hypertext software programs strengthens the instructional classroom situation of the user, due to the ability of the multimedia hypertext software program to meet the learning style needs of each user.

Although the use of multimedia hypertext technology is quite original and unique, the Reading/Language Arts community cannot disregard that, "...as every instructional designer knows, the power of an instructional approach lies in the science and art of instruction - not in the technological components which comprise a hardware system" (Schwier & Misanchuk, 1993, p. 3). Through development of a multimedia program for Reading/Language Arts, the blending of visual, textual and auditory information enhances the environment for the learner and aids in the understanding of information. Therefore, the integration of hypertext, the examination of linear versus non-linear structural software arrangement, the aesthetic experience of the user, the creation of a multimedia product and the inclusion of instructional principles in the design of multimedia software packages is integral to the development of a sound multimedia hypertext software program within Reading/Language Arts. The new, imaginary realms that can be created using multimedia hypertext technology within the world of Reading/Language Arts have the power to move beyond the written word to embrace each learner's needs as well as strengths. Perhaps the most enticing aspect of this new technology is the realization that it is only a page turn away.

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Optimize Literacy Learning with Computer & Video Technology

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Technological advances are appearing faster than we can easily integrate them into our educational contexts and settings. Businesses quickly buy up the latest "fully loaded" multi-media computers with all the business software anyone could need. School boards and individual schools jump on the same band wagon, sometimes before deciding what is needed and for what purpose. Educators, administrators, and parents may be easily swept away by promises of optimal learning environments, easy progress tracking and relative low cost for a powerful return on investment. We need to be cautious, however, in thinking about technology in education, remembering always to put relevant technology to use in the achievement of our educational goals, not defining goals according to the latest technological innovation.

All of us who work in teaching and learning recognize the potentially immeasurable benefits that can arise from the uses of technology in our daily work. Some would even suggest that the ways in which children learn shall change through interaction with technology (Pappert, 1987). Others remind us these changes are not to be enjoyed without complications in the transition to new forms of teaching and learning (Selfe & Hilligoss, 1994). This paper will describe how uses of technology have supported an enhanced environment for teaching and learning in Graduate Reading Education.

Computer technology has led recently to possible answers to questions in the field of reading education. The "great debate" in the reading field has been driving discussions in reading education for decades. Frank Smith (1978), following (1967), described the process as primarily one of searching for meaning, driven by a reader's thoughts and understanding based on a sampling of text. Jeanne Chall (1983) on the other had describes the process of reading on the basis of specific skills and letters and words in isolation. Roger Schank (1982) wrote a computer program to "read". It soon became evident that decoding is not as valuable as reading for meaning first using prediction on the basis of understanding as a guide. Constanzo (1989) outlines these ideas in The Electronic Text.

Children's interactions with technology may well lead to expectations of a more "video-like" learning environment, consisting of attractive visual displays and quick changing backgrounds, contexts, and even topics. We need to be careful that we are not being driven by a technology we begin to believe is forcing us into these kinds of changes regardless of the value to learning and educational environments. As educators we do not want to put computers and technology to use simply "because it's there", we want to learn about the ways in which the uses of technology can enhance the educational environments we wish to create to support the learning goals we plan. Sometimes existing technology while improving certain aspects of the learning environment causes deficits in other areas. An impetus behind the exploration of new technologies was stimulated in part by just such an eventuality.

Audio Context

A technology in present use at my university is a telephone bridge to support what we call "audio" classes. These are classes in which the instructor meets at one location with a small group of students and other groups of students meet at sites around the southern part of the state where they dial in on a speaker phone to a designated "phone bridge". The class meets weekly over the phone lines from five to ten different sites, where there are anywhere from one to several students at each site. Students (except for those at the instructor's site) meet with the instructor and class speaking into a microphone and listening on a speaker phone. Although the use of this technology allows students from a wider area to "attend" such classes, the opportunities for activities to support student learning during class can be severely limited by this audio context.

Although this setting is suited to a "lecture" style presentation, it is impossible to track students' attention and status during the class. One is led to create many small activity requirements for students to share as a way of ensuring their participation and attention. Everyone has access to a mike and speakerphone at their site, but the quality of either the mikes or the speakers sometimes leaves much to be desired. Many times what is spoken or heard is incomprehensible to the listeners. This setting is ideal for experimentation with additional uses of technology to support a closer association between teaching and learning.

The familiar technologies of reading and writing find a new high light and cause celebre in this setting. It is easy to convince individuals attending a class that substantial amounts of writing can be required as one of the few ways of staying in close touch with students. Written reports, critiques of professional literature, weekly journals, brief reflective book reviews and outlines of practical activities all take on real meaning as the only mechanisms for communication between teacher and students. Without the possibility for personal communication between class members and the professor, it is likely completing a paper through subsequent drafts can help the instructor be in closer touch with the students' writing. Students themselves who value the access to coursework that audio courses provide quickly seem to put high value themselves on their written work. It is that much more important for them too, it seems, to provide their best work to the professor. But even with the increased benefit and valuing added to an even greater load of written assignments, there are drawbacks added.

The forced and continued distance between Professor and students causes a greater sense of distance in communication. The time it takes for assignments and papers to be exchanged via the mail system causes a forced delay. It is difficult to discuss in class any relevant aspects of assignments or issues that arise without the documents in hand. This technology that facilitated simplistic communication over distances creates new problems and breaches in communication. However, other forms of technology can provide new bridges across these distances. Interactive exchange across the Internet can create a medium for immediate communication with and about written documents or files.

Computer Support

Computer technology has been used to support the exchange of students' papers with the instructor and with each other, as well as the uses of email among class participants. The exchange of student work using email, not only allows papers to be handed in as soon as they are completed (instead of traveling by surface mail), they can also then be easily read by the instructor, commented on in the file, and returned as soon as read with comments to the student. E-mail exchanges between instructor and students allow for questions to be easily asked and answered, as well as this information shared amongst all students who need only to read the exchanges and can participate in the "on-line" discussion as well. Transcripts of sample exchanges and edited and commented-on papers will be shared with participants at this presentation. A variety of set ups of such technology have been used to support this kind of interaction.

Local Area Network. The computer network that provides the easiest access for use as well as training is the local area network (LAN). This technology of linking a number of computers together (usually 20 or 24) simplifies the ability of each computer to access a databank of software housed in one of the computers on the network. It has been found that each user can access the software more quickly if it is in his or her own hard drive. It was not long before I found we had all the necessary software available on each computer in a network.

VAX Notes. Another network setup we have tried is Notes, a bulletin board communication software available on the mainframe. Such software supports email exchange, file exchange, and an ongoing bulletin board communication. This bulletin board allows users to read messages posted by anyone else in the group. Each message appears in order, allowing those in the system to read each message in order as it is sent and anyone may choose to respond to any message. Looking at this as a medium for communication it is interesting that no one is required to respond, yet everyone has access to read and to respond if desired. One of the aspects of the way this system is configured may actually create more of a problem than is immediately obvious.

The Notes bulletin board displays each message as it is entered. There is a very short delay between typing and entering any message and submitting it. This creates an illusion of immediate communication and contact. But if you read a message and wish to respond, that respond becomes coded in the bulletin board listing, as a response to the first message. In fact, it is not even coded with an identifiable subject heading. Although this bulletin board seems to allow for a free flow of communication, once you are involved and responding to messages you soon find it is actually more cumbersome than talking. The groups participating typically had a large number of students relatively unfamiliar with computers, some with keyboarding. Extra time had to be assigned to provide sufficient training for students to participate. "On-line" responses had subject headings which could be perused prior to selecting and reading according to class assignments. But responses, which were required of students, and often led to interesting discussions, did not receive a subject heading. After each subject heading listed for each original entry, Notes simply provides the "number" of responses to that note. This made it difficult to get engaged in a discussion on a topic without tediously reading through all responses before finding those of interest and responding.

Internet Email. Eventually, the simplest network setup proved the most useful. In search of a solution of the amount of training time required for novices to learn the necessary commands to participate, and to find a way around the cumbersome set up of "numbered" responses to "named" Notes, as just described, it was decided to simply provide students with computer addresses and NOT require the use of notes. A Group was created and named, so that, any message sent to the group name would go to all members of the group. separate or individual messages could also be sent to the professor or to any student in the class. All that was necessary for the group to be established was for the email addresses of the entire group to be named as a group and for this list to be accepted as a file by each of the members of the class group. This enabled anyone in the class to be able to send to the entire group. This simple format was noticeably the best for providing the exchange of communication needed: e-mail exchange, file exchange, group access to communication, and relatively easy access for each member of the class.

Video Support

Whenever there are more than one student at each site, it is possible to institute small group discussions at these sites and then report back to the entire group, but there are usually one or more sites with only one student in attendance. It became evident that the pace of discussion in the class, whether of lectures, questions, or group discussion was greatly slowed if not disrupted across this audio setting. This was made considerably more difficult when equipment did now allow for easy change from one speaker to the next. There is typically too much of a delay for this to be like "discussion" and with voice-prompted mikes, the slightest noise can cause disruption. It was necessary to find some alternative forms of communication to add to the setting.

Besides the uses of computer communication already discussed, brief videos of "mini-lectures" were created, copied, and sent to each site. This enabled students at each site to go "off-line" during the class time and view the week's video before returning to the whole class setting on audio. Students responded favorably to the addition of these video mini-lectures.

The use of video "mini-lectures" was expanded to allow for student in-class activity assignments related to literacy learning to be video-taped and sent to the instructor. Not only did this enable the instructor to see a student teaching reading in his or her actual classroom, it also allowed for excerpts to be re-taped and a "class demonstration " tape to be subsequently shared by the entire group of students. These tapes became a means for using technology to establish greater communication in the group.

In conclusion, the positive effects and responses from students related to these demonstrated uses of technological support for learning were enormous, by their accounts. The great benefit students themselves write about in comments on line and about the class suggest that the extra effort and time required to set up and provide these elements of support are certainly worthwhile. What the students have to say about how their own learning was enhanced provides excellent justification for anyone considering implementing these uses of technology to support students' learning experiences in any class.

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Plainspeak or Technomorph? Communication in a Web-enriched Teacher Education Course

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LAE 4360 is an English language arts methods course, the culminating methods class before students go into the field for their internships. The course has been traditionally paired with a two-hour participation and observation class — LAE 4941 — which requires that students spend a great deal of time in the schools helping teachers and making field observations in journals, which have always been kept in spiral notebooks. Instructors of LAE 4941 usually take up the notebooks at the end of every week so they can see what students have seen and to comment on the student observations. In this manner, the instructors and the students hold an extended dialogue throughout the semester.

As part of the curriculum in LAE 4360, students are required to read and respond to a variety of articles. These readings and responses are coordinated with the students' experiences in LAE 4941. The instructor of LAE 4360 makes the request that responses should be at least a page in length.

The Web-enriched Environment

Prior to the Fall 1996 semester, Web-sites were created for all LAE 4360 and LAE 4941 classes. (See the attachments to see how the site was set up). The creator of the web-sites gave all instructors of both courses a mini in-service concerning how to use the Web-site so that they could incorporate it in their classes. The faculty who taught the LAE 4941 course were initially excited about the prospect of not lugging home thirty spiral notebooks every weekend. They all became familiar with the Web-site in a trial run.

The Websites included sections for the following: class roster, syllabus, readings (some articles in their entirety were placed on the Web — a new article about every three weeks), conference rooms, and an interactive message board, where students were to write their responses to the articles available over the Web. The responses posted to the Interactive Message Board (IMB) on the Web were assigned to be "of similar length" to those done off-the-Web (written in pen and paper or word-processed —no student ever handed in copy written on a typewriter). When students signed on to the Interactive Message Board, they could read other students' comments, then post a response, themselves. If a student wanted to respond specifically to a comment made by one of her peers, she would have one of three options:

1. Click on the person's e-mail address at the end of that student's response and send an e-mail message directly to them.
2. Post a second response to the individual on the Interactive Message Board.
3. Contact the student via e-mail (or in person) and move the discussion into one of the three conference rooms, designated for just such a purpose.

During the semester, the 22 students of LAE 4360 posted three responses to the IMB and wrote out three responses using pen and ink or a word-processor. Initially, it was thought that computer availability would not pose a problem for students, as the College of Education had over 100 Internet-accessible computers available in their lab, another nearby building had 60 Internet-accessible computers, and there were several hundred others available in the three libraries and scattered around other locations on campus. Although no student said that they were ever "closed out," many students complained that it was "just a hassle" to come into campus to respond to the topic rather than being able to "scribble something on a sheet of notebook paper." Few complained of a wait to gain access to a computer, and, of those who did, none complained of a wait longer than five minutes.

The Differences of Language in the Two Environments

Of the 132 possible responses, there were 116 samples of writing in all, 59 on the Interactive Message Board and 57 handed in on pen and paper (some students failed to turn in particular assignments or turned them in late and were not counted). For each response, I calculated the number of words written, the number of sentences per response, and the number of words containing more than three syllables. I also made notes on the kinds of language used.

In general, when students did NOT use the Interactive Message Board, they tended to write 2.5 times more words and tended to write sentences that were twice as long. In addition, the number of grammatical and spelling errors in the Interactive Message Board responses were about three times higher than when students wrote handwritten or word-processed responses. Given these three conditions — that students tended to write fewer words, compose shorter sentences, and have more errors, it is a little surprising to note that the vocabulary used by students over the Interactive Message Board tended to be a little more polysyllabic.

A Closer Look at Some Student Responses

Below are some sample excerpts taken from student responses in both conditions — from the Interactive Message Board and from handwritten/word-processed papers.

Bess (Interactive Message Board)

"The one thing I'm confused about with the project is the sequencing. Have the students already read the play at home, so that the class can begin discussing it together? I assume we don't ask them to figure it out on their own and then come together. Also, is this six weeks set up for black [sic] schedules or hour classes? Also, how are grades given? I didn't understand the 10-%/20% deal. I also think I might leave out the summary option — it seems kinda lame compared to the other projects."

Bess (Word Processed Response)

"This article brings up another important issue: that pedagogical theories often become limited when we as teachers jump on the bandwagon of what's 'fashionable,' without thinking of what's good for our individual students. While I do believe wholeheartedly that I should be open to revising my teaching practices, to always listen to new ideas, etc...I also know what it feels like to try, even in small things, to fit into a certain mold because of pressure not to be too (gasp) traditional."

Randy (Interactive Message Board)

"But, what I've found over the last year with the increasing popularity of the Web, that the Web is actually becoming as complicated to find specfic [sic] material on specific subjects due to time constrainst [sic]. How will the [sic] become organized as it continues to grow bigger and bigger everyday?"

Randy (Handwritten Response)

"As teachers, we are said to be a sense of authority in the classroom to our students. We didn't go through four years of college for nothing. So, yes our jobs are to guide the classroom learning environment, but also to be an authority figure on the subject of English."

Pearl (Interactive Message Board)

"I like the ideas in this article — especially the hints about links to Web sites around the world. Students will find an interactive approach to the language arts fresh and relevant."

Pearl (Word Processed Response)

""'At this stage of the process, whether as a result of peer editing or teacher conferences, students will have had several opportunities to work on content, grammar, punctuation, and form. Thus, bringing in the red pen for objective comments enables the teacher to 'be constructive, but should also provide enough encouragement to make students want to keep writing" (2)."

Sarita (Interactive Message Board)

"Would even a great approach to studying Shakespeare, as the one in this article, be capable of getting these students involved in the Bard? Can't hurt to try, I guess! I was also curious to know, when arriving at the mention of 'discussing' the text, exactly how a discussion of the play would transpire in this non-traditional approach to Shakespeare."

Sarita (Word Processed Response)

"While I believe a certain emphasis on these philosophies is healthy, I also firmly believe in the teacher as role-model, mentor, and authority (in the sense that you've gone to school for many more years than your students and, hopefully, know a little more than they do). So, I believe there is plenty of room for both systems to coexist in the classroom, but I also strongly believe that teachers shouldn't be afraid of pushing their students, of challenging them beyond what they think they are capable of and then, when the student founders, providing students with their expert guidance."

Table 1.
A comparison of the language of responses on the Interactive Message Board and handwritten/word-processed responses

	total number of words (mean)	number of words per sentence (mean)	number of words using 3+ syllables
Interactive Message Board	178.3	9.0	1 per every 10 words
Handwritten or word-processed responses	431.3	17.8	1 per every 12 words

Even a cursory examination of the differences in these pairs of student responses will reveal that the tone and style of the writing on the Interactive Message Board differed markedly from the handwritten/word-processed responses. In the Web environment, word choices are much more like oral language than written — Bess wrote, "kinda lame," Randy made many proofreading errors (and used the phrase "bigger and bigger" to describe the growth of the Internet), Pearl and Sarita wrote in noticeably less sophisticated language on the Interactive Message Board.

Conclusions

While there is much evidence to support the contention that students writing on the Interactive Message Board tended to be more conversational, to employ simpler sentence structure, and to utilize many features of oral language, the high use of polysyllabic words makes categorization more complex. Anyone who has ever transcribed an oral interview from audiotape knows that informal oral speech has many, many more false starts, repetitious language, and nonsensical sentences than were evidenced by the four excerpts of student writing on the Interactive Message Board. Indeed, it appears as if student responses on the Web were somewhere between the sophistication of written language and oral speech. Because the assignment was identical in both conditions, the disparity in the language used by students may be attributable to student perceptions of the limitations and propensities of the Interactive Message Board.

Student Observations of the Different Writing Environments

For a final assignment, students wrote a ten-minute response (using pen and paper) concerning the differences between posting a response on the Website and writing one otherwise. Most of the students reported that they perceived **ease of use** to be the major advantage of posting responses on the Interactive Message Board.

> "It's pretty tough to lose the article once it's assigned — and with the amount of loose paper in my life, this is a wonderful thing." (Sunny)

> "I like to post things on the Net because I don't have to worry about turning it [sic] in." (Cathy)

> "I feel less pressured to turn in perfect copy when using the Net." (Katrina)

> "The whole issue is [one] of convenience. Using the computer seems to be a lot easier for me." (Mykeisha)

> "I am so used to writing on my dated word processor that I think that I am used to writing on a screen." (Cody)

> "By using the Net, I am forced to do my response while the article is fresh in my head." (Craig)

> "I prefer the Internet because I feel like it can be more of a freewriting response. I don't worry as much about grammar and mechanics." (Leigh-Anne)

> "When we write on the Net I am a lot more comfortable with my writing language. It sounds more casual to me and doesn't feel very well thought-out." (Coleen)

Two disadvantages to using the Interactive Message Board listed by most students were the difficulty of revising written responses and inconvenience of reading articles on the screen.

1. Difficulty of revising written responses

> "I like to write in the margins, and use a highliter pen when I read and write. Posting the answer to the bulletin board was quick, but I felt unsure of what sized response to make." (Pearl)

> "I felt myself having to abandon writing to go back up to the text so that I could refer back [sic]. If I had the actual text I could simply look up and see the part of the text I needed. I just felt restrained." (Larry)

> "I don't feel I ever do my best writing on the Net. I feel everything I do is like my e-mail correspondence — random connections, stream-of-consciousness." (Bess)

2. Inconvenience of reading articles on the screen

> "When I have a hard copy I have the luxury of reading outside and writing my response at the park, in the pool, or wherever. I lose that once I log on." (Deidre)

> "I like having the text in front of me to refer to which you cannot do on the computer. It's most irritating that I do not have a computer at home." (Janie)

> "I tend to read more carefully and my writing is generally of a better quality when I write on paper." (Sarita)

> "When responding to an article, I like to have the article in front of me so I can refer to it. This is pretty much impossible since the article is on a totally different page than the IMB." (Cade)

Only a few students chose to mention what initially was considered to be a major advantage for posting responses on the Internet — the ability to read other students' responses.

"I like reading what other people have already posted. I like a little time to 'digest' what I've read before I respond to it." (Rose)

"With the Net, I feel like I'm sending my ideas out into nowhere for anyone to criticize them. It's kind of a defenseless feeling." (Bertha)

Plainspeak or Technomorph?

In a study of participants' use of "long-distance conversations over computer," Wilkins (1991) found that correspondence over the computer tended to share many linguistic similarities to oral speech, including lexical repetition, false starts, and prevalence of informal language. These features were evident to some degree in most of the students' responses on the Interactive Message Board.

Although Walther (1996) has suggested that computer-mediated communication might allow for even more ego involvement and personal interaction (called "hyperpersonal interaction" by Walther) than face-to-face encounters, no such hyperpersonal interaction was detectable in student responses. In fact, the feature of a student being able to respond immediately to the response of another student via e-mail was rarely utilized. No group of students ever established a sufficiently compelling conversation to take it to a conference room, which had been expressly created for such a purpose. To be sure, the e-mail and the conference room features were not utilized much.

What is most interesting about this semester-long study is students' perceptions of the limitations of the Website. Indeed, one disadvantage to the Interactive Message Board which was cited often by students — the difficulty in revision — could have been easily solved by word-processing a response first.

A word-processed response could be copied to the Interactive Message Board easily. Although students were shown how to perform such an operation early in the semester, none chose to try it during the course of the term. It was as if, once students logged on, there was a sense of urgency to fire off a rapid reply that was not present off-line.

Similarly, students could have avoided the inconvenience of having to read the articles on the computer monitor by printing out the article on one of the many printers available. At the time, all laser and dot-matrix copies were free of charge. Yet, few students ever printed out copies of the articles.

While the language of the Interactive Message Board had many qualities of plainspeak — an easily accessible, easily comprehensible almost oral type of language — the prevalence of polysyllabic words and the unexpected perceptions of students regarding the limitations of the technology, seem to characterize the language of the Interactive Message Board as a sort of technomorph — a language that exists somewhere between the oral and the written, moderated by the individual's perception of the capabilities of the technology at-hand.

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POTENTIAL READING AND WRITING ACTIVITIES ON THE INTERNET

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The Internet (Net) is a powerful and versatile environment for literacy development. Teachers can actively engage students in writing by providing individual students with opportunities to communicate with one another on-line, to locate current literature for a research report, or to compose a World Wide Web (Web or WWW) page for the class. However, the Internet can also become a complex and uncontrollable learning environment if not monitored properly. Internet users may sometimes get lost in the large amount of information which might be either inappropriately presented or useless. To obtain the best results using the Internet in the writing class, it is crucial to plan adequately and implement tasks only after careful analysis of how each component of the Net meets students' literacy development needs.

There are many different services or components of the Internet, such as electronic mail (e-mail), Gopher or File Transfer Protocol (FTP) for information exchange between remote computers and the local computer, discussion lists, and the World Wide Web. These components, as briefly described in this article, make the Internet versatile and interesting. More importantly, these components can facilitate a rich and exciting learning environment for reading and writing instruction. With good planning, teachers can set up highly engaging and authentic activities that make extensive use of Internet components.

Examples of Internet-based instructional writing activities include the following:

- Learning to find resources on-line. On-line databases, files, and information accessible via the World Wide Web greatly expand the speed and immediacy with which students can conduct research. Students can track weather conditions in far-away places to write reports for earth science or geography classes; in a history or government class, they can read and discuss the texts of candidates' speeches on the same day they were delivered, and can then write responses to be sent immediately to the candidate; they can extend their interest by writing messages to be posted to discussion groups, where they will be read by hundreds or thousands of others with similar interests. They can explore careers by visiting sites on the World Wide Web that allow them to learn about the work of individuals in many fields, or by downloading information about educational programs and requirements.
- Presenting the results of their research in a variety of interactive formats using multimedia and hypermedia programs. To enhance the traditional oral or written report, students can create graphical slide shows, or even Internet home pages, to share their knowledge and interpretations with others.
- Establishing interpersonal exchanges, including "keypal" (electronic penpal) connections and on-line "mentoring" of students to facilitate language learning, to improve precision and clarity in writing, and to learn directly about other people and places.
- Posting questions to solicit other people's opinions about books and other media, current events, or issues in their research projects.

Engaging in critical and creative thinking through on-line simulations. Through vivid programs that replicate the experience of being in a place, or through interacting with others in a MUSE (a real-time, multi-user simulated environment that may be text-based or object-oriented), students can come to know about an era, a locale, a social dilemma, or a political decision in a way that was not possible without the technology. These virtual experiences, like actual experience, can form the basis for vivid and detailed writing and more active, engaged learning.

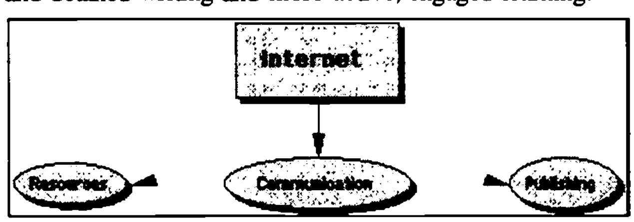

Figure 1. Internet-related activities.

Types of Internet Activities

When considering the many components and services available on the Internet, three different areas (or types) of activities related to writing instruction can be identified (as shown in Figure 1), according to their function: resource-based, communication-based, and publishing-based. Resource-based activities are those in which students use the Internet to locate information relevant to various projects that involve writing. For example, when writing research papers on career choices or health issues, students can visit Web sites of schools, corporations, or support groups. Communication-based activities are those in which the main purpose is to engage students in use of written or oral language for "real" communicative purposes, so that they become more fluent and comfortable with interactive language processes. An example of a communication-based activity would be an e-mail exchange between students at two different schools collaborating in data collection for a science project. Publishing-based activities also involve communication, but to a wider audience than e-mail. By creating home pages that can be visited by anyone in the world browsing the Web, for example, students can publish their work for a wider audience than was possible before the Internet.

Within these three areas, two types of activities are identified to engage students in active learning: a) activities that develop basic skills and knowledge about Internet components; and, b) activities that require application of Internet tools for integrative writing tasks.

Once students have mastered the basics of the Internet through assigned activities, the goal should be for them quickly to start using the Internet as an essential tool for learning their school subjects. In doing so, they will develop literacy skills such as organizing information, considering audiences, spelling and punctuating correctly, reading critically, and formulating ideas clearly in writing.

Using the Internet for Communication

Using the Internet for communication means e-mail, but it now can involve much more (as in Figure 2). E-mail remains one of the most popular applications of the Internet. If there is no other use of computers for communication in schools, teachers will probably want to use the Internet's capacity for one-to-one message exchanges between teacher and student, student and student, and students with others outside the classroom as ways to develop an understanding of how to use written language effectively. Mail provides not only an immediate, real audience for students' writing, and therefore a motivation to write, but also an opportunity for users to see each other's written work, to offer critiques and comments within a community of writers, and to develop a sense of the relationship between oral and written discourse.

The potential of electronic mail expands when students have access to listserv discussion groups and Usenet newsgroups. With these facilities, the audience for student writing is expanded and students' literate communities can begin to encompass a much wider world than their individual classrooms and neighborhoods. With proper precautions, participation in discussion groups can introduce students to the ways that common interests and purposes help to define different styles of communicating within subcultures. The tone and style of messages, and not just the content, differs greatly between sites, ranging from the whimsical, spontaneous postings on alt.rec.MST3K groups to the polished, thoughtful, and knowledgeable postings on alt.rec.music.classical groups. Teaching about "netiquette" and the discourse conventions of on-line discussions can enhance students' appreciation of the relationship between language forms and social contexts, audiences, and purposes.

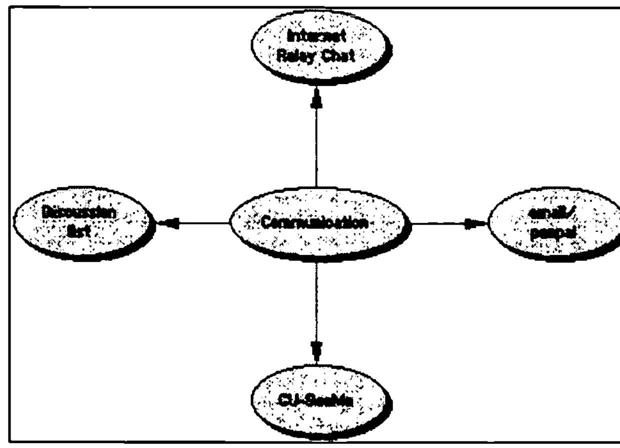

Figure 2. Communication-based activities.

Additional communication-based activities include Internet Relay Chat (IRC) and videoconferencing. These real-time modes allow several individuals at separate remote locations anywhere in the world to exchange instant messages, viewing the messages as they are entered, or actually seeing moving pictures and hearing audio of others in the group during a conference. Already, on-line services such as Scholastic On-line have provided students with many opportunities to interact with well-known adults such as the authors of children's books in on-line forums; these new technologies make it easy for teachers themselves to arrange for on-line "guest speakers" with knowledge directly related to students' reading and writing assignments, and in an even more vivid and immediate way than could be done before. Also, if students in classes at different sites are collaborating on projects, conferencing technologies can allow them to contribute ideas for immediate evaluation by the whole group.

These communication-based activities all allow teachers to engage their students in dynamic activities for meaningful discussion. Rather than completing static and predictable exercises, students focus on issues that are important to them while interacting with others via language.

Finding Resources

Students can use the Internet to find a wide range of resources using several different technologies (as shown in Figure 3). Kinds of information to be found on the Internet include complete texts of famous speeches and works in print , high-resolution pictures from recent space exploration , sound clips, digitized movie clips, and application programs with educational value. The latter are available in demo versions, as shareware, and sometimes as freeware. Some materials available on the Net have been placed there by other students, including pictures, maps, and local information related to particular schools, artworks, stories, poetry, and research results developed by students in all grades, and requests for information and correspondence.

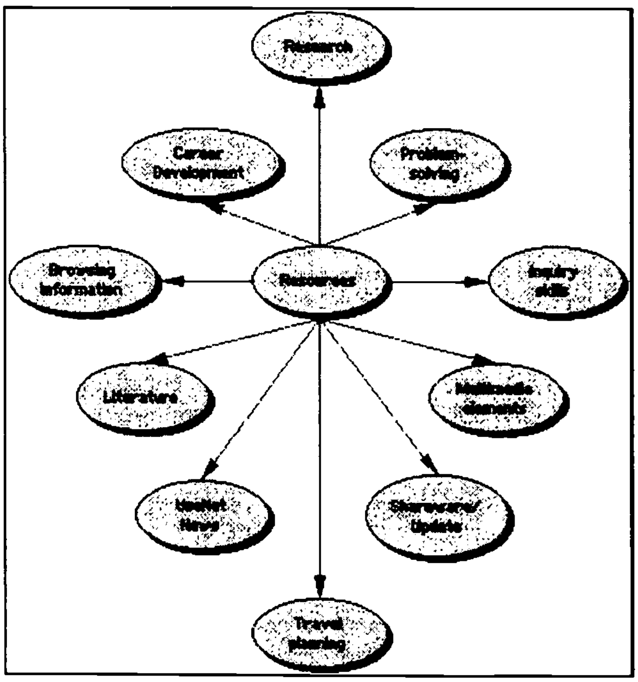

Figure 3. Resources-based activities.

How students obtain these resources depends on the kind of hardware and software they have for accessing the Internet. Even the least sophisticated forms of Internet access usually allow for file exchange through FTP, which can be used to move files directly to and from any site for which students know the current address. Students can also use FTP to make their own files available to others by uploading to a server. Beyond basic FTP, different degrees of searching capacity are available through Gopher and the World Wide Web. Many sites still use Gopher to organize information and make it searchable. With a Gopher client, students can select from hierarchically organized menus that enable ever more narrowly defined searches. With a web browser, the possibilities for organized information searching become much more diverse. Students can learn to use a half dozen or more search engines easily accessible through the World Wide Web.

Recently, a wide variety of directories and maps have become available on the Internet that might be interesting and useful for students. By simply entering an address, students can obtain a detailed street map, weather report, and listing of local attractions. Names and telephone numbers of potential research sources are more readily available than ever on the Internet. Companies, colleges and universities, government agencies, and media outlets have sites on the World Wide Web that are rich with possibilities for browsing, analysis, and criticism.

Opportunities for developing organizational and locational skills and critical reasoning abound as students learn to recognize the most efficient pathways to the information they need to complete writing projects. If, in their searches, students discover many different pieces of information that are useful and would like to plan return visits to specific sites, they can use bookmarks to keep track of their paths to information. Through out their use of the Internet, students can develop inquiry strategies and cultivate an attitude of curiosity. They continually practice problem solving as they attempt to find the most useful information in the most expedient way possible.

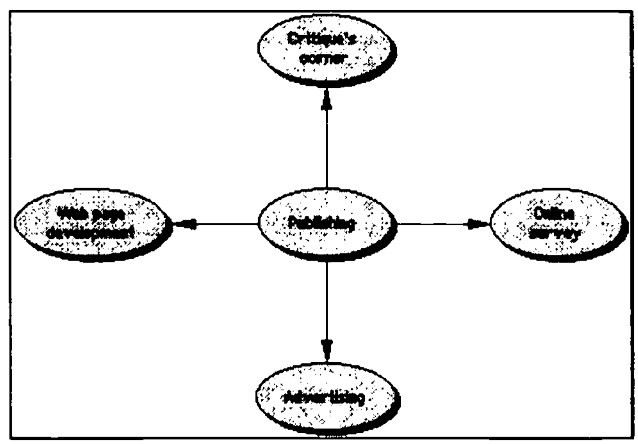

Figure 4. Publishing-based activities.

Publishing

Using the Internet gives students an unprecedented opportunity to have their work seen and responded to by others. With the ability to make files available through and especially on the World Wide Web, any student can reach a potential audience of countless, diverse individuals easily. To make the most of this potential for students' literacy development, teachers can help students develop an increasingly sophisticated sense of audience and can guide them toward an appreciation of principles of design as well as of appropriate forms of language.

Developing a personal home page can be the occasion for exploring and discussing the many different elements that go into an effective publication. In addition to text elements that must be concise and informative, students need to produce pages that are visually attractive and easy to navigate, or else risk having few visitors to their site. Learning about screen design can involve collaboration among art, business, and English language arts teachers. Students can quickly learn from visiting sites on the Web that the best home pages are under constant development, which demonstrates the importance and authenticity of revising one's work.

While learning how to design a home page, students can integrate other aspects of their reading and writing skill and their knowledge of school subjects. They can gather information about timely issues, perhaps the themes of their literature units such as family, friendship, or survival, through surveys of those who visit their site. They can make their reactions to individual reading or viewing available to others in a "critics' corner," which also might spark the interest of remote peers to read a well-reviewed children's book or young adult novel.

There are practical considerations in Web publishing more complex than those associated with either e-mail or Internet searching. Some community leaders have advocated the sale of advertising on school home pages — similar to the sale of sponsorships in a school yearbook or newspaper — as a way not only to forge a mutually supportive school-business partnership, but also as a way to teach students about the reality of how all kinds of media operate in society. Also, Web pages are currently based on HyperText Markup Language (HTML), which is difficult to learn. Teachers can facilitate their students' publication on the Web through use of specific Web editing programs, or through use of newer office suites that provide for easy conversion from word-processed documents to Web pages.

Suggestions

Whether the Internet is used for interactive communication, for resource gathering, or for publication, teachers may want to consider the following suggestions.

Get on-line. Just as teachers of reading must read the material carefully before showing students how to read, and just as the best teachers of writing write along with their students, teachers who use the Internet should take time to explore the Net themselves. Only by negotiating the complex links and the many pathways to information can teachers develop a true appreciation for what their students must do to learn with the Internet. Internet technology is growing and changing so rapidly that it may be especially true in Internet-using classrooms to say that the teacher is learning along with students; even so, it is important for the teacher to try to stay at least a few steps ahead.

Provide necessary guidance for students as they explore the Net. Perhaps because it is still largely unregulated and conducive to many forms of free expression, the Net incorporates material representing a wide range of accuracy and appropriateness. Teachers need to insure that students' use of the Internet remains educationally productive and focused on appropriate content. The same strategies teachers use to encourage careful, critical reading of books and articles are even more important when the materials students encounter may not have been subjected to rigorous editing. It is important for teachers to know which sites their students visit, and sometimes it is appropriate to limit access to the most educationally relevant sites.

Let students explore. For the Net experience to remain authentic and for students to develop the habits of inquiry and problem solving mentioned above, students need to seek their own pathways to information. This implies developing open-ended assignments that allow for dynamic and interactive searching and exchanges of information with others.

Encourage students to define their own topics and interests. When students' literate activity is grounded in their own experience, their ability to manipulate language is least constrained, and they have the greatest motivation to work and to learn.

Encourage sharing. Whether by exchanging messages or drafts with a partner, by working collaboratively in pairs or teams of students on publishing projects, or by seeking replies from others via e-mail, students learn best about the nature of language when they are engaged with others in meaningful discourse.

Take full advantage of off-line browsers for safe and efficient browsing. Off-line browsers help to avoid not only inappropriate kinds of interaction and information, but also the bottlenecks that occur increasingly when too many people at one site try to access the Web at once, or when too many people try to access the same site at the same time.

Develop integrative tasks for the Internet. Because of its dynamic and interactive nature and the variety of resources available, the Internet lends itself to cross-disciplinary and integrated learning across the content areas. Communicating, finding resources, and publishing on the Internet can be the occasion for more integrated and applied learning than was possible before Internet tools were available.

Checklist

The following checklist includes items that teachers will need to consider when planning instructional reading and writing activities that employ Internet components:

1. Do students have sufficient access (time, computers, etc.)?
2. Are the materials on-line appropriate for students to explore?

3. Are project objectives clearly defined?
4. Which inquiry and problem-solving skills will students apply in their search for information?
5. Are students encouraged to take the initiative to find materials of interest to them?
6. Do students have adequate direction in their choice of subject matter?
7. Do resources obtained actually satisfy the students' need for information?
8. How will each student who writes something be insured of an individual response?
9. Will exchanges among students be structured to maximize useful feedback?
10. Has the target audience for writing and publishing been clearly identified?
11. Are the various elements in students' web sites coherently presented?
12. Does each student have an opportunity to contribute to publication?
13. Can students integrate several different components (text, graphics, sound) in their projects?
14. Are follow-up activities arranged so that students reinforce their learning through debriefing and sharing?
15. Are students' Net experiences exciting?

Conclusion

The Internet has provided an environment which is conducive to literacy learning. With the amount of information available and the speed of access to the Net both increasing, the distance between people is greatly shortened. While effective strategies for communication within one's own culture are critical, cultural awareness of other people and other countries has become increasingly important. With the help of the Internet, students' literacy skills, such as reading, writing, and communication, can be immensely enhanced and directed toward expanded cultural horizons. Once teachers and students get on-line, they arrive at a wide, mostly informal arena where they can locate countless up-to-date resources relevant to the topics they are interested in. They can also develop effective communication with people all over the world in a short time.

The Internet, if employed dynamically, can facilitate a great variety of activities for teaching and learning. This paper identifies three different types of activities for reading and writing instruction: resource-based, communication-based, and publication-based. These activities are not isolated, but should be integrated to address individual student's needs, and to inspire students to explore various resources, and to learn to think and communicate effectively. Teachers should become actively involved by updating their own knowledge and skills about such a new, yet powerful globally networked learning environment. More Internet-based reading and writing projects should be developed to further enhance the value of the Internet for learning.

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Experience Stories Teach the Writing Process and Foster Technology Skills

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The language-experience approach (LEA) has been traditionally used as a means of teaching students to read by "capitalizing on their interests, experiences, and oral language facility" (Nessel & Jones, 1981, p. 1). Young students typically dictate experiences to their teachers, who print them on paper, recording the students' exact words. These "experience stories" then become the basis for reading instruction. Since students "write" about their personal lives at their expressive language levels, experience stories are not only meaningful but also highly motivating.

The LEA in Special-Needs and Traditional Classrooms

The flexible nature of the LEA makes it ideal for use with special-needs children (Hansen-Krening, 1982). As a teacher of the hearing impaired in the late '70s and early '80s, I used experience stories on a daily basis in my total communication classroom, providing real-life, language-rich adventures for students to write about and read. This helped counteract the utter frustration many hearing-impaired students met, trying to develop literacy skills during formal reading instruction using the required basil reading series—one that was designed for children with normal language proficiency.

Later, when I moved from special-needs to traditional classrooms, the LEA moved with me. Experience stories proved a valuable tool for teaching and learning with these students as well. Experience stories were used to document classroom activities and special events, to teach and reinforce appropriate classroom behavior, to express and promote the beauty and value of both cultural diversity and similarity, and to motivate students to keep reading, reading, reading.

The LEA and Computer Technology

The introduction of computers have provided a new dimension in LEA. Michael Corey Alger, currently a third-grader at Franklin Park Magnet School in Fort Myers, Florida, won a first-place ribbon in last year's district-wide Young Author's Conference for his experience story, *The Biggest Fish Story*. Michael first wrote his story by hand. Later he keystroked it into the computer at home and added clip art from Corel Draw.

Robert, Michael's father, is dedicated to using experience stories to motivate Michael to practice his reading, writing, and thinking skills. This year, Michael has written *Bob the Bass* and *The Peacock Story*, using the computer for both text and graphics, including scanned images. (See Figure 1.)

Bob the Bass by Michael Corey Alger

Figure 1. Cover for Michael's Experience Story, *Bob the Bass*.

Robert noted that Michael has a much easier time composing experience stories when he has photographs, drawings, clip art, or other visual cues to prompt his writing. So now, the creation of experience stories has become a family activity. Father and son plan stories together, developing sequences and time lines. They capture appropriate snapshots of events or situations and compile them into beautifully finished, desktop published works. Truly family treasures! As a result of these technological features, coupled with more recent research on writing have enabled LEA to evolve.

Using the LEA at the University Level

At the Ole Miss (University of Mississippi), preservice and inservice teachers enrolled in EDRS 557 Computers in Education learn about the LEA, the writing process, and computer technology concomitantly while creating their own experience stories.

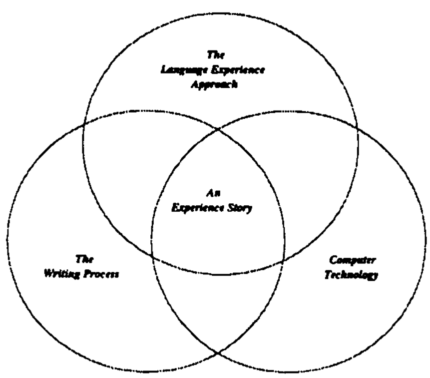

Figure 2. The LEA, the Writing Process, and Computer Technology Are Combined in the Creation an Experience Story.

First, university-level students are introduced to the LEA. They are provided with not only the educational philosophy associated with this approach but also with examples of its application for young learners.

Students are encouraged to begin thinking about the experience stories they intend to create, the key question being, "Is it meaningful to me?" Students must determine whether the stories they chose to develop are meaningful to them as educational practitioners, as parents, as students, as individuals, or as children at heart. The more meaningful the stories become to the writers, the greater the chances for their successful completion of rich, interesting, exciting experience stories for all of us to share.

After discussing writing, in general, and the use of style, tone, and voice, specifically, participants learn that the parameters of the experience stories they will create are an expansion of the traditional LEA. They have the options of creating experience stories with their students at school, their children at home, or by themselves. They can use their own voices and write from adult perspectives, or they can write from the perspectives of children, animals, plants, or inanimate objects. They can take on the roles of narrator, storyteller, main character, instructor, distant observer, etc. Their stories can be based upon single experiences or a multitude of experiences with unifying themes. The stories can be factual or fictional, serious or humorous, etc.

Incorporating the Writing Process

Students are introduced to the writing process that will be used during the creation of their experience stories. This process includes prewriting, drafting, revising, proofreading, and publishing. At first, the writing process appears linear to students. They soon discover, however, that it is dynamic.

Although many preservice and inservice teachers seem to have an intellectual understanding of the writing process, few have ever truly used it in their classrooms with their students. Even fewer have used the writing process for their personal or academic compositions. However, once students apply the process to their own writing of experience stories, it soon becomes a personal educational tool for them.

Incorporating Computer Technology

At the same time, students are introduced to several software applications and computer technologies that they can use in the production of their experience stories—from using simple word processing applications for brainstorming during the prewriting stage to using scanners and digital cameras for importing pictures during the drafting and publishing stages.

Establishing Experience Story Guidelines

This semester, student were provided with the following *Experience Story Guidelines*:

1. Your experience story must be created, developed, and produced using the writing process. This process includes prewriting, drafting, revising, proofreading, and publishing. Remember, this is not a linear process. It is dynamic, challenging, and fun!
2. During the prewriting stage, your idea(s) for an experience story must be presented to your instructor and other classmates for consideration, questions, comments, and discussion.

According to Hubbard (1988), author of *How Writing Works: Learning and Using the Processes*, "One of the richest resources in your writing class is the other people in it, not just the teacher but the teacher plus all the other students" (1988, p. 10). The sharing of experience story ideas at the prewriting stage also helps establish a learning community within the classroom. It sets the tone for a cooperative learning environment. Such cooperation will be essential in later stages of the writing process, when fellow students are called upon to edit and proofread the experience stories.

3. Although the initial rough drafts of your experience story may be done by hand, the first draft that you submit for the revising stage should be desktop published.

Students in these classes vary greatly in their computer technology comfort and ability levels. Some have barely touched computer keyboards. Others have already published Web pages. Therefore, a wide range of publishing options and expectations are presented.

Students who are new to the world of computers are expected, at a minimum, to desktop publish the text for their experience stories in a word processing program, such as Microsoft Works, Microsoft Word, or WordPerfect, and adhere photographs to their printed pages. For novice computer users, just dealing with margins, page orientation and numbering, text alignment, and changes in font size and style offer sufficient technological challenges.

Students who are more experienced computer users are expected, at a minimum, to scan photographs for importing into their experience stories. Some students have abandoned the scanner route, using digital cameras to capture and download images. Others have created their own illustrations using paint programs. Some students have developed on-line experience stories using multimedia authoring tools, such as HyperStudio.

As an instructor, it is gratifying to watch students challenge themselves to go beyond their initial technological capabilities. Motivating students to do so has never been an issue. The experience stories themselves seem to be the greatest motivating factor. Because they are based on some aspect of students' personal lives, the experience stories seem to capture their authors in whirlwinds of creative self expression.

4. Your first published draft must be edited by at least two classmates. Make sure you and your editors have discussed all questions, concerns, special style considerations, and revisions recommended for your experience story. Afterwards, your editors must sign the Experience Story Tracking Sheet, including comments as necessary.

Prior to this step, students were introduced to proofreader's marks. They completed practice exercises in reading short compositions and marking them for revision. They were also introduced to basic page layout and design specifications and standards.

Students also learned the "rule of the pen" when marking for revisions. The rule of the pen dictates that writers use blue pens, editors use green pens, proofreaders use red pens, and the instructor uses a purple pen. This avoids confusion when determining which marks to follow. For example, when a page is marked with conflicting green and blue revisions, indicating a point of contention between a writer and an editor, the purple pen prevails!

In addition, students were introduced to using the Experience Story Tracking Sheet, a form used in the writing and publishing process. (See Figure 3.) The tracking sheet provided students with a visual means of monitoring the progress of their experience stories.

Experience Story Tracking Sheet
Name:
Experience Story Title:

Stage	**Date**	**Name**	**Notes**
Writer First Draft			
First Editing Pass			
Second Editing Pass			
Instructor Check			
Writer Second Draft			
First Proofreading Pass			
Second Proofreading Pass			
Instructor Check			
Writer Final Draft			
Writer Presentation			

Figure 3. The Experience Story Tracking Sheet Used by University-Level Students.

5. You have the option of submitting the draft of the experience story to your instructor for review now or later, after you have incorporated the recommended revisions. (This depends upon your personal preference and the extent of the recommended revisions.)
6. Following the revising stage, your experience story must be proofread by two of your classmates. The proofreaders will check for the incorporation of recommended revisions and mark any additional corrections that are necessary. Therefore, you need to provide your first draft, as well as your revised version for the proofreaders. (It is recommended that you keep previous versions in a pocket folder with the Experience Story Tracking Sheet attached.) After completing their review, your proofreaders must sign the Experience Story Tracking Sheet.
7. Following the proofreading stage, your experience story should be turned into your instructor for review. If necessary, you may repeat numbers 5 and 6 above.

8. Be prepared to share your published work with the entire class during the final week of the semester.

Some Samples of Students' Experience Stories

Just like show-and-tell time in the primary grades, there is an excitement in the air when the university-level students share their experience stories. Not surprisingly, the stories were as varied as the students themselves, and provided individual insights. Some students wrote about their children, while others wrote group experience stories with their classes based on field trips. One student even used the narrative genre to help clarify educational theories.

The Need for Life-Long Learning with Computer Technology

Of course, there were several measurable instructional objectives that these students mastered during the creation of their experience stories. However, the most important instructional objective can only be measured over time: students will become life-long learners, always striving to improve their computer technology skills in education.

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TECHNOLOGY AND THE TEACHING OF WRITING

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The Teaching of Writing course was first taught in 1980, the same year that the Master's Computers in Education degree program was initiated at Lesley College. For many years there was no connection between the two. Then, in 1993, two faculty in the School of Education collaborated to bring writing and technology together. The venue for the course shifted to a computer laboratory where students had easy access to the tools that facilitate composing. Over a four year period the course has continued to evolve by adding new technologies that extend and enhance the writing process.

The Teaching of Writing course was first offered as an elective in the Lesley College Graduate School elementary education certification program. The Teaching of Writing course was first offered as an elective in the Lesley College Graduate School elementary education certification program. In its original conceptualization, it was based on the research done at Atkinson Academy in New Hampshire by Donald Graves, now Professor Emeritus, the University of New Hampshire, and the Bay Area Writing Project (BAWP), a summer program initiated at the University of California, Berkeley. The Graves research established the importance of teaching writing as a multi-step process rather than through a red ink product model. The BAWP brought groups of teachers together during the summer to experience the process of writing as well as to study the research in the field. The ongoing work at both of these institutions created a new paradigm for the teaching of writing.

The course offered at Lesley combined these two approaches in a fifteen-week model that involved students in the stages of writing such as prewriting activities, multi-draft writing, peer response groups, conferences, self-selection of topics, and Author Chair. Pre-service teachers were asked to write memoirs, poetry, personal interest and research pieces and to live through the stresses and successes that their students from kindergarten to middle school might experience.

When the course was first offered the term "writing process" was just entering the glossary of education and most students had little formal training in writing. Although they often were intimidated at first about writing and sharing early drafts in small peer response groups, this quickly became an empowering experience that facilitated revision and heightened pride in publication via Author Chair. The point repeatedly made was that ownership and audience encourage students to find a suitable voice and to strengthen their writing. Students consistently comment that having been through the process lessens their anxiety about teaching writing.

The course, which had not at first been wildly popular, began to be selected more and more frequently. It is now required in the Consultant Teacher of Reading program and is a starred elective in a number of other Master's degree programs. But what also began to happen was the looming presence of the computer, especially word processing. The writing course needed a new look and this time the faculty found it right down the hall in the pioneering and exemplary Computers in Education degree program.

Writing and computer technology are natural bedfellows. Each in its own way terrifies novices and each requires considerable exposure, training, and trial and error to become a comfortable tool for teaching and learning. It was the vision and the gentle prodding of one of the technology faculty that emboldened the faculty of the writing course to entertain the entry of technology. The collaboration began in a tiptoe fashion with suggestions of software that might motivate students.

The paradigm shift took place when several members of the literacy faculty were invited to a summer computer faculty training session in Snowmass, Colorado. This gave the two faculty who had applied for permission to team teach the Teaching of Writing course in a computer lab the opportunity to develop an entirely new syllabus. What made it possible for the writing faculty to view this shift with a manageable level of panic was the reassurance by the computer faculty that the content of the course would remain the teaching of writing and that the technology would support and extend that purpose.

This has, in fact, been the case, and as new tools have appeared they have been integrated as appropriate within the context of the course. These include: writing and graphic tools including word processors, publishing programs, digital cameras, and paint programs; CD-ROMs and limited use of the Internet to support writing across the curriculum; and software to build reading and writing connections. After three years of what could now be labeled "local" technology, another quantum leap was in the works. During the Spring 1996 semester, we recruited a third faculty to collaborate in designing a World Wide Web (Web) site to be used in the course for the Fall term.

Quantum Leap

Fall arrived quickly. It was time to launch the Web page and to begin using Net.Thread conferencing software. During the planning stage it was all excitement, but reality set in when we faced the actual implementation.

During Fall 1996, we taught two sections of the course. The on-campus section was based on a fifteen-week semester. The off-campus section met in Westford, Massachusetts, on two weekends (one in September and one in October).

Our original hope was to have the two groups use the Internet to share their published work and to do on-line peer editing. This did not happen. The timing of the two classes was out of sync. The Westford group was always far ahead of the on-campus section. This might have been overcome if the Westford group had Internet access outside of class but only a fourth of the class had it.

We quickly realized, we would need to change our plans. To develop the on-line community of writing teachers we envisioned would take more than a semester to achieve. Although we tried everything we had planned, we did not do everything with both groups.

Throughout the two weekends in Westford, we used software to enhance the writing process. At the end of the course, we requested, but did not require, students to select one piece of their writing to be published on our web site. Eighty percent of the students signed the permission forms. The students submitted disks and hard copy. Digital pictures of each student were taken during the first weekend of the course; these too would be published. The students used a variety of word processing programs and, of course, some students used Macintosh's while others used PC's. When the page was complete, students received the Uniform Resource Locator (URL) of the site. We have heard from a few of the students who are pleased with the published work of the class.

Meanwhile, the on-campus group marched on at the orderly pace of one three-hour class each week. As in the past, students used a variety of writing and drawing tools for the composing process.

The first Internet activity for this group was using the Web for research. The students were working on a personal interest non-fiction piece. Our intention was to have them use the Internet to do research for their projects. After a brief explanation of search strategies and search engines, we turned the students loose. For many of them this was their first experience using the World Wide Web. Frustration reigned as students found either volumes of information to be waded through or nothing at all. Some were successful; one student located relevant information on the rescue of greyhounds. She was ecstatic, unlike most of her classmates. The instructors tried in vain to respond to all the requests for help in developing search strategies. Students seem to expect immediate results when using the web. We doubt that they would expect this when using traditional library resources. It is interesting to note that, although we feel this session was problematic, many students forgot their frustration and subsequently commented on how pleased they were to actually use the web.

But a second technology calamity was lurking. We were curious about how students would respond to their readings if they wrote responses on Net.Thread. They could create a dialogic notebook by responding to one another in a series of entries. One of the instructors had used Net.Thread successfully with another class. She found that students who never participate in discussion in class, suddenly found a voice. With this success in mind, we were excited to try Net.Thread in the writing class. The demonstration of the software went smoothly. The students moved to the computers with enthusiasm only to be met with a technical problem. Only three or four students accessed Net.Thread; all the other computers hung up at various points in the process. The next morning the e-mail correspondence with the system operator went as follows:

Dear Vincent,
Net.Thread was a disaster last night. The demo went fine, but when we put the students on the machines, all hell broke loose. It worked properly on 3 machines out of 16. Some people could not get in at all. For others, Net.Thread hung after they typed the password. Some got in but got crazy looking icons for the navigation tools. I am hopeful that you can figure this out. We are planning to use Net.Thread again next week. Angie

Dear Angie,
The WWW server on that day experienced tremendous problems, we lost electronic mail, Web access, and Net.Thread access. These utilities were brought back during the course of the day. I believe the machine is now stable. Vincent

Even with this calamity the students who did get into Net.Thread were able to use the software without difficulty. We are not sure why one student posted so many "No More Barney's." One of the limitations of the software is that the teacher cannot go in and remove undesirable material.

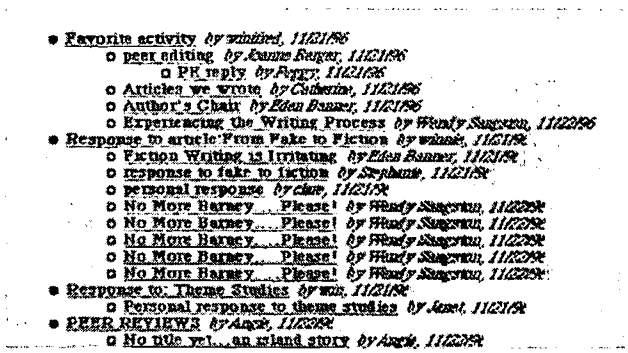

Figure 1. Screen dump from Net.Thread.

Undaunted, we tried Net.Thread during the next session and the rest of the class had a chance to react to the readings.

Also, we added a piece of faculty writing to begin on-line peer conferencing. Later, we will ask for volunteers to post their work for peer review. We believe this type of conferencing could be beneficial. Students would not have to wait between classes for comments and communication could be developed between groups. We also hope to develop a community of writers which will include past and present members of the course.

Electronic Writing Workshop

The third faculty member to join the team had taken the class several years before and was familiar with the instructors and their work on incorporating computer technology into the writing class. He had previous experience designing Web sites. The intention of this group was to develop a Web site that would encourage and enhance the writing process.

The first map of a Teaching of Writing site was somewhat rough. Since the college had not yet implemented conferencing software, we decided to set up web pages to show student work in a password-protected environment and allow feedback with e-mail links.

A section of the Web site was called "The Electronic Writing Workshop", where students would bring drafts of work for feedback from their peers. This fit with one of the major goals of the course: to develop peer conferencing as a strategy for writing a series of drafts. The Electronic Writing Workshop would be available only to students enrolled in the class through password protection. We felt this would create a safe environment for development of works in progress.

In our initial concept, the instructors planned to create a page for each student in the class. The page would have a picture, a short biography, and links to enable other students to give feedback on each other's drafts. This plan required an unrealistic amount of work by the instructors: creating the pages and posting them to the Lesley Web server, posting writing drafts, and posting pictures.

The initial plan was built around the idea that students would have Internet connections, Web browsers, and e-mail. Most of our students do not have access to the Internet from home and the college does not provide dial-in access. Therefore, students would be interacting with the web site from a computer lab which made the e-mail feedback links on the student pages a problem. Since the students were working on lab computers, the Netscape Navigator browser was not set up with their own settings and preferences, such as their return e-mail address. The browser would have to be configured in the lab by the student each time, using the mail preferences for their return e-mail address. This seemed like a cumbersome way to accomplish the task. We wanted technology that was fairly transparent and easy for the students to learn and remember.

Late in the fall, the college began to use Net.Thread, conferencing software that had been used by The New York Times On-line Web site. This software had many advantages over our earlier model of individual student web pages with feedback links. Net.Thread runs on the World Wide Web within the Netscape browser and was easy to use. Students would be able to learn it quickly in one session and be up and running without a lot of instructor intervention. It had clear directions and a help area and worked in an intuitive way. We found that Net.Thread would hold longer pieces of writing (5 to 10 pages), and that students could write a piece in a word processor and then paste it into Net.Thread after spell checking their work.

There were problems with the Net.Thread software. The first time the class tried to log on and use it, the program froze and caused many problems on the Lesley network. The whole class came to a halt. This brought up the idea of a backup plan, which we will develop in the future.

Once Net.Thread was running, it worked very well. Students can look at pieces and write comments, and whole threads of conversation can be built. The software shows topics in outline form, and it is easy to navigate the discussions and to post messages.

We have decided that the conferencing software will be the basis of the electronic writing workshop, and that the student Web pages will be used to publish final drafts.

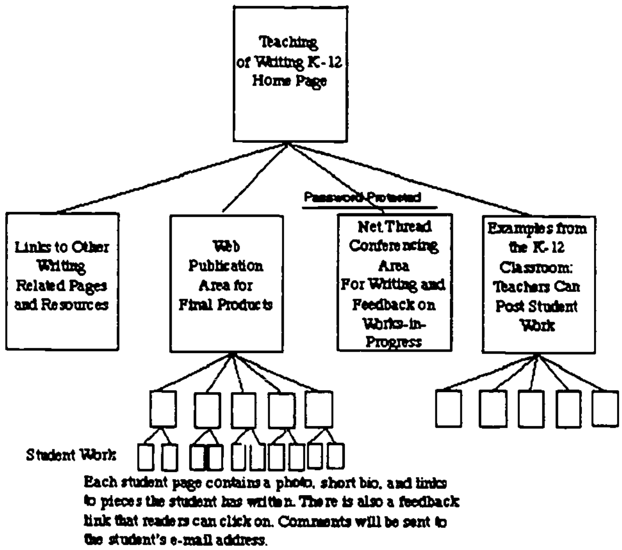

Figure 2. Map of *The Teaching of Writing* Web Site.

Conclusions

The integration of technology into The Teaching of Writing course has had three major positive effects. First, the gradual expansion of publishing formats from small peer response groups to Author Chair to a class magazine to the World Wide Web has increased student confidence in their writing. Second, the use of visual media added measurably to motivating the writing process.

Finally, the most significant conclusion is that the seamless integration of technology into a content course provided the catalyst for a paradigm shift in the teaching of writing. Students have been surprised by their mastery of both writing and technology. When the focus is on the assignment rather than the technology, the course works for students whether they are computer literate or not.

Some questions remain. Where does the Internet fit into this course? With a Web page, students in different geographic areas can share published work. While this is a desirable goal, it is not clear whether, given faculty time constraints, this is feasible. In addition, searching the Web for research produces mixed results. It takes too much class time, and we question whether this is the appropriate course for teaching search strategies.

On the other hand, we think the potential for Net.Thread or a similar conferencing program is enormous. It encourages informal writing, conversations about readings and responding to each other's writing, and, perhaps most important, seems to give shy students a way to become a part of class discussions.

As this semester ended, we were sobered by the amount of additional time it has taken to add the Internet-based features to the course. Our immediate task now is to weigh the advantages of the technology while maintaining the central focus of the course which is to provide strategies for the teaching of writing.

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Efficient Use of Story Writing Programs

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Anyone who has ever observed or used one of the story writing programs, such as StoryBook Weaver Deluxe, knows that hours can be spent deciding which graphics to incorporate into the story. Hundreds of items (which include people, objects, animals, buildings, foregrounds, and backgrounds) can be combined in a multitude of ways. The decisions about which graphics to use takes up time that students could use for writing. Students spend time selecting items, changing their sizes, repositioning the items, deleting items, and then adding more items. Often computer time is over and the students have not written a word. Indeed, the graphics often overtake the story and become the focus for the young writers.

While observing students who were working in one of the story writing programs, one of the authors noticed that the students spent the majority of their time on selecting graphics. Some students never wrote during the time, while others wrote very little. If the purpose of the program was to encourage story writing, the program was failing. On the other hand, if the purpose was to explore graphics, the program was a smashing success. With advance planning, we believe the program can do both and still allow the students' creativity to emerge.

Program Choices

First consider, the choices available in one program, StoryBook Weaver Deluxe. There are a large number of items students can choose to complete their graphics. For example, there are 78 foregrounds and backgrounds (not counting the patterns or colors that can be used) and 256 adult figures. In addition, there are categories for animals, decor, kids, make-believe animals, nature, shelters, storybook people, things, and vehicles. Additional graphic changes can be done by changing the brightness level of the pictures to indicate day, night, or twilight. Therefore, thousands of combinations can be achieved when using the graphics. This can translate into hours of graphics production with little or no attention to the writing or to story structure. Graphics are not the only thing that can sidetrack students.

In addition to graphics, there are many sounds and musical selections which students can choose to include with their story. Of course, this involves the students listening to the sound effects and music several times in order to make decisions. The musical selections are less time consuming than the sound effects as far as entertainment value to most students. When observing, we noted that students spent more time listening to the sound effects and choosing how to place them with their graphics. For example, in Storybook Weaver Deluxe the sound effects are triggered by the use of buttons. The buttons are seamless, in that they are attached to different graphic objects in the picture. Some students put a sound effect with every object in the picture. Again, time is diverted away from writing. With all of these choices, it is understandable that little or no actual writing gets done. More writing can be done if the choices can be limited. There are several ways that teachers can do this and meet additional curricular requirements by advance planning.

Advance Planning for Using Writing Programs

One of the simplest ways would involve the teacher creating totally graphic stories. Teachers can prepare stories that have the graphics prepared in advance so that students could write the story that goes with the graphics. These prepared graphic stories may be used in several ways. One way to use these stories is to have a whole class pre-writing, drafting, editing, and publishing session. This can be conducted using overhead transparencies made from the graphic pages. Using the overheads, the teacher can guide the students through the writing process. Using the overhead transparencies is particularly useful when introducing the elements of stories for the first time.

Another way to use the predesigned graphic stories is to print out the graphics and laminate the pages. This allows for both group and individual activities using the laminated pages. Working in small groups, students can discuss how the story should be written and complete both drafting and editing together. When the groups are finished working on the same story, they can compare how each group worked on their story and compare and contrast the stories. This activity provides several aspects which are useful for meeting objectives in many curricular guides. Not only are the students working on story structure and writing skills, but the after writing activities involve them in comparing and contrasting which is one of the thinking skills many curriculum guides address. The laminated graphic stories can be used by individuals in the same type of activity which would engage individual students in the writing process. When using the laminated pages, students can write on the pages with waterbased erasable markers, or students can write the text on separate paper. In either case, when students are finished the stories can be orally shared with the whole class or published and bound. There are other ways to maximize time when using these programs.

One more way to maximize time and effectiveness is for the teacher to create a story that needs the writing and graphics for the beginning or the ending. Notice this is not a story starter. The whole story has been written except for one or two beginning or ending pages. Students would then plan how they would handle the graphics and writing, then complete the story at the computer. Both of these strategies would involve printing out what the teacher made so that students could think about what they wanted to do before going to the computer. This would require students to prewrite and predesign graphics, so that placing the information into the computer would take less time. The additional time would allow for rewriting and editing.

In using these programs to help students develop a clearer understanding of story elements, each element can be worked on individually and then put together. For example, setting can be explored in terms of foregrounds, backgrounds, and time of day. In addition, other factors which affect setting, such as, weather changes can be explored. Students can develop setting with the graphics only and then talk about how they can translate the visual display into words. When the curriculum calls for adjectives and adverbs, activities which have students develop lists of different ones and use them in their setting description can be used. Next students can add characters to their first page. If this is their first time working specifically on characterization, have students limit themselves to the use of two characters (people and/or animals). Once the students have decided on their characters, they should be asked to describe what their characters think, how they act, and what kind of feelings they have. This can lead to further discussion about descriptions. If one of the curricular objectives is to use dialog and quotation marks, their use can be incorporated with characterization (or later with plot). Students could then move into plot development. In this manner, curricular objectives are addressed as the students use the software.

Another way to approach some curricular objectives is to have students explore genre through the use of the software. As students are learning the differences among genre, they can plan stories within that genre. Genres students could work with are fantasy, westerns, historical, mystery, science fiction, realistic, and adventure. In order to save time, teachers should print out foregrounds and backgrounds; people; animals; and other items that would be appropriate for the genre being studied. In addition, the number of items for students to choose from could be limited. A teacher can make booklets using either folders or a loose-leaf which are labeled with the genre. In the notebook the type of genre that is addressed and the characteristics found in that genre. A copy of the graphics which would be appropriate for the genre would also be included in the notebook. As the notebook is used appropriate lists of descriptive words, adverbs, action verbs, and nouns could be included. Students could add other words to the word lists. Here we extend student understanding of literature by genre and address vocabulary through practical application in their story planning and writing. While limiting what students can choose can increase the writing productivity, it's also possible to let students use some of the other capabilities of the program, such as the music and sound effects.

Advance Planning for the Incorporation of Music and Sound Effects

The first method for incorporating music and sound effects would involve having students use stories that they have already written. One computer period could be spent in letting students chose music they want to attach to each page of their story. Another computer period could be spent letting the students chose sound effects to attach to different objects in the graphics. Both of these methods are not as productive as they could be, but none the less would give students the opportunity to use the full capabilities of the program. It would be better to prepare an audio tape with the musical selections in the program. A page or pages of the music icons from the program should be prepared to go with the tape. The icons for each musical selection can be given a number and on the tape, the number should be recited before the music represented by that icon is recorded. The students can listen to the number and compare it with the numbered icons. In this manner they can plan what music they will use in advance. An additional tape can be prepared for the sound effects. Again, putting a number with each sound effect icon can facilitate the students' recording of sound effects they wish to use. Students can plan which objects will have sound effects attached and write the name of the object and the sound effect they want to attach to the object in their notes. So far, we have taken small aspects of the program and isolated them into smaller portions in order to save computer time. It is possible to let students use the full capabilities and all of the choices available, even with limited instructional time and limited computer time.

One way we can let students use all of the bells and whistles in these programs is to plan ahead. Just as we prepared tapes for the music and sound effects, we can prepare notebooks for the graphics. The notebooks should have tabs which identify the categories where the items in that section can be found. Students can then examine the loose-leaf notebook and begin planning what they want to do once they are at the computer. This would allow better student choice and greater student creativity. The previously discussed tapes discussed could also be incorporated, letting the student use all of the choices the program has to offer. Students can write prewrite text and plan music and sound effects. Once the students are finished with their preplanning, they can take their notes with them when they work on the computer. At times the students may have to refer back to the pages with the icons and numbers for their music or sound effects, but this method should allow students to produce very nice publications with even limited time at the computer.

Conclusion

Story writing programs can help students publish books which can be bound and placed on the classroom shelves for sharing. One of the authors did this in her elementary classroom and found that her students were more anxious to write and share their work when they were printed in the same form as "the books we usually read." This contributes to the development of student writing skills and to the development of a love for writing and sharing what has been written. Further, this makes the programs well worth using and we can expand their usefulness by tying what we do with them more firmly to the curriculum.

In order to effectively and efficiently use story writing programs, it is necessary to limit the choices or provide students with the means to make choices prior to computer time. In addition, we believe that story writing programs can be used in a more effective manner with relation to the school's curriculum, if preparations are made in advance.

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Teaching Reading Specialists with Computer Technology

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This paper focuses on the use of computer technology in a Summer Reading/Writing Program designed to teach Reading Specialists to work with K-8 elementary school students. This paper describes a study that was conducted on the usefulness of computer technology for developing skills of Reading Specialists and for tutoring struggling readers. Additionally, several recent software programs that can be used to diagnose developmental literacy skills are discussed.

In recent years, many new technological tools for enhancing reading and writing skills and strategies have become available. These include a variety of computer software packages for word processing, for creating writing products, and computer assessment of language arts skills, as well as for CD-ROM storybooks. It is important to ascertain which of these new software packages are most beneficial for helping children who are struggling readers. Researchers have investigated beneficial aspects of software usage by both elementary student and university students. A key factor for effectiveness identified by several studies is the focusing of student interactions with software on identified learning objectives or specific needs of students (Millman & Clark, 1996; Pan & Zbikowski, 1996). It has been found that elementary students often use software in ways that do not lead to intended learning if they are not supervised and guided during the experience (Castori & Paprzycki, 1996; Goldstein, Olivares & Valmont, 1996).

At Eastern Kentucky University for the past two years a Summer Reading/Writing Program has been conducted that served two purposes: to teach reading specialists, and to help struggling readers and writers at the elementary school level. The program consists of individual and small group tutoring based on specific areas of identified needs in reading and writing. These settings provide opportunities to structure usage of computer software on specific literacy objectives.

During the first year of the program, children were given the opportunity to use computers for word processing of stories they wrote as part of the program. Teachers also brought some skills-based software from their own classroom for use during tutoring. It was observed that children enjoyed working with computers and gained some computer use skills as part of this experience. However, there was no organized attempt to use this experience systematically for developing literacy or computer skills.

As a result of these observations, the authors decided to conduct a study to investigate available software and technology and how it could best be used to work with struggling readers. An additional purpose of the study was to investigate ways to use technology to facilitate the process of refining skills of reading specialists in the areas of reading diagnosis and tutoring.

Project Description

Children from local elementary schools were recommended for the program by their regular classroom teachers or parents as needing help with reading and writing. A survey was designed to establish baseline information on levels of computer skills and knowledge for both teachers and children. Each of the twenty children who were enrolled in the summer program was also assessed using an informal reading inventory and other measures to determine specific strengths and weaknesses in reading and writing.

Nine experienced classroom teachers, enrolled in a graduate program leading to state certification as Reading Specialists, served as tutors for the children. A media specialist demonstrated to the teachers the process of loading software and gave tips on software usage. Teachers spent one class period exploring the software before using it as part of the tutoring process. The teachers diagnosed the students' literacy needs, administered the computer skills survey, then planned and implemented remedial lessons for a time period of five weeks. The remedial sessions focused on identified strengths and needs, and incorporated the use of computer software as a regular part of the instructional program.

At the conclusion of the five weeks, students were given a second form of the informal reading inventory to determine progress in reading and writing. Teachers reflected on the experience, and using a second computer survey form, described their own progress as well as that of the children in acquiring computer skills. They wrote case summaries of each student, including samples of student work and recommendations for future lessons.

Results

The results of this research showed the positive impact of computers on the teachers and their students.

Use of Computers: Teachers

Demographic data from the baseline survey instrument revealed that the teachers involved in the study ranged in age from 26 to 45. Seven of the teachers had 3 to 5 years classroom experience, two had one year experience, and one had 23 years experience. Seven of the participants were currently employed in education, while the remaining two were full-time graduate students. The baseline data revealed varied levels of computer experience and knowledge at the beginning of the five weeks. All of the teachers had some training either in-service computer training or a college credit course on computers. The teachers reported personal skill levels ranging from being able to turn on a computer to being comfortable with word processing. They reported feeling "somewhat confident and positive" about using the computer.

At the end of the program, teachers completed an open-ended questionnaire to indicate whether their computer skills and knowledge had increased through the experience of tutoring children with computer software. All indicated increases in one or more areas, and the amount of progress made in improving skills was directly related to the amount of previous experience. Those who had little previous experience reported larger gains than those who had used computers on a regular basis. It is interesting to note that using computer software as a part of literacy tutoring was new to virtually all the teachers. Their reflections described their reactions to and evaluation of the software as well as providing insights for using computers with students as part of the program. The most common response was that they had learned about new software programs and how to use them. They also reported feeling more comfortable with using the software and awareness of the benefits to students. Actual comments included: "I am learning to use more options." "I'm still unsure of installing programs but am comfortable using them."

Use of Computers: Students

Of the twenty students involved for the full five weeks in the program, eleven were primary, four were intermediate and five were middle grades. The students had previously used either Apple IIe, Macintosh, or IBM-compatible computers. The frequency of reported use was about evenly split between using every day, once a week, and once a month. When asked what kinds of things they had done on the computer, the students listed reading, writing, and math games most often. Data collected at the end of the five week program in comparison to the initial assessments indicated that the elementary students did improve in computer usage skills. Specific gains cited by the teachers included typing, process writing, operating the software programs and finding things in them, saving work, and mouse skills. Teachers also cited improvement in student reading and writing skills. Specific areas of language arts improvement cited by the teachers included reading, composing, spelling, editing, revising, using more description in writing, and producing longer pieces of writing.

Primary level students reacted to reading stories on the computer with eagerness and anticipation. They especially enjoyed the graphics and sound associated with some software, which was the overwhelming favorite program for primary students. Teachers used this software program to enhance reading fluency and comprehension in several ways. For example, they used the on-screen text to provide practice with word recognition by asking students to read along in chorus with the computer narration. They also incorporated such phonic skill activities as having students highlight words beginning with particular sounds, or finding words that rhyme.

An overall favorite with intermediate and middle grades students among the writing software packages used was a package that was more novel in its use of graphics and sound than other writing programs. While the middle grade students initially enjoyed this program, they switched their preference to another toward the end of the five week period. Reasons cited for the switch included the fact that this other program allowed more flexibility in format and ease of word processing for the longer compositions of the older students.

Teachers found that students created better products when they did preliminary work with prewriting and creating a first draft before coming to the computers. It seemed necessary to allow students time to focus on content first, then on the mechanics of keyboarding, revising, and editing with computer software.

Gains in Reading Scores

Three of the twenty students were absent during the post test sessions with the Analytical Reading Inventory (ARI) (Woods & Moe, 1995). In addition, a five-year old student, an emergent reader, was given an alternate assessment because the ARI was inappropriate for him. For these reasons, there were sixteen students for whom both pre- and post-scores were available. An examination of the scores revealed that nine of the sixteen showed gains on the post-test of at least one grade level on both word recognition and comprehension. Three other students showed gains on one of these two areas, and one other student showed a gain in listening comprehension. No gains on the ARI reading measure were found for three of the sixteen students. The five-year old student showed gains in several areas of emergent reading skills.

Conclusion

The Summer Reading/Writing Program was successful in terms of gain scores in reading. Work samples and teacher observations also indicate gains a variety of gains in student writing. In addition, both teachers and students gained computer skills and knowledge of software programs. The positive results from computer software usage that were achieved by the students may have been due to a close monitoring provided by the teachers and the tutoring situation. Teachers used the computers and software as tools to help students toward specific learning outcomes that had been identified. The authors plan to refine procedures and repeat the project with a new group of teachers and students in the summer of 1997.

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Preservice Teachers Integrating Technology Into a Corrective Reading Course

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The need to incorporate technology into our teacher preparation courses has become so self-evident that we are now faced with the question of how are we going to accomplish this goal. The need for technology-using teachers is beginning to receive more attention in accreditation standards, in state certification programs, and in reforming and upgrading teacher education efforts. But according to Teachers and Technology: Making the Connection, the report by the Office of Technology Assessment (1995), state policies and leadership vary widely, as does the implementation in colleges of education. Additionally, there has been virtually no connection between reforms in colleges of education and reforms in the K-12 schools, nor are there many incentives to make those linkages. Our research attempted to address some of these findings, specifically regarding technology and teacher preparation and modeling by teacher educators.

Description of the Project

During the summer semester of 1996, the course instructor and co-author of this research effort decided to expand technology usage in her section of a corrective reading course. This course is the final required reading course for elementary preservice teachers before they begin student teaching. Part of the requirements for this course involves each university student tutoring one K-12 reluctant reader, referred to in our program as a client. The whole language philosophy guides the literacy activities. Prior to this summer, technology was incorporated into this one section by using several CD-ROMs with only one computer-on-a-cart rolled into the classroom for each class, but more integration of technology was needed. With the assistance of the co-author, a doctoral student interested in helping faculty integrate technology into teacher education courses, we developed ideas for authentic uses of technology.

Review of Literature

Reviewing the literature, it was apparent that a number of considerations should guide our design. In the theoretical framework of Bruner (1960, 1966), learning is an active process in which learners construct new ideas or concepts based upon their current and/or their prior knowledge. Learners select and transform information, construct hypotheses, and make decisions, relying on a cognitive structure to do so. We recognized that most of the students had taken, or were taking, a general introduction to technology course whereby they learned productivity tools, for example, word processing, spreadsheet, database management, some graphics, some exposure to e-mail, and an introduction to the Internet.

Additionally, we wanted to use technology that was not only non-threatening, but that had proven effectiveness. Johnson (1996) described the success she had in incorporating e-mail into a reading methods class. She felt that the combination of real life application and effective instructional practice increased the likelihood that these preservice teachers will use the technology in the future. Brovey (1996) also indicated how his use of e-mail and e-journals provided preservice teachers with purposeful computer-based experiences and led to more responsiveness between him and his students.

Matthew (1996) pointed out the effectiveness of using CD-ROM storybooks to enhance the literacy experience of young children and the lessons learned by the preservice teachers while observing the youngsters interact with the multimedia. Land (1996) demonstrated the efficacy of integrating the Internet into his teacher education course. His home page organizes Web resources into categories that are appropriate for his students.

Both Dertouzos (1991) and McKenzie (1994) have shown the importance of availability and accessibility to successful employment of computer technology. The location and the number of machines per person are critical factors affecting usage. Until the advent of the graphical user interface browsers, the man-machine interface of the Internet was anything but user friendly. Busy students and teachers will find struggling with unreliable hardware or difficult to use software unrewarding, and will consequently refrain from using it. Because we did not have a state-of-the-art telecommunications lab to use until the end of the 1996 spring semester, this research could not have been carried out before the summer semester.

Since usage of e-mail, e-journals, interactive multimedia CD-ROMs, and the Internet, have been found effective before, we decided to use a combination of these technological applications in our program. We felt that a combination of all of these approaches would give the students additional tools to use with their teaching strategies. For example, in order to show the usefulness and application to instruction of e-mail, both authors e-mailed the university students regularly, and in fact, we even e-mailed messages to the clients. The clients were also given a choice of having an e-mail pen pal in another state. Although not required to use e-journals, the university students were encouraged to do so.

Participants

The class was composed of twenty female students, nineteen undergraduates, and one graduate student working on elementary education certification. Eighteen students were majoring in elementary education, one was in middle school, and one was a special needs preservice teacher. Nine students were 18-25 years; six were 26-35 years, and five were 36-50 years. Three identified themselves as African-American, thirteen as Caucasian, and one as Spanish-American. Although three students left this field blank, they appeared to be Caucasian, bringing that total to sixteen.

Research Setting

The course was conducted in three separate buildings, the College of Education (COE), the University Computer Center (UCC), and the Learning Resource Center (LRC). The corrective reading course is designed to teach students how to implement various strategies for assessing and teaching reading, and to provide university students practical experience in tutoring a client. During the summer, the course met twice weekly for about three hours per day for six weeks including the tutoring experience. Both before and after the students tutor their clients, there are discussions about strategies to help their clients become better readers.

The students met their clients for a total of fifteen contact hours spread over five weeks, meeting twice weekly for an hour and a half each day. For two hours per day during the first week of class, the university students met, without clients, in a twenty station IBM telecommunications lab in the UCC. This training was for introducing basic e-mail and Internet. In addition to showing the students how to use this technology, a further purpose was to get them thinking about how they could integrate this technology into their teaching. Although no effort was made to directly teach technical vocabulary, equipment and software were named as they were used. An integral part of the lab is the Liquid Crystal Display (LCD) panel that facilitates whole group instruction. The CD-ROM software that the students used with their clients was installed on six multimedia pentium computers in the LRC.

During the five weeks that the undergraduates worked with their clients, they were given the opportunity to use the twenty station lab for a half-hour each class period. This meant that the clients had an opportunity to use this technology for at least one hour per week or for five hours for the session. Students were not required to use the lab, since science, writing, art, and math centers were set up in their regular classroom. The undergraduates made use of the technology as their comfort level increased, and as the needs and interests of their clients required it.

Data Sources

A survey was given on the first day of class to assess the students' levels of technology familiarity, usage, and their general attitudes toward technology. This survey was readministered on the last day of class to allow for pre-post statistical analyses. In addition, students' e-mail dialogue with the instructors and their weekly entries in a technology journal provided narrative data that would be used to document changes in knowledge and attitudes regarding technology.

Results and Discussion

Although twelve of the twenty students indicated they had computers at home, only ten had modems, and most only used computers to do word processing. By the end of the semester, their computer usage included finding lesson ideas on the Internet, conducting on-line database searches, using CD-ROMs in their lesson plans, and regular and continued use of e-mail. One interesting observation was an increase in the language of technology that occurred within e-mail dialogue, journal entries, and during informal conversations with other students and the instructors. Another observation revealed their initial e-mail to be full of typographical errors and strange letter and word spacings. By the end of the semester, as students became facile with the editing feature, much of their e-mail looked as if it were done with a word processor.

Examination of the pre-post survey items indicate positive changes in familiarity and usage for computer LCD projection panels, CD-ROMs, modems, local area networks, wide area networks, computers in the classroom, database searches, New Orleans Freenet, Internet, World Wide Web, and e-mail.

In Their Own Voices

The most meaningful way to indicate the changes in attitudes toward technology by the students is to examine their own statements. Students were required to keep weekly anecdotal notes of their tutoring session, including their reflections about technology usage. Additionally, they wrote a technology reflection included as part of their final portfolio. The following are excerpts from these documents categorized into three sub headings which are: client changes, student attitudes - beginning/ending, increased student technology knowledge.

Client Changes. The following is a good illustration of the positive effects integrating technology into lesson plans had on the writing process for one student's client. The client was a very reluctant writer at the beginning of the semester. The following is from the tutor's anecdotal notes:

> I am amazed at the willingness to write that M. expresses now that she is typing her book rather than writing by hand. She obviously prefers the keyboard to pencil and paper and I can't say that I blame her. Another thrill for her is seeing how nice her book pages look when they are printed with the laser printer. She says it looks like a real book and of course I tell her that it is a real book.

In her final reflection about her client, the student had this to say about the client's self confidence as a direct result of this course:

> M.'s family purchased a computer this summer. She felt comfortable enough to show her family how to browse the Internet sites. What a confidence builder that must have been for the youngest family member to be able to show the way! ... Hopefully, her home computer will be a source of writing pleasure.

The following indicates a remarkable change in the attitude of one client toward computers. In her anecdotal notes about technology, for the week of June 6, 1996, this student noted about her client, "O. hates the computer! I tried to find info about the sanddollar with him through Netscape, but he didn't want to look at the computer. He didn't even want to read e-mail." Continuing, for the week of June 23, 1996, she said, "O. loved working with Seaside Adventure [1995]. He did not take his eyes off the screen. He laughed and danced like never before." By the end of the course, she stated, "O. has advanced so much on the computer. He works it all by himself - taking complete control of it. He can even control the mouse." This is an excellent example of why we need to try different computer applications. Although O. did not respond to the Internet, his attitude toward computers completely changed when he found software that met his needs.

The following excerpt from another student's anecdotal notes displays the progress made by one of the clients that was typical of clients who came to the class with little or no computer skills. For the week of June 18, 1996, she wrote, "After using the computer in the UCC, she demonstrated very little knowledge of the mouse and keyboard." For the week of June 20, 1996, she wrote, " L. was amazed that we could receive mail through the computer. L. wrote a letter inquiring about a pen pal. She enjoyed typing on the keyboard." The student concluded her anecdotal records with this comment,

> I have included the letter to B. [her pen pal] that L. has typed and sent through e-mail. The reply that L. typed and sent to Joan [co-author of this research] is also included [in her submittal with her portfolio], to demonstrate that L. has gained knowledge of writing, typing, and sending a letter/reply through e-mail.

Student Attitudes - Beginning/Ending. Some students entered the course expecting it to be taught in the usual fashion, and were upset in the beginning when they found out they were going to be using computers. The following, from a student's final technology reflection, demonstrates her initial attitude:

> I was very frightened at first, when we began talking about using the computer in our lessons with the students. ... I must admit that I was frustrated and felt overwhelmed at times, however with more time I know that I will get more comfortable with the computer. ... I feel that as a teacher I should have access to and knowledge of how the Internet works.... I feel grateful to have this opportunity to get training and learn how the Internet works and the many uses there are for teachers.

The following, taken from a final reflection, is a wonderful illustration of how some students felt at the beginning of the class, the fear of failing, the fear of looking foolish in front of a child, and the change that occurred over the semester.

> I have resisted the computer ever since it was first introduced to me, simply because it seemed too difficult. ... At the beginning of this semester I was completely freaked about having to use the computer every class period, and to make matters worse I had to have a 9 year old student with me. I was sure that I would make a total fool of myself, not to mention the fact that I would be completely embarrassed to let a child see that I did not know what I was doing.
>
> ... I have learned more about the computer this semester than I ever thought possible. ... Oh what fun I have had, learning about this overwhelming piece of equipment that I have abhorred all these years. ... I cannot wait until I can go buy my very own computer, with Windows!! Internet, here I come!!

Increased Student Technology Knowledge. The enthusiasm for using technology that the students gained by watching the effect of technology usage with their clients can be seen in this excerpt from a student's final reflection:

> This summer has given me a new perspective about using the Internet in my classroom. I had

> heard about the Internet but this was the first time I had used it. I found it to be very helpful with gathering information for lessons and catching my student's interest in learning about new things. ... The ideas and lesson plans available are great, having the students write back and forth to other students is just amazing. The student becomes so involved in writing and reading on the Internet it is just great. As for the CD-ROMs I have worked on the computer in the LRC lab, I found them to be very informative and interesting not only to the student but myself as well.

The following is representative of how students felt about themselves as they mastered the technology, used the Internet from their home computer, and realized that they could learn from their clients.

> One of the areas that I have truly grown in this semester is in the area of technology. ... I have Kermit [the only telecommunications software program supported by the UCC] up and running and have been using e-mail, surfing Lynx [the only browser that UNO students have access to from home] to surf through Yahoo, and ERIC. I now have a better understanding about using CD-ROMs. I am now pretty good at e-mail. ... I am really pleased that I finally got "hooked up" [to the VAX from home]. ... I feel that is quite an accomplishment. I have learned a lot about computer technology from both my teachers in this course and from my client, S. So it is important to realize that our students are not the only ones who do the learning. I feel I am off to a good start and am looking forward to the future.

The above was a typical example of how proud the students felt when they were able to use the Internet from their home computer.

Although students are required to take a computer literacy course early in their curriculum, many of the students were still only in the word processing stage of computer literacy. Since they had no authentic uses for some of what they learned, many forgot what they had learned. This can be seen in the following, and again it is tied into the client's learning also:

> This was the first semester that I had so much time and availability to use the computers. I am very grateful for the experience. I learned more this semester than I did when I took Computer Literacy 1000. ... I also believe this was a good experience for my student. ... She especially enjoyed the CD-ROMs.
>
> ... I got my greatest joy out of receiving and responding to the little notes from Dr. Gipe and Joan Lamare. Every semester that I had an account I was never able to access the e-mail again and so my notes all went unread. But this semester was different.
>
> ... As for the pen pal, that was very exciting. ... it was quite exciting to communicate via the computer. I feel like I have made great strides towards becoming computer literate and will continue to do so in the future.

Challenges

We would be remiss if we were to leave the impression that all proceeded smoothly. The major obstacle to overcome was the logistics of conducting this course, especially since there was no Netscape lab in the College of Education building. Because of this we had to conduct the technology part of the course in two other locations, away from the regular classroom located in the COE building, – the University Computer Center and the Learning Resource Center. Consequently, for the technology component, there were times when the class met in the UCC and times when it met in the LRC. If there had been a telecommunications lab in the COE building that also ran the CD-ROM software, the students and clients would have had more time with the technology, and less travel and interruption time.

Since this was the first time the course was conducted with an emphasis on technology, there were some course delivery problems, for example, we gave out too many handouts at first, and didn't allow enough instructional time before the students had their clients. Because of switching locations so frequently, some students forgot to bring their earphones when we met in the LRC. Even though the LRC had multimedia computers, there were no speakers, since it was an open lab and the computers were used mostly for word processing.

Conclusion

Although we anticipated a positive change process, it was fascinating to observe it. Some of the students were intimidated by computers originally, but, by the end of the course, most of these students were making full use of all of the technology. Many students indicated they will use technology available to them during their student teaching experience. We attribute this willingness to use technology, as well as an increased technology vocabulary, to the fact that students had authentic experiences using technology.

In conclusion, we would like to present the voices of two students, taken from their final reflections. The first student wrote about her own personal growth and development as a result of this course. The second student reflected on the impact that this technology had on her and her client. The first student wrote:

> During the course of the summer I have grown tremendously with my computer knowledge. I have grown comfortable with the Internet, e-mail, and CD-ROMs. At first I was very hesitant to accept why I was being forced to learn the computer and why I was being forced to use it with my student, much less in my classroom. My whole outlook is different. I now feel that I must grow

with technology and become technologically literate if I am to become a teacher in the 21st century. I can use the Internet to gain access to lesson plans and information for my lessons. I was not aware of the amount of information that I could obtain through the use of the computer.

The e-mail part of the computer is such an advance in technology that I don't know how we survived without being able to communicate through a screen and keyboard. My student was the real driving force behind my knowledge and enjoyment with the e-mail system. I feel very confident with the system that I could use it on computers other than at UNO.

My first thought about CD-ROMs was "Why didn't I find out about these sooner?" I will definitely use them in my classroom given I have the resources to do so. They are so easy to use and the children enjoy them. Lots of learning and teaching can be done with CD-ROMs. ... To sum up my experience on the computer — FANTASTIC AND ENJOYABLE, not to mention enlightening.

The second student reflected:

The most important aspect that I learned was the different attitudes/reactions that I as an adult have towards computers versus that of a child. During the sessions I struggled with using the computer because I felt so computer ignorant. I knew that the computer was benefiting B., but I felt so dumb because I did not know what I was doing. ... B. had no problem using the computer. She loved the CD-ROM programs. She especially liked reading the new information on various sea creatures. This was beneficial to me because I was able to observe some of her reading strategies.

... This is the first class that has allowed me to experience computer technology with a student. I think this is extremely significant ... computer knowledge is essential. Therefore I think it was very important for me to have had this experience because I was able to explore the use of educational computer programs. ... Through watching B. this summer I can see the impact the computers have in relation to student learning. Computers allow learning to be challenging and at the same time fun.

Inasmuch as this was only one class, this project has shown that undergraduates can effectively incorporate technology into their lessons when provided authentic learning experiences in a supportive environment.

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Preservice Teachers' Use of Technology in the Construction of Literacy Events

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Technology has increasingly played a critical role in the professional development of teachers. Colleges and universi ties have progressed from offering a basic introductory computer course to the inclusion of technology within other education courses such as reading and language arts methods (Williams & Matthew, 1995.). Consequently, reading and language arts professors have continued to respond to the challenge of fostering the use of technology within authentic contexts for teaching literacy theory and applications. Specifically, the use of the Internet for e-pals (Johnson, 1996) and book dialogues (Williams & Matthew, 1996), the development of teaching materials such as big books (Long & Reehm, 1996) and fostering children's writing (Parson & Johnson, 1996) have motivated both preservice and inservice teachers to use technology as one many ways of constructing literacy lessons.

Innovations in education are not isolated to the inclusion of technology. More recently, many colleges and universities have recognized the success of field-based learning environments, and have provided opportunities for students to practice theories of learning in public elementary school classrooms under the supervision of both university and public school teachers. Although most participants in this type of teacher preparation program are excited about the practical applications of teaching, they are challenged by the additional complexity of teaching preservice teachers within a different technological context. Many universities may have the necessary equipment and teaching materials to illustrate the potential for using technology to engage students in literacy events; however, the reverse may be true in many public elementary schools. Therefore, if preservice teachers are encouraged to use technology within the confines of the university, but are not able to use it during their field based experiences or during student teaching, it is most unlikely that they will continue the practice as inservice teachers (Johnson & Harlow, 1993; Wright, 1993). Based on the premise that technology is best learned and appreciated when implemented within authentic contexts, the authors investigated the role of technology in a field-based reading and language arts course. The purpose of this study, then is to describe how reading and language arts professors and instructors implemented technology in a field-based setting. Specifically, the study sought to address the constructivist processes of both preservice teachers and the university instructors as they met a technological objective for the reading/language arts methods course.

Method

Participants

The participants for the study included five university instructors and 132 preservice teachers enrolled in a comprehensive field-based teacher preparation program at a large metropolitan university. The five reading/language arts professors and instructors taught the reading/language arts in the elementary school methods course as part of the teacher preparation program. Three had doctoral degrees in reading/language arts and were full time assistant or associate professors at the university, while two participants were doctoral students in reading/language arts at the same university and were part time instructors. All of the professors and instructors were experienced classroom teachers at both the elementary/middle school level and at the college level. Additionally, they had experience working with field-based teaching and were comfortable working with technology. All had access to a computer at their homes and/or their offices. The preservice teachers were all senior level students who have completed the majority of their coursework including the basic educational technology course and had varying degrees of competence and confidence with computers. They were enrolled in the pre-student teaching phase of the teacher education program and consequently, took all of their methods courses at an elementary school site, called a cluster. Therefore, all of the students were assigned to a cluster of approximately 25 students, four methods teachers, and the cluster coordinator. This format enabled the students and the instructors to not only learn about content information and to practice it within an authentic context, but also established a classroom community. However, the establishment of this type of educational milieu was a two edged sword. On the positive side, the students had access to elementary and middle school students on a daily basis. The negative aspect was that the students did not have an easy access to the university and all its offerings, particularly the computer lab. This component limited the students' access to a computer to the elementary site, or their homes. As full time students to the university, they were still invited to participate in the technology available there, and though some did, many found the inconvenience too cumbersome and opted to "make do" with their limited resources.

Course Description and Procedures

Prior to the start of the semester, we were informed that each of the five school sites would be provided with a Macintosh Performa, a printer, and an LCD panel, and that all methods professors were encouraged to utilize technology in their teaching and in assignments. In keeping with the overall expectations for the preservice teachers in the comprehensive program, the literacy instructors decided to include an assignment based upon technology. Here, the students were required to develop curriculum material to teach reading and/or language arts using technology. Reflective of a constructivist philosophy, and keeping in mind the challenges that may face these preservice teachers, we decided to frame this assignment according to the needs, abilities, and interests of the individual students. We gave the students several options for this assignment, including the development of big books, concept books, games, slide shows, or other types of presentation. Additionally, we allowed the term "technology" to be interpreted according to the students' concept of curriculum development. Although we anticipated a product that was completed using the computer, we allowed the use of more traditional means of technological instruction (i.e. audio or video taping). Once the participants understood the concept of the assignment and began working with students with their site-based elementary and middle school teachers, they began developing materials to enhance literacy development. As they progressed in this area, we anticipated that we would have the needed hardware and software that would enable us to encourage the students to share their ideas and have in-class time to work on the materials following a writing workshop approach.

Unfortunately, the use of technology varied at each elementary or middle school site. At some schools, the computer was set up in the university classroom and students had regular access. Several schools even supplied access to the Internet. At other sites, where our classes were held in portable classrooms or on a stage, the computer was housed in an inconvenient room, or not at the site at all if security posed a problem. Adding to the complication was that there was only one computer for the entire class, and that the additional technological support (the printer and LCD panel) was not delivered to the sites until the final week of classes. Consequently, student response to the assignment resulted in various approaches. We differed in the ways which we fostered and guided the students, based upon our own experiences with technology and with the resources available to the students at each of the sites. For example, several of us were able to approach the assignment through a "workshop" strategy where students were given in class time to construct their materials. Others offered the students time to share their ideas in class while still others suggested that the students visit the computer labs on campus, or in the homes of fellow students or the instructor.

Results

All of the students presented their technology project at the conclusion of the semester. These projects varied according to the abilities and interests of the students. Although most of the participants shared big books that were developed for use in an integrated unit, required of all students, others applied their own constructivist philosophy by developing curriculum that encouraged student dialogues about literature. They also ranged in the amount of technology that was utilized. Again, most used the computer to write the text for their books, but some downloaded pictures from the Internet or used pictures from a variety of computer programs. Interestingly, most of the students reported that they did not complete the project individually, and often stated that they had assistance from family members or close friends. Therefore, many viewed this assignment as an opportunity to interact with others and responded favorably to the assignment and were pleased with the connection to the overall technology assignment of the comprehensive program. Many of the students also expressed their interest in using technology created teaching materials in their future classrooms, as well as using technology to create literacy events for their elementary and middle school students. Others were reluctant to use computers, and limited the technology component to fulfilling only minimal requirements. These students were primarily those who were faced with the challenge of little to no resources, and were greatly frustrated about completing this assignment. Not surprisingly, these were the same students who shied away from technology through the entire semester, turning in other assignments in more traditional mediums such as paper and pencil.

Conclusions

At the conclusion of the study, we met to discuss the types of student projects and compared both successes and failures of this assignment in the reading and language arts methods course. The results of this study indicate that despite some of the difficulties, these preservice teachers recognized the value of using technology to develop instructional materials that would be helpful in the planning and implementation of literacy lessons. They also enjoyed the social aspect of technology planning and expressed interest in using technology in their own future classrooms. We agreed that the assignment was valuable and should be continued. We believe that it is essential that university professors remain proactive in our commitment to technology in the schools, and continue to stress its importance, particularly as it pertains to creating valuable literacy events for elementary school students.

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Learning to Use the WWW while Learning to Teach ESL

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In addition to being proficient in employing effective instructional methods and materials, teachers who are fully prepared to succeed in today's world must also have technology skills. One of the most rapidly developing areas is the use of the Internet and World Wide Web (WWW) as teaching tools, communication channels, and information resources. Recognizing these trends, I concluded that it was important for the preservice teachers in my "Introduction to ESL (English as a Second Language) Methodology" course to gain experience with the Internet and World Wide Web early in their academic careers. This paper recounts my experiences as a teacher educator integrating these telecommunications tools in my methodology course and, concurrently, convincing and teaching my students to use them. It also reports on my students' changing attitudes and developing skills regarding their use of these technological tools.

Method

Participants

The participants in the study were 18 graduate students (16 females, 2 males) and 2 auditors (1 female, 1 male) enrolled in Linguistics 577, Introduction to ESL Methodology, at Brigham Young University. One third of these students were native to countries other than the United States—Australia, Indonesia, Italy, Japan, Taiwan, and Tonga. In addition, most of the U.S.-born students had previous experience living abroad—in Australia, China, Germany, Israel, Japan, Korea, Taiwan, and Russia. For the most part they were pre-service teachers in their first semester of a teacher preparation program. Most of them were in their early twenties, but a few were in their thirties and forties.

A survey conducted at the start of the semester revealed that over half the course members had access to a computer either where they lived (60%) or where they worked (50%). For those without such access, campus computer labs provided a means whereby they could access the Internet. Fifty percent of the participants ordinarily used an IBM-compatible PC, 25% used a Macintosh, and the remainder did not know what type of computer they used or did not respond to this item.

Virtually all the students claimed to have basic computer skills, but they used them almost exclusively in "traditional" ways. For instance, 85% reported normally using computers for word processing. Only 20% had used spreadsheets, and the same percentage had experience using e-mail. Only 15% had "surfed" the Internet. When asked if they considered themselves "computer literate," 45% replied, "Yes," 40% indicated they were somewhat or semi-literate, and 15% said, "No."

As noted above, few of the participants (15%) had any experience with the Internet, and only two of them considered themselves "Internet literate." A few others said they were marginally Internet literate, but the great majority (70%) reported they were not Internet literate at all. When asked what they knew about the WWW, 20% responded that it was "useful" and/or "enormous," but only 15% had actually experimented with it, and 65% wrote, "Very little," "Not much" or simply left this item blank.

When asked about their feelings toward learning to use the Internet and WWW, some participants were initially enthusiastic about using computers in these new ways, some were "technology reluctant," and a few bordered on being technophobic. How their feelings changed in the course of the semester will be reported in greater detail below.

Treatment

An experiential learning approach was employed to involve the participants in the use of computers and the Internet and develop their technology-using skills. Aside from a few quick in-class demonstrations, very little direct instruction on how to use the Internet and World Wide Web was provided. Instead, the students were almost immediately immersed in technology-dependent activities. These activities involved instruction as well as information gathering/sharing and included the following:

- Accessing the course syllabus (objectives, requirements, calendar, descriptions of major learning activities, etc.) on the WWW.
- Following links from the syllabus to various other WWW sites, including many ESL teaching and employment resources.

- Learning the evaluation criteria for major assignments via the course WWW site.
- Viewing sample "model" assignments on the same site.
- Contacting the instructor via e-mail.
- Subscribing to TESL-oriented listservs and electronic journals.
- Using e-mail for communicating announcements and conducting other course-related business.
- Using e-mail for inter-student communication.
- Submitting assignments (journal article reports, lesson plans, etc.) electronically.
- Finding the answers to in-class quizzes on the WWW.
- Accessing electronic reserve readings from our university library.

This experiential approach was chosen for two reasons. First, the course calendar was already full; there was no additional time for teaching computer and Internet skills. In addition, following the overall experiential learning philosophy of the course, I felt that the most efficient and effective way for my students to learn about technology would be for them to actually use it.

Data Collection Procedures

Participants' feelings toward computers and technology in general, as well as the Internet and the World Wide Web, were surveyed at the outset of the course and at approximately one-month intervals thereafter. With the exception of the first survey (which, as reported above, went into considerable depth concerning their experience, skills, access, and attitudes regarding computers, the Internet, and the WWW), these were rather informal. Typically, they consisted of just two questions. Participants' responses were analyzed qualitatively and grouped longitudinally.

Results

The results of this study are organized into two main sections. The first looks at the advantages as well as the problems of using the Internet and World Wide Web (hereafter I/WWW) from the perspective of the teacher. The second presents the reactions of the participants to using the I/WWW.

The Teacher's Perspective: Advantages and Difficulties

In my view, implementing the use of the I/WWW into my existing, introductory ESL methodology course produced a number of definite advantages, including the following:

- Quick and easy updating of syllabus materials.
- The ability to add new materials as the semester progresses.
- "Paperless" electronic reserve readings, study questions, and even quizzes.
- A significant reduction in the number of pages in the printed packet.
- A corresponding reduction in the cost of the packet.
- Access to useful material for students enrolled in my other courses.
- Student access to syllabus materials and guidelines at any time.
- Links to a multitude of other ESL-related resources on the WWW.
- Connections with several on-line ESL-related journals.
- Students' becoming computer and I/WWW literate *early* in their academic program.
- Simplified, "paperless," and extended sharing among students of their lesson plans and journal article reviews.
- Connections with various WWW sites and Internet listservs where students can learn about ESL jobs almost as soon as openings occur.
- Direct connections with professional organizations so students can learn for themselves about membership, conventions, resources, and other services.
- Improved coordination of 577 students' "practicum" teaching assignments in our English Language Center.
- Saving of class time previously devoted to announcements and business (now conducted via e-mail).
- Immediate distribution of urgent e-mail messages.
- Distribution of messages in their entirety, instead of a quick, oral in-class summary.
- The assurance that e-mail announcements reach all students in the course—not just those who are in the classroom.
- More efficient (and less threatening) teacher-student communication via e-mail.
- Increased inter-student communication (ranging from academic discussions to informal conversations) out of class via e-mail.

On the other hand, technology is certainly a mixed blessing. Even with some of the new software tools, converting my syllabus and packet materials into Web pages was time consuming. Fortunately, I had a graduate assistant who helped with this task, but in order to accomplish it we both had to learn the basics of HTML.

Some students had difficulty setting up their e-mail accounts and Web browsers—especially on their home computers. Fortunately, friends and family usually came to the rescue. Then, when they finally got everything working, the College server would go down, giving students a new excuse for not doing their homework.

The Students' Perspective: Reactions to Using the I/WWW

After being introduced to the course and its I/WWW-based assignments, the participants were surveyed in September, October, and November. The survey sought to address both their feelings about the I/WWW and the course materials they accessed on the WWW.

Survey One. Administered only a few days after the I/WWW had been explained to the class, this survey consisted of only one question: "What one word best describes your feelings about the use of the Internet and WWW for this course?" Participants' positive and negative responses were fairly evenly balanced, with a few students remaining cautiously in the middle. The positive responses used words like *exciting, dandy, comfortable, fine, colorful, resourceful,* and *convenient.* Those in the middle employed terms such as *necessary, curious, possibilities,* and *progressing.* One respondent ignored the instructions and wrote, "It has been both *encouraging*, and *frustrating* [emphasis hers]." Two students indicated that the I/WWW was "challenging." The rest used more negative descriptors: *unfamiliar, frustrating* (two respondents), and *undone*—although whether it was the work or the student that was "undone" remains unclear.

Some students expressed their feelings through other channels. For example, a couple of weeks into the course, one student sent the instructor an e-mail message. In it she explained that, in addition to carrying out her course assignments over the Internet, she was excited to begin sending and receiving e-mail to/from her family, former colleagues, and friends back home in Asia. A few weeks later, another student complained: "This is all new to me! I'm too old to learn these new tricks!"

Survey Two. A month later, students had more experience with the I/WWW and more to say. At this point, they were asked two questions: "So far, what course-related activities or purposes have you used the Internet or World Wide Web for?" and "What one word best describes your current feelings toward the Internet and World Wide Web?" Seventeen students responded. Once again, the reactions were mixed, but this time they were much more positive.

In response to the first question, at least two participants indicated considerable use. One wrote: "I do at least half of my work (homework, study, research, communication, etc.) via the Internet and World Wide Web. I have found it extremely valuable with the limited time I have. It offers vast resources at home that would require much more time otherwise." Another reported, "I use the Internet extensively in searching for information and materials for my classes." The other students had not yet mastered the technology so thoroughly, but they were not far behind. They had used the I/WWW for the five main purposes listed below. The percentage of respondents who mentioned each purpose is indicated after the category title, and the categories are arranged in descending order.

- Course syllabus (assignment information, instructions, and criteria; course calendar; answers to quiz questions) (71%). Consulting the syllabus for course information was the most frequently mentioned use. Many respondents wrote, "I look certain things up on the syllabus (the links are very helpful)" or words to that effect. One also noted, "I printed out a few pages I lost from the syllabus."
- TESL-related resources—ideas for lesson plans and teaching materials (35%). Only half as many respondents mentioned this category, but this use was still substantial. Responses included: "I've searched for ideas for my materials file. I wanted to check on songs, CNN News, and materials for the ESL classroom." and "I've used it for looking up things that would help me with my teaching. I've found some fun locations such as cartoons, songs, etc."
- E-mail communication (35%). An equally large number of participants reported using e-mail to communicate with classmates, professors, and friends/family. A few also mentioned "E-mail with TESL-L" an ESL-oriented listserv with some lively and pertinent discussions.
- Information about TESL jobs (12%). Even though 577 is an introductory course, a couple of students were already combing the WWW for information on "ESL teaching opportunities." One reported enthusiastically, "I've also found places where I can look up TESL jobs, etc."
- More general WWW surfing and searching (12%). Two of the respondents also reported "surfing" or conducting more formal "Net searches" regularly.

At this stage, students also reported considerably more enthusiasm and less apprehension about using the I/WWW. Ten (59%) of the responses were decidedly positive: "Invaluable," "Impressed," "Feeling better and better," "Fascinating & scary," "Great!," "Interesting," "Comfortable," "World-wide," "Useful," and "Excited neophyte." Even the less enthusiastic responses tended toward the positive: "Learning," "I'm getting there," "Progression," and "Getting used to it!" Two responses were realistically balanced: "Amazing (but sometimes it's confusing)" and "Fun, but takes a lot of time to find what one wants." Only one was still decidedly negative, using the word *frustration.*

Survey Three. After another month had passed, the participants were surveyed again. This time, however, participants were even more comfortable with, and enthusiastic about, the Web. An even greater percentage of them reported uses of the I/WWW in four of the five main categories used for analyzing Survey Two. In addition, a new category of WWW use emerged.

- TESL-related resources—Ideas for lesson plans and teaching materials (88%). As the course moved into the phase where students started doing more actual teaching, their interests naturally turned to the resources needed to support that teaching. Nearly 90% of the participants reported searching and "finding things for teaching—poems, songs, etc." as well as "pictures, story, games, etc." In sum "Hunting for materials" and "looking for lesson plan ideas" on the WWW became extremely common activities.

- E-mail communication (56%). In comparison with the results of the previous survey, an even greater number of participants now mentioned using e-mail to communicate with colleagues, professors, and friends. In addition, more sophisticated e-mail uses were reported. For instance, more students reported subscribing to TESL-L and other on-line forums to "read up on current (T)ESL topics." One class member had even become actively involved in several specialized sublists, such as one for ESL materials writers.
- Course syllabus (25%). Consulting the course WWW syllabus and ancillary materials was the most frequently mentioned (71%) use of the I/WWW in Survey Two. Apparently, with the passage of time, students became familiar enough with the course requirements and activities that they no longer needed to consult the WWW syllabus so often. Only a fourth of the respondents to Survey Three mentioned looking at it.
- Information about TESL jobs (19%). In contrast, the number of mentions of ESL "job-hunting" increased in Survey Three. At least one student had even started using specialized TESL employment listservs.
- More general WWW surfing and searching (13%). The number of respondents who mentioned "surfing" or "just browsing and seeing what's there" remained the same as in Survey Two, although an additional student wished she had "more time to search."
- Research (new category) (13%). With no specific urging or guidance from the teacher, at least two students apparently started using the WWW for an additional purpose. In this survey, they mentioned doing "research" ("on topics such as English only and English plus, humor, grammar, etc.") on the Web.

All but one of the responses to the "one-word" I/WWW reaction item were favorable. Expressions participants used to describe their current feelings toward the I/WWW were *exciting, resourceful, comfortable* (three respondents), *acceptance, fine, necessary, interested, great!, fascinated,* and *interesting/fun!* A few could not confine themselves to just a word. One gushed, "My skills are improving!!" Another, who had experienced considerable frustration with the I/WWW earlier in the semester, wrote, "Finally sent a message. Just needed time." One realist commented, "I like it, but it takes a lot of time." An enthusiast wrote, "With my schedule, I heavily rely on the Internet to survive." Possibly the most rewarding comment of all, however, written by a student who had earlier shown some resistance to "learning new tricks," was a simple "Thank you!"

Conclusions

Changing from a paper-based course to one which relieves heavily on the I/WWW is not a simple task. Such a step should not be undertaken on a whim, without support. Nevertheless, it offers many rewards, among which is seeing students overcome their fears and learn to use a technological tool that will be of great use to them in the future.

The most obvious pattern in the data is one of steadily increasing confidence, competence, and enthusiasm on the part of the students regarding their use of the I/WWW. Another interesting pattern which appeared in the data was the rise and fall over time of certain categories of use (i.e., consulting the course syllabus).

More important than any general pattern that might be deduced, however, is the realization that people react to new technology in individual ways—based on their personalities, talents, or previous experiences. When introduced to the advantages of technology, many people will almost immediately put them into practice, quickly mastering the technology and becoming enthusiastic "opinion leaders." Not all students, however, follow this path. Some continue to resist the technology and have difficulty mastering it. For example, toward the end of the semester, at least one of my students still spoke of "going to do battle with the computer" when she needed to submit assignments via e-mail.

The amount of confidence that these findings merit is limited. The sample was small, the length of the study was limited, and the data-gathering methods were rough. The "one-word" responses on the monthly surveys were not sufficient to capture the complexity of students' true feelings about the I/WWW. Also, there was a potential for a "halo effect" in the responses, as participants might have tried to make a good impression on their teacher. Additional experience in future semesters, with additional participants, and in other research settings will be needed before any solid conclusions can be drawn.

An important question, which this study only raises, is whether the participants will continue to use the new technology once the course is finished. While the answer to that question lies beyond the limits of this study, the data did provide some encouraging signs. For example, one formerly reluctant WWW user commented, "I plan to continue using it as a resource."

Those interested in seeing the actual Linguistics 577 course syllabus and related materials used in this research can find them on the WWW at the following URL: http://humanities.byu.edu/linguistics/Henrichsen/577ReqCalF96.html

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Teaching Reading Strategies: A New Approach for ESL/EFL Teachers

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The goal of teaching reading to ESL/EFL students is to help them become strategic and independent readers. Teaching students how to read has become increasingly important in the ESL/EFL curriculum today.

Reading is a complex process; even more so in a second language because readers need to construct meaning through culturally determined cognitive frameworks. Teaching ESL/EFL students reading strategies is a complicated but worthwhile task for ESL teachers. Preservice ESL/EFL teachers, in particular, should be aware of the fact that teaching reading strategies will lead students to become proficient readers. It is crucial that ESL/EFL teachers understand the process of using strategies and have the ability to teach them.

The Importance of Using Reading Strategies

According to Block (1986, 1992), good readers are more capable of monitoring their comprehension, are more aware of the strategies they use, and are more flexible in using strategies than poor readers. Specifically, good readers adjust their strategies to the type of text and to the purpose for which they are reading. Good readers distinguish between important information and details as they read and are able to use clues in the text to anticipate and integrate new information.

Reading is an active process in which the reader makes efficient use of strategies to understand printed information (Goodman, 1970). Research in reading English as a second/foreign language (ESL/EFL), (Alderson, 1984; Benedetto, 1984; Coady, 1979; Goodman, 1973; Hudson, 1982; Koda, 1990) indicates that the reading process is similar in all languages and that reading strategies transfer across languages. Reading strategies developed in a first language can be transferred to a second language, regardless of how similar or dissimilar the second language is. Therefore, it is thought that an individual who is a good reader the native language will be a good reader in a second language.

Reading strategies determine how readers conceive a task, what textual cues they attend to, how they make sense of what they read, and what actions they take when they do not understand (Block, 1986; Johnston, 1983). Strategies reveal a reader's resources for understanding (Langer, 1982). Readers employ a range of strategies in order to read efficiently. This includes such strategies as adjusting the reading speed, skimming ahead, previewing titles, headings, pictures and text structure information, and anticipating information to come. A proficient reader has knowledge of cognition, including language, which involves recognizing patterns of structure and organization and using appropriate strategies to achieve specific goals. The reader must also search for specific information and formulate questions (Grabe, 1991).

Teaching Reading Strategies

ESL/EFL teachers should consider teaching their students how to use all information sources available to them (i.e., language, text, and reader) to make sense of what they read. In other words, teachers should consider teaching reading strategies as part of the teaching process in order to help their students become strategic independent readers. Teaching efficient reading strategies such as comprehension monitoring, using text organizational patterns, and making predictions about what they read can help nonnative speakers compensate for language difficulties while reading (Alderson, 1984; Carrel, 1989).

Effective teachers need to be aware of the reading process and the strategies students use while reading. When they understand the process of strategic reading, they will be able to teach strategies to their students. To make the concept more appealing to preservice ESL/EFL teachers, a computer program was developed to facilitate assessing the strategies used and developing awareness of using them, through a series of reading tasks. The program allows individuals to work through all the strategies. It provides practical opportunities to apply the strategies while reading, which helps them to understand the efficiency of the reading strategies. At the same time, the computer program helps reduce the in-class practice time.

In addition, while being exposed to the use of modern technology, the preservice ESL/EFL teachers will be able to gain personal experience in the appropriate use of technology to make the learning more interesting. They are encouraged to utilize appropriate technology to enhance teaching and learning. This program is available for them to use later during their teaching careers.

The Use of Computer Technology

The computer program (available on the CD of the annual conference proceedings) includes a series of reading tasks, such as skimming and writing, scanning and writing, reading and predicting, and so on. Each task requires a specific reading strategy or strategies. The correct answers are included in the program. Thus, the students will be able to get feedback immediately. It is designed as a self-study tool to help them learn the theory and the application. By examining the reading performances, preservice ESL/EFL teachers will be able to find out what strategies students use in reading and what strategies they don't use while trying to comprehend the text. These tasks help them to discover their students' strengths and weaknesses in reading. By increasing their awareness of students' reading skills as well as their teaching skills, they will improve their teaching and be better prepared for the new challenges of their profession.

By utilizing a popular commercial software program, HyperStudio, the software is designed for the students to use a mouse and other features, similar to word-processing, to complete the tasks. It provides feedback for the user and the ESL/EFL teachers can use the tool directly in their reading classes. It is also designed to let the ESL/EFL teachers have control of how much time should be used to finish a given task. With increased familiarity with HyperStudio and technology in general, they should be able to use the program as a shell and replace the original tasks with new material for more practice. In addition, the program is designed for the teacher to use as an assessment tool. It automatically stores test results, allowing only teacher access. All the correct answers are on the last card. If it is used as an assessment tool, the teacher can keep the information somewhere else and then cut the last card and put it back when it is needed. The program was evaluated by a group of students who were taking a methods course in teaching English as a second language. The feedback from this group was taken into consideration. It obviously has produced a positive impact on them, as they all asked for a copy to use in their future classrooms.

Formative Evaluation

A formative evaluation is critical after the students have used the program. Therefire, the ESL/EFL teachers will need to discuss the results of the performance with the students. This evaluation can be best achieved through one-on-one conferences or through peer reviews. Such feedback will become the key to improve their instruction, especially in the issue of the length of time for each task and the levels of difficulty included in the content.

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R E S E A R C H

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Research has been a section in the Annual since the first Annual was published in 1991. It is an odd category in many ways. Most of the sections in this book contain papers on a particular type of technology such as telecommunicationsor the use of technology in a particular level or subdiscipline of teacher education such as graduate and inservice or social studies teacher education. The Research section is different. Papers in this section are here, not because they relate to a particular type of use or a subject area like reading or language arts, but because they have taken a "research" approach to considering a topic. Not long ago, "research" generally meant one of three things: studies based on experimental or quasi experimental designs, correlational studies, or surveys. All three types of research were based on the same empiricist or postempiricist philosophy of science, and they all sought to discover the "truth" about something. Today, with the rising popularity of many types of qualitative research, the term research covers a much wider range of approaches.

The papers in the 1997 Annual reflect the emerging diversity of the definition of what constitutes research. The papers also reflect a growing interest in research as a topic. The first set of papers, for example, make research itself the subject matter rather than using a research approach to address other questions.

Research as a Topic. The first paper in this section, by Randall Parker at Louisiana Tech University, is a good, brief introduction to the use of computers in qualitative research. His paper is a good beginning point for anyone in education who is thinking about doing qualitative research but is unfamiliar with the many types of software that can be used by qualitative researchers. A second paper, by Bauder, Carr, Mullick, and Sarner, is also takes a broad brush approach. These authors offer some guidelines for researchers on how to do research that has an impact. The third paper, in contrast, is a study of using technology in a graduate research course. It was written by Clara Young at Mississippi State University.

Research on a Topic in IT and TE. Most of the papers in this section are reports of a study on a particular topic in the area of IT and teacher education. The topics covered include hypermedia CAI and cognitive apprenticeships (Chyung, Repman, Lan, & Winiecki), using ISTE guidelines (Matthew), how teachers use and learn to use computers (Galloway), factors that influence teachers to learn about computers (Pan & Lee). Several studies dealt with teacher education students' perceptions and attitudes (Dennison, Long, & Reehm; Dunn; Algozzine & associates at the University of North Carolina at Charlotte, Liao, Huang and Padron, and McCoy and Baker). The last paper in this group, by Crhistensen and Kzezek, looked at the reliability (internal consistency) of 14 of the computer attitude scales available in the literature.

Conceptual Issues and Questions. A third group of papers looks at broad issues relevant to the technology and teacher education. In some cases, these papers include reports of research conducted by the authors; in others, the papers are more like reviews of existing literature with a discussion of the implications of that literature for teacher education. The first paper in this section, by Jones and Paolucci, for example, looked at articles published in nine of the refereed journals in the field of educational technology. The authors analyzed the articles published in the period 1991-1996 in terms of the general focus of the papers and the type of data reported. The authors draw conclusions about the policy decisions being made today relative to technology versus the research available to support those decisions. Other papers in this section look at cooperative learning in distance education (Ichiko), navigating in hypermedia (Gedge), network-based learning (Gradinarova), distance learning in higher education (Hillesheim), electronic textbooks (Chen & Willis), telementoring in methods courses (Weiss), mentorships for teacher education faculty (Phillips & Walker), virtual worlds (Peretti), the Synergistic Curriculum (Harnish, Migotsky, Gierl, & Maskell), workshops, distance education for adults (Dudt & Dean), instructional technology programs in American and

Canadian universities (Smith & Smith), and Virtual Reality systems (Sims and Elson).

The 1997 Research Section is the largest, and most diverse, thus far. It provides some indications of the directions this field will take in the coming years.

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USING COMPUTERS IN QUALITATIVE RESEARCH

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The development and increasing availability of computers and software programs to help record, sort, retrieve, and analyze data is perhaps the greatest recent change in research technology (Bogdan & Biklin, 1992) the use of computers in research design and analysis continues to be a growing phenomena. While access to mainframe and PC programs has traditionally been used to analyze quantitative data, there is a growing use of this technology in the field of qualitative research. Almost ten years ago, Brent, Scott, and Spencer (1987) reported that over 70 percent of their respondents acknowledged using computers in qualitative studies. With continuing advances in software development and Personal Computer (PC) accessibility, one can surmise that this percentage is now even higher. With these advances in technology, it is important for the researcher to be informed as to the available and appropriate uses of technology, so that the most appropriate methods may be selected (Tesch, 1990).

The use of qualitative research designs and aspects of qualitative research in program evaluation are also increasing (Fink, 1995). Such evaluation methodologies are often useful when the goals of a program are in the process of being defined or when more quantitative data regarding the validity and reliability of program outcomes are unlikely to be available in time to complete an evaluation report. Qualitative methods are also often employed in program evaluations to complement and to add emotion, tone, and phenomenological meaning to otherwise purely quantitative data(Fink, 1995).

The application of computer technology in qualitative research and evaluation ranges from simple word processing to doing sophisticated data sorting and retrieval (Tesch, 1990). Researchers are encouraged to consider the use of computers in data analysis in light of their own familiarity and comfort level with technology, the types of data to be collected, and the planned analysis (Miles & Huberman, 1994). Most word processing programs have indexing or search-and-find features that allow the researcher to quickly locate key words or specific codes. Programs with data base managers can also be helpful in retrieving and sorting data. Software programs specifically designed for data coding, sorting, and retrieving are increasingly available for both IBM (QUALPRO, TAP, and ETHNOGRAPH) and Macintosh (HYPERQUAL) platforms.

General Software Types and Uses

Many software programs are actually combinations of application programs, but it may be helpful to discuss the general types of programs used by qualitative researchers. Miles and Weitzman (1994) have identified the following six categories of software types and functions.

Word Processors

Word processing programs are basically used in the production and revision of text. Whether IBM or Macintosh platform, these programs are useful in recording, transcribing, and editing field notes; for preparing files for coding; and for writing report text. Once information is saved in this format, it is easily retrieved, edited, and revised. Some popular word processing programs are WordPerfect, Wordstar, Microsoft Word, and MacWrite.

Word Retrievers

This type of program is useful in finding all instances of words, phrases, and word/phrase combinations that you are interested in locating. Some have the capability to present words in context, count the number of selected words in a file, and create word lists. Examples include Metamorph, Sonar Professional, The Text Collector, and WordCruncher.

Text Base Managers

This type of program will organize text more systematically for efficient search and retrieval. These programs essentially search for and retrieve numerous combinations of words, phrases, coded segments, or memos. Some of them can highly organize the text into specific cases while others are more useful in managing free form text. Examples are askSam, Folios VIEWS, and ZyINDEX.

Code-and Retrieve Programs

These programs will help you divide text into segments or chunks, attach codes to the chunks, and allow you to find and display all instances of the recorded and coded chunks. Examples are HyperQual, NUDIST, QUALPRO, and The Ethnograph.

Theory Builders

These programs are often researcher developed. In addition to code-and-retrieve systems, they also allow you to make connections between codes, develop new classifications and categories, and to imply a conceptual structure that fits the data. Examples are HyperRESEARCH, and NUDIST.

Conceptual Network Builders

This type of software not only allows you to build and test theory, but also to work with systematically built graphic networks. The researcher can view the variables linked with other variables by specific relationship (looks like, leads to, is a kind of). The networks develop from the data and the concepts and relationships seen among them. Examples include MECA, and SemNet.

Considerations in Software Selection

In addition to the main functions that specific programs can carry out, there are other criteria to be considered regarding all software collection. The first criteria is the flexibility of the program — does the program only do what it is built for or can it be used in additional ways to do other types of analysis. One should also consider if the program can be customized to create new routines as the needs emerge.

A second fundamental criteria is the degree to which the program is user friendly. Is the time and effort needed to learn the new program justified by the results? Are there adequate supports for learning the program — in effect, how useful and understandable is the manual, what tutorials and help screens are available, and will anyone respond when you call for technical support?

Other criteria to be considered are the match between the available hardware and the software, the researcher's own level of expertise with the specific program, as well as with the needed hardware and software; and his/her general comfort level with technology.

An Initial Study

After acknowledging the general criteria to be considered in the selection and use of computer software in data analysis, interviews and observations were conducted with twenty doctoral students enrolled in one of two sections of a doctoral course in qualitative research. In addition to several IBM and MacIntosh word processing programs, students were also provided with the NUDIST and ETHNOGRAPH software programs. Students were observed in the computer lab analyzing data on selected programs, and were interviewed by the researcher to determine the value of using computers in qualitative research. Results of these observations and interviews can be summarized as follows: (a) participants who were more familiar with technology before the course were also more easily engaged in using new programs for data analysis, (b) participants felt more comfortable with word processing programs and tended to stay with analysis through word processors, even when other, more complex programs were available, (c) the greatest impediment to using computers in analysis appears to be the vast amount of time needed to learn the new programs, (d) access to the computer lab, (e) lack of knowledge of software, and (f) hardware interface problems.

It should also be noted that participants appeared quick to share their success with others in the class and to assist others in learning new aspects of analysis with the selected programs. Participants also acknowledged the efficiency of using computers and several have inquired as to how to acquire additional programs and/or upgrade their own, personal computer hardware.

Pitfalls and Promises of Computer Analysis

Although computers and various software programs can be of great aid to the qualitative researcher and evaluator, there are some inherent dangers associated with their use in data analysis. The attitude and assumptions of the researcher toward the use of computers in analysis can dictate the success of the technology.

In using computers for data analysis, one must first realize that the technology is the servant and not the expert — it will do only what it is told to do. The computer program will not set up the initial organization of data, determine interpretation, or "create" phenomenological meaning. Data retrieved by code may not show the context of the word or phrase. There is also a danger that data will be deconceptualized or reconceptualized in inappropriately. The researcher must always keep in mind that using technology is not a substitute for competence.

Just as with quantitative analysis, the speed and convenience of technology may lead the qualitative researcher to perform inappropriate tasks. A program such as TAP will take key words and create codes very easily. This may lead to the development of very convenient but unnecessary codes and categories.

In addition, the researcher may be tempted to design inappropriate analyses based on what the computer can do, rather than on what is needed and relevant. There is also the danger that the inherent structure used in any particular program can predispose researchers to view, manipulate, or interpret data in specific or different ways. Effective analysis may require the use of two different types of programs in order to broaden and enhance the interpretation of data (Horney & Healey, 1991).

Finally, the programs and processes that are most convenient for the researcher or evaluator may "freeze" his or her thinking which, in turn, may lead to the same types of analysis for all projects even when a different process would be more appropriate. It is easy for researchers to "stick to what they know" and in so doing limit the types of analysis used. Qualitative researchers should be open to divergent ways of thinking so they can attempt to "expand rather than confine understanding" (Bogdan & Biklin, 1992, p. 42).

Conclusion

The use of technology and computers in qualitative research analysis and program evaluation is an ever increasing and fast moving field (Miles & Weitzman, 1994). As new programs continue to emerge that address new aspects of data analysis in improved ways, it is incumbent upon researchers to consider the appropriateness and usefulness of computers in their analysis of data. By understanding the broad range of common functions and unique features of available software programs, while at the same time being aware of the dangers of relying too much on technology for analysis, qualitative researchers can be liberated to make a "truly informed choice of methods" (Tesch, 1990, p.299).

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Making Research Count: Some Guidelines for Researchers

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The goals of research are to build a body of knowledge relevant to a profession, to inform practice, and to provide leadership. The first of these goals is the narrowest, suggesting research for its own sake and studies that appear to have no practical relevance. Concerns with this aspect of research are expressed by Schön (1983), "Is professional knowledge adequate to fulfill the espoused purposes of the professions? Is it sufficient to meet the societal demands which the professions have helped to create?" (p.13). This perceived inability of professions to use professional knowledge to solve societal problems has lead to a "crisis of confidence in the professions" according to Schön.

Schön (1983) suggests a shift from the paradigm of technical rationality, where research is separated from and considered superior to practice, to reflection-in-action as a link between the practitioner's context and the art of research. Schön recognizes that the technical rationality emphasis on problem solving ignores the conditions of problem setting, which frame the problem and possible approaches to solutions. It is this setting and framing of the problem which leads to relevant solutions that inform practice, the second stated goal of research.

The third goal of research is to provide leadership. Gustafson (1996) asserts that "...all members of the profession have both the opportunity and the obligation to exercise leadership through writing, publishing, and presenting" (p.15). Maddux (1993) points out that research is "... particularly important in all areas of educational technology since the field in general, and educational computing in particular, seems especially vulnerable to being driven by new products" (p. 11). In exercising leadership, researchers and practitioners have an obligation to set and adhere to standards of research that will both advance the knowledge of the profession and inform practice.

Research Issues

What are the standards in the field of Information Technology and Teacher Education (ITTE)? Stemming from educational technology, with roots in education, psychology, cognitive science and communications, ITTE research reflects the both the variation and the commonality of its beginnings. In describing the distinction between a research methodology as a specific technique and a research paradigm as a belief system that guides the methodology, Waxman and Bright, (1993) suggest that technology may influence both paradigms and methodologies in ITTE research.

Clark, (1983) set off a debate that still reverberates in the profession when he stated that no evidence exists to support the notion that media affects learning. Instructional designers, teachers, and budgetary gatekeepers began to question the questions asked by research. Ross (1994) suggests that misinterpretation of Clark's argument limits research to narrowly defined media comparison studies employing rigorous internal validity standards at the expense of external validity. Suggesting a paradigm shift from a natural science to a design science orientation, Kozma (1994) asserts that it is time to reframe the question from "*do* media influence learning" to "*will* media influence learning". Research should therefore be grounded in the interaction between information, cognitive processes, and the contextual environment of instruction. The suggestion to restructure the debate gives evidence of the maturation of the profession. Media are no longer viewed as simply delivery mechanisms, but have many roles, from facilitators of knowledge construction to mind extension devices and resource enabling tools (Jonassen, Campbell, & Davidson, 1994). Willis (1993) contends that for maximum benefit, current ITTE research should reflect an Instructional Development (ID) model that uses theory and basic research in the development of validated instructional packages, rather than a research-to-support-theory model.

Another crisis of confidence that plagues the profession is the perceived quality of research. While some argue about rigor versus relevance, it is clear that poorly defined problems, faulty research methods and sloppy interpretation of results have resulted in the perception of educational research as less than professional. The rest of this paper describes current trends in ITTE research and provides some guidelines for those interested in quantitative research.

Research Paradigms

Tellez (1993) examines research paradigms typically used in instructional technology research. The two qualitative methods include narrative studies and case studies. A review of the literature suggests that these techniques are heavily relied upon in ITTE even at the present time. Not all narrative studies exhibit sterling design. Gunn (1991) for example, reports on experiences in a single first grade classroom in which the researcher introduced the classroom teacher to word processing, assisted in the development of a strategy to incorporate word processing, observed the class three mornings a week over a six month period, participated as a teacher's aide, and later interviewed the students in her capacity as researcher. Having contaminated the process, she used the results to establish an elaborate ten-component staff development model and conclude that under certain circumstances computers are appropriate for a first grade classroom.

According to Tellez (1993), qualitative research designs have received much attention over the past few years because of backlash against quantitative research. The three types of quantitative research described by Yarger and Smith (as cited in Tellez, 1993) include correlational studies, quasi-experimental, and experimental designs. Much of the "bad press" received by quantitative research is due to the narrow Research-to-Support-Theory (RTST) model involving a one-time experimental study attempting to support a specific aspect of a theory (Willis, 1993). One problem with this type of research is that in educational settings, it is usually impossible to select and assign students randomly to conditions. In addition, the measures of performance used as dependent variables, may not be indicative of cognitive changes but use measures that are easy to obtain. Finally, the researcher must control other variables such as instructional methods, media, and context in ways that alter the teaching/learning process to the extent that results are not meaningful.

Maddux(1993),Tellez(1993), and Willis (1993) suggest that appropriate research designs for understanding the impact of technology on the teaching/learning process must take place over time and consider the interaction of teacher/ learner variables on students' performance. Many experimental and quasi-experimental studies take some of these variables into consideration. The assumption in experimental designs is that random selection and random assignment will ensure that the groups are as similar as possible prior to the interventions. Other techniques that may achieve comparability of groups include matching subjects on some relevant variables related to dependent variables. If significant differences are found between or among the groups, the most likely explanation is in the interventions.

Cathcart (1991), in a particularly well-designed study, monitored mathematics and language arts achievement of two classes of third grade children over a two year period. In the experimental group, there was one computer for every two children during the first year and one computer on each child's desktop for half of each day during the second year. The experimental and control intact classes were closely matched on IQ score. Post test scores were reported after adjusting for pre-test differences using one-way analysis of covariance.

In educational settings, researchers are confronted with intact groups. Campbell & Stanley (1963), offer several designs to circumvent the problems of controlled experimental designs. One type is a correlational design in which a group is selected and two or more measures of performance are obtained. The interrelationships between the variables are determined. Even when significant correlations are obtained, the researcher must be cautious in interpreting the results. The researcher must recognize that a significant relationship does NOT imply causation. A second problem in interpretation of correlations is a failure to consider the Coefficient of Determination (r2) ,the amount of total variance accounted for by the relationship between variables, and (1-r2), the amount of unexplained variance or variation due to error.

A second type for dealing with intact groups is to use the subjects as their own controls using a pre-post test of performance. This quasi-experimental design meets the criterion for longer duration. The pre-post design has several variations; it may consists of only a single group, two groups, or more. Campbell & Stanley(1963) suggest that this design is particularly suited for situations in which researchers must used intact groups, cautioning about such threats to internal validity as maturation, history, sensitization, to the performance measure and mortality.

Data analyses should take the effects of the pre-test into consideration either by using change scores (not without problems) or by statistically controlling for the effects of the pre-test. Even after these precautions have been taken, the researcher should interpret the results with care, recognizing that alternative explanations for the findings are possible. Care should also be taken in generalizing the findings to other groups.

Weller and Dodl (1991) designed an intervention intended to alter naive conceptions about science. A "representative" sample of students (n=60) was selected from eighth grade science students in two schools. From that group students with naive conceptions were divided into two groups of unspecified size. The experimental group was exposed to computer simulations of scientific properties; the control group did not do the simulations. A post test was administered to both groups, and a retention test was given to seven members of the experimental group (but apparently not to the control group) 1.5 months later. Having failed to control for initial differences between the groups, and neglecting to post test the control group, Weller and Dodl nonetheless conclude that computer simulations help students to "...alter their naive conceptions to a significant degree"(p. 101)

Research Guidelines

Phase I: Conceptualization Stage

Devising or identifying a problem. The research questions may be obtained from existing theories in the field resulting in Research-To-Support-Theory types of studies criticized by Willis (1993). Alternatively, questions can arise from interesting problems or contradictions found in the literature. Personal observations or observations made by others may be extended or investigated more fully.

Formulation of the research question. The literature review should present the researcher with alternative frames of reference including alternative conceptions rather than looking for one true definition. Once the literature has been reviewed, the researcher must articulate the research question in unambiguous terms. In formulating the questions there are three areas of concern. Who are the subjects? What is the program or intervention and how will it be carried out? Finally, what are the goals and the expected effects on participants' performance? As the questions are formulated, additional literature review may be necessary. One approach is to list all the questions that come to mind considering all possible alternatives without judgment. This list can be revised and refined to yield the final questions.

Definitions of terms and concepts. Overlapping conceptualizations obtained from the literature review can be used to identify dimensions specific to the study. This allows researchers to recognize that other studies using different conceptualizations of similar concepts cannot be directly compared. Once the specific dimensions have been identified, all terms must be clearly and objectively defined.

1. **Participants**. Who will be involved in the study? What are the relevant characteristics of participants and from where will they be selected or chosen?
2. **Program or intervention.** The intervention may consist of multiple factors having an effect on the outcomes of the teaching/learning process. These will become the independent variables. One guideline that can be used in selecting program factors is to select features that can be modified or manipulated by the researcher.
3. **Define the goals and objectives.** This phase of conceptualization involves the development of outcome criteria. The goals must be clearly stated; specific and measurable. These become the major dependent variables for the study. Guidelines for selecting the goals are usability and practicality. If goals identified are unachievable ideals they should not be included as major dependent variables; however, goals that are easily identified and easily measured may not reflect the underlying intent of the research. For example, when measuring the effects of instructional technology on learning, standardized achievement tests for reading and mathematics are often used, even if the learning was defined as creative writing.

The major issues that should be addressed in operationalizing the dependent measures follow.

1. Should indicators be measured using existing instruments or should researchers develop their own? As Tellez (1993) suggests, researchers should try to make use of "tried-and-true" measures used in previous research. When existing scales do not fit the conceptualization of concern to the study the scales will have to be tailor-made.
2. How many indicators are necessary to carry out research? Is one overall, global measure sufficient, or should there be several specific measures to tap various aspects of the intervention? If more than one measure is used, when should the assessment occur? Should it be taken proximally, soon after the participants have been exposed to the intervention, distally, after the material has had some time to "sink-in", or longitudinally to determine the longer term effects of the intervention?
3. Finally, what general types of information are required? Should subjective reactions of the participants be assessed? Should objective behavioral measures be taken? Is formative assessment required? Formative measures allow the program or intervention to be fine-tuned as participants proceed. The researcher must keep in mind that altering the intervention also alters outcomes. Should summative measures be obtained? If the intervention involves development of instructional materials to be disseminated to others following the research, summative data is imperative.

Phase II: Developing the Research Design

After all components have been defined in unambiguous terms, the appropriate research design must be developed. The research design is determined by: a) the research question , b) the scaling and number of independent and dependent variables, and c) the pragmatic concerns of conducting the research including accessibility of subjects, availability of physical and financial resources, feasibility of conducting the research, staff, and time. A multi-step approach integrating various methodologies should be considered.

There are five major research methodologies from which to select. The first set, descriptive studies, yield qualitative results and make up the major body of research in ITTE. This type should be considered preliminary, requiring further investigation using more rigorous techniques. Another type of research is the quasi-experimental, using. intact groups. Although quantitative, the results must be interpreted with caution. Experimental design allows the researcher to identify causal relationships with a high degree of confidence. While the most rigorous quantitative method, it is also the most difficult to carry out in an action setting. The nature of the intervention and the teaching/learning process may be obscured by the strict requirements for control dictated by this type of design. With an understanding of various types of design methodologies available and the strengths and weaknesses of each, the researcher is in a good position to develop an appropriate design for the problem at hand.

Phase III: Carrying out the Research

The next phase involves setting up a procedural plan to conduct the research. After data collection, the researcher must decide on appropriate data analyses. Data analysis is dictated by the research design, level of scaling and the number of independent and dependent variables in the study. Careful and appropriate interpretation of the results is essential; researchers must be careful in the types of conclusions they draw. Care must be taken not to draw causal inferences on descriptive or correlational findings.

The literature is replete with examples of poor design and/or interpretation. Brody and Lange (1991) conclude that reading and writing skills of students improve after use of a hyper-card like tool named *HyperStories*. Their sweeping conclusion fails to note that (a) their subjects were atypical - they were Deaf and Hard of Hearing students spanning elementary grades through high school; (b) their single quantitative measure of writing ability was the word count of student writing samples; (c) the pre- and post test assessments were made eighteen months apart without consideration of other intervening variables nor controlling for pretest differences; (d) there were no tests for significance; and (e) there was no control group.

Manus and Denton (1996) examined two schools; one an intermediate school encompassing grades five and six, no description is provided of the other. In one school participation in a staff development program was mandatory; in the other it was voluntary. Over a three year period, a sample of ten teachers accrued 513 hours of staff development time in school one and a group of ten teachers accrued 503 hours in school two. Participants in both schools were observed on multiple occasions using the Stallings Observation Instrument. From these observations, the mean percentage of classroom time spent was calculated on various indicators such as teacher-student interaction, teacher involvement in instructional activities, and student involvement in instructional activities. The research design did not provide for measuring changes over time and there was no pre- or post test. No control group was provided. Undeterred, the researchers confidently conclude that "...staff development training has resulted in greater use of technology for classroom management and instructional purposes," that "...off-task behaviors...diminished significantly when technology was integrated into the instruction," and that "...technology can alleviate, but not eradicate ineffective teaching" (pp. 437-438).

Carey (1991) designed an "informal" study to ascertain the effects of classroom visitations upon the computer confidence of preservice education students. Using a six-point Likert scale, levels of computer confidence were calculated at the beginning of a semester for two small groups of students - one group made the classroom visits, the other did not. The instrument was readministered at the end of the course. After (a) failing to control for the initial differences, and (b) not finding statistically significant changes in computer confidence, Carey proceeds to interpret the results anyway.

Sometimes sophisticated statistical methods are employed without apparent reason. Pelton and Pelton (1996) administered a 42 item questionnaire designed to assess attitudes toward technology to a single class of 60 college students. A principal component factor analysis was then employed to reduce the 42 questions to eight factors. The first factor accounted for 18.6% of the variance, the remaining factors for 12.0% to 6.9%. Having engaged in this elaborate statistical calculation, scant use is made of the results with the authors merely concluding that "attitude is indeed a multi-faceted variable," (p. 171) and that students are enjoying the course.

At the other extreme are studies where measures are primitive or unreported but substantive interpretations are still made. Breithaup and Wentworth (1996) divide college students enrolled in a Teaching Methods course into two self-selected groups based upon section of enrollment. One group received instruction on integrating computer based technology into the secondary curriculum, the other group did not. A survey instrument was given to all 103 subjects; the response rate was about 12%. After acknowledging the poor response rate and presenting no quantitative analysis, the authors nonetheless conclude that "these results firmly imply that the inclusion of formal computer technology instruction...has some impact on the way computers are used to support secondary education curriculum" (p.361).

Conclusions

No matter how carefully a researcher conceptualizes the problem, defines the terms, develops the design, analyzes data and interprets and draws conclusions, difficulties arise. No research paradigm is perfect and no study is free from pitfalls. Researchers should follow the guidelines closely. In interpreting and reporting results, researchers should use the "self-critical" approach described by Tellez (1993), recognizing the limitations of the research in light of threats to internal and external validity.

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Utilizing Technology in Educational Research: Implementation with Graduate Students

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Why Infuse Technology? As this world continues to convert information to an electronic form, students in almost every area of academic endeavor will have greater access to existing, evolving, and new electronic data bases. Utilizing and understanding these databases will frequently serve the student well beyond the classroom (Kawamoto, 1994). However, when that same statement is made to graduate students, utilizing electronic information appears to be more frightening. Poling (1994) asserted that students feel as if they are dragged, kicking and screaming into the realm of computerese. How can educators encourage graduate students to utilize technology if the aforementioned attitude is present? How can educators utilizing technology in the classroom enhance learning, especially in a graduate research course?

Most students, in education, pursuing a graduate degree are required to complete a course in educational research. However; many enter the course with anxiety due to previous conversations with students, writing apprehension, and limited use of the computer. These aforementioned concerns, in addition to the difficulty level of the course, creates even more anxiety. This researcher was concerned with avenues to ease the anxiety level of students who must take a required course. Crossman & Behrens (1992) postulated that a means of easing some anxiety in a graduate course is a teaching collaboration, but for institutions that have more specialized instructors, other means need to be implemented. The means for this study was technology.

Technology, in a graduate research course, should emphasize simulation, direct instruction, and interactive modes of instruction to enhance student learning. Maley (as cited in Wright, J.R., 1991). According to Rodriguez (1993), the aforementioned emphases can also motivate graduate students in finding the work more challenging. Technology should serve in providing the student with the opportunity to engage in significant research activities, disciplined inquiry and serve as a prerequisite to a scholarly career (Householder, 1993). Therefore, implementing technology in a graduate research course is extremely relevant if institutions want to produce effective researchers.

Variations in electronic information gathering can be utilized very well in a graduate course. Availability may not be the question in choosing to utilize technology as much as the attitude of the student utilizing it. Some students fail to realize that technological innovations allow both teachers and learners the ability to interact with each other beyond the confines of the classroom (Redmond & Waggoner, 1992a; Hiltz, 1994). Technology is essential can also provide encouragement and further interactions among students, which in graduate studies.

Therefore, the purpose of this study was to investigate the attitudes towards technology of graduate students in a research course prior to and after the implementation of technology. This study also addressed the type of technology that was implemented in the course and how students utilized it.

Methodology

Subjects

The subjects for this study were 40 graduates students who were completing an educational research course required for their program. These subjects were in various stages of their programs and ranged from 22 years to 50 years of age. Some subjects were taking their first graduate course and some were taking their last graduate course. The subjects volunteered to participate in the study.

Instrument

A modified version of the CARTS II Attitudinal Survey was utilized in this study. This survey is designed to address the attitudes of students regarding technology implemented by instructors and the library assistance available. Another data collection procedure included the instructors perceptions of students attitudes.

Procedure

The instructor was asked to participate in the study by utilizing the class available and by implementing technology in the course. The listing of computer-assisted instruction available for use included:

E-mail
Computer Conferencing

the Internet
Netscape
Word Processing programs
Bibliographic access
World Wide Web.

At the beginning of the course, students were administered the surveyThey were then assigned an E-mail account. After assignments were received, the students were taken to the computer lab to access their e-mailbox. Instructions were provided regarding how to access, obtain and send messages. The e-mail was used as a means of communicating with the instructor and other students, it was also a means of browsing the web to obtain literature regarding their proposal as well as using the information to refine their topic.. The next exercise in technology included a bibliographic demonstration to obtain information for the review of the literature. This demonstration also introduced students to the use of the internet, netscape, and web sites. The demonstration required one (1) hour of their time, after which each student was required to begin a literature search. As part of their review of literature, one source was required to have been retrieved from the a web site. Each student was also required to join a listserv to obtain additional information from sources. All information required for submission in the course had to be completed using a word processing program. The students were also required to check e-mail for messages from the instructor. The instructor answered questions via e-mail daily and also sent messages regarding class information.

Results

The results indicated in this study are based on the perceptions of the instructor who has taught this course for 6 semesters. The course at this particular institution has been identified by most students as a difficult and much anxiety and fear enters the classroom. Some of the issues include a lack of understanding of course information, fear of conversing with the instructor, and accepting the magnitude of time required to excel in the course.

Based on the implementation of technology in this graduate educational research course, the attitudes of the students changed and the classroom environment became more comfortable. Eight (8) hours of the course time was assigned to the computer lab. In the lab time, students were allowed to access e-mail, browse the web, access the library, and construct a proposal with the assistance of the instructor. Students also had accessibility to the computer lab beyond class hours. Based on the perception of the instructor, students interacted more via e-mail and demonstrated more comfort when making an office visit. Several students lived over an hour away from the institutions and utilized the e-mail as a continual communication network with the instructor. Because writing apprehension is so high in a graduate research course, many students took the opportunity to e-mail parts of the proposal for the instructor's comments and corrections. One student utilized the listserv to assist in formulating a proposal topic.

Conclusions

Because of the experience of this instructor with perceptual difficulty in the level of the research course, implementation of technology eased a lot of anxiety, addressed issues for the students, and created a comfortable climate for the classroom. Students were able to converse with each other over the internet as well as in the classroom, especially during the computer time. Two (2) students stated their gratitude for the implementation of technology. Prior to their graduate program, technology utilization was limited. Technology was also used as a avenue to vent frustrations comfortably. Students took advantage of the technology which helped to improve their productivity in the coursework and thereby increased academic performance. Future implementation of technology will include accessibility of previously submitted proposals for viewing on the internet.

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Hypermedia CAI with Cognitive Apprenticeship for Pre-service Teacher Education

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Recent innovations in hypermedia computer technology permit learners to have highly individualized and interactive computerized instruction. However, adapting hypermedia computer technology to computer-assisted instruction (CAI) does not guarantee effective learning. Research studies have revealed that when learners were not fully aware of or responsible for what they needed to learn from CAI, they made poor decisions on their completion levels of learning (Kinzie & Sullivan, 1989; Kinzie, Sullivan, & Berdel, 1992; Steinberg, 1989). Therefore, consideration should be given to designing hypermedia CAI environments with appropriate instructional strategies, which guide learners to acquire necessary knowledge and skills.

Our current computer authoring system technology enables instructional software developers to incorporate special constructivistic instructional strategies such as the cognitive apprenticeship method into sophisticated CAI environments (Lajoie & Lesgold, 1989; Parkes & Self, 1990). Researchers and practitioners of the cognitive apprenticeship teaching method suggest that cognitive knowledge and skills can be effectively learned by "learning-through-guided experience" (Collins, Brown, & Newman, 1989, p.457). The learning-through-guided experience occurs through the sequence of modeling, coaching, fading, and reflecting. A cognitive master (i.e., a teacher or a computerized coaching system) shows the appropriate way of performing learning tasks, and apprentices (i.e., learners) practice the tasks with the strategic hints or scaffolding provided by the master. As the apprentices improve their skills or knowledge, the master gradually withdraws the guidance, and the apprentices take on the responsibility of performing the learning tasks. When completed, the learning responsibilities and the expertise have been shifted from the master to the apprentices. This learning-through-guided experience technique is beneficial when the learning subject is a type of situated problem solving or dilemma handling, which students in pre-service teacher education especially need to practice before they become classroom teachers.

The processes of learning responsibility and expertise shift can be observed by the utilization of self-regulated learning (SRL) skills as well as in academic outcomes of instruction (Schunk, 1989; Zimmerman, 1989, 1994). According to Zimmerman (1989), self-regulated learners are metacognitively, motivationally, and behaviorally active in their learning processes. When constructively taught how to use the SRL skills such as self-monitoring or self-evaluating, novice learners, or ineffective impulsive learners, have been shown to successfully shift themselves from being ineffective, low academic achievers to effective, responsible high academic achievers (Schunk, 1989; Zimmerman & Martinez-Pons, 1990). SRL skills can be taught and learned at any age (Butler & Winne, 1995). The positive effectiveness of SRL skills on learning has been shown in many research studies across a wide range of learners from young children (Pintrich & DeGroot, 1990; Zimmerman & Ringle, 1980) through college-level students or adults (Lan, Repman, Chyung, & Bradley, 1996; Zimmerman & Paulsen, 1995).

An important approach for pre-service teacher education is hypermedia CAI that implements the cognitive apprenticeship method. A hypermedia CAI program incorporating with the cognitive apprenticeship method may monitor an individual's performance, evaluate his or her progress in mastering the content, and provide guidance through learning sequences with strategic hints and scaffolding at appropriate moments. This innovative hypermedia learning environment may enable pre-service teachers to learn in constructivistic ways exploring a rich information world, help them develop and use SRL skills, and increase ownership of the learning process and expertise with the content. This will eventually lead them toward becoming successful academic and professional performers.

Based on this theoretical framework, a research study was conducted to compare the effectiveness of two forms of hypermedia CAI. The goal was pre-service teachers' acquisition of knowledge and performance in professional problem-solving situations. One instructional method was based on the cognitive apprenticeship teaching method and the second used a total learner-control method. The effectiveness of the two hypermedia CAI environments was evaluated by the pre-service teachers' utilization of SRL skills and their academic performance.

Method

Participants

Seventy-five pre-service teachers, who were enrolled in undergraduate courses in the college of education at a west Texas university, participated in this study. The participants were predominantly Caucasian (90.7%), female (93.3%) and between 20 and 29 years old (86.7%).

Variables

There were two independent variables: (a) hypermedia CAI with two levels: cognitive apprenticeship hypermedia CAI environment and a totally learner-controlled hypermedia CAI environment and (b) a personal factor as impulsivity or reflectivity. The SRL skills were measured by self-evaluation levels, self-efficacy levels, and self-learning activity levels. These variables were derived from Zimmerman's SRL model: i.e., how metacognitively (self-evaluation level), motivationally (self-efficacy level), and behaviorally (self-learning activity level) active students were. Academic achievement was interpreted to support the outcomes of utilizing SRL skills.

Instruments

The instruments used in this study were (a) the adolescent-adult version of the Matching Familiar Figure Test (MFFT, Kagan, 1981), which was converted to a computerized version, (b) hypermedia CAI programs, and (c) a computerized achievement test with 15 questions.

The Computerized Version of MFFT. The adolescent-adult version of MFFT was converted to a computerized version and used to rate the participants' personal factor as impulsivity or reflectivity. The MFFT contains 12 problems. Each problem requires a participant to match a standard figure with the identical one from eight alternative figures. Each participant was evaluated according to how fast and accurately he or she answered each problem.

The Hypermedia CAI Programs. The hypermedia CAI programs were developed to teach the pre-service teachers about educational measurement and its application on the Texas Assessment of Academic Skills (TAAS). The hypermedia CAI with the cognitive apprenticeship teaching method employed coaching and scaffolding techniques using an interactive agent, "coach." The coach offered guidance on pacing and the sequence of lessons. The hypermedia CAI with total learner-control allowed the participants total learning responsibilities in terms of the pace and sequence of topics covered during learning. Both hypermedia CAI programs contained two lessons with identical content, each of which recorded the number of mouse clicks made by each participant. The number of mouse clicks was used to assess the participant's self-learning activity level. The hypermedia CAI programs also recorded the participants' levels of efforts in learning measured by the total number of completed lesson items and the elapsed time spent for learning with CAI.

The Computerized Achievement Test. The participants' self-efficacy levels, academic achievement scores, and self-evaluation levels were obtained from the computerized test. Self-efficacy levels were measured by asking the participants whether or not they were confident in solving each question. There were two possible self-efficacy responses, "I think so," or "I doubt it." Academic achievement scores were recorded in terms of right and wrong. Self-evaluation levels were calculated according to the discrepancies between the expressed self-efficacy levels and the actual performance on the tests. For example, if a participant's prediction of performance matched actual performance, the participant's self-evaluation level on the performance was reported as high.

Procedures

Among the 75 participants, 32 participants were defined as impulsive and 43 were reflective according to the MFFT. Using a stratified random sampling method, participants in each category were randomly, but proportionally, assigned to one of the two hypermedia CAI environments. A maximum of five hours was provided for the treatments.

Results

Two-way MANOVA revealed that, in hypermedia CAI environments, there was a significant difference in the pre-service teachers' SRL skills and academic scores due to the different instructional strategies, $F(4, 68) = 10.82, p < .01$. Implementation of the cognitive apprenticeship method was significantly more effective on encouraging the pre-service teachers to exercise SRL skills than the totally learner-control strategy. A univariate test showed that the self-learning activity levels were the most significant contributor to this significance, $F(1, 71) = 38.50, p < .01$ (see Table 1). That is, the pre-service teachers who received the cognitive apprenticeship teaching method were significantly more active in terms of the numbers of clicks during the learning processes ($M = 111.39, SD = 16.56$) than those who were allowed to have total control over their learning processes ($M = 81.29, SD = 24.44$). No significant interaction was found between the pre-service teachers' personal factor (academic impulsivity or reflectivity) and the different hypermedia CAI environments.

Table 1.
The Two-way ANOVA Summary Table for Each Variable.

(Self-monitoring Levels)

Source	df	SS	F	p
Model	3	317.66	.33	.80
CAI	1	17.02	.05	.81
Personal factor	1	74.64	.23	.63
CAI * personal factor	1	225.99	.70	.40
Error	71	23028.11		
Total	74	23345.77		

(Self-efficacy Levels)

Source	df	SS	F	p
Model	3	890.07	.57	.63
CAI	1	1.67	.00	.95
Personal factor	1	43.35	.08	.77
CAI * personal factor	1	845.04	1.62	.20
Error	71	37079.70		
Total	74	37969.77		

(Self-activity Levels)

Source	df	SS	F	p
Model	3	17328.86	13.10	.00
CAI	1	16981.77	38.50	.00
Personal factor	1	55.56	.13	.72
CAI * personal factor	1	291.51	.66	.41
Error	71	31317.72		
Total	74	48646.58		

(Academic Achievement Scores)

Source	df	SS	F	p
Model	3	484.05	.66	.57
CAI	1	20.39	.08	.77
Personal factor	1	458.23	1.89	.17
CAI * personal factor	1	4.48	.02	.89
Error	71	17234.46		
Total	74	17718.51		

There was also an evidence that the pre-service teachers in the cognitive apprenticeship group significantly shifted their behavioral learning responsibilities from the computerized coach to themselves, as lessons proceeded. A MANOVA repeated measures analysis within the cognitive apprenticeship CAI group was conducted on the ratios of the frequencies of utilizing the coaching features to the self-learning activity levels between the first lesson and the second lesson. There was a significantly reduced ratio of frequencies of requesting help from the cognitive "coach" per learning activity, $F(1,37)=5.55, p<.02$ (see Table 2 and 3).

Table 2.
Ratios of Self-learning Activity Levels per a Click on the Coach Button (SA/Coach).

SA/Coach	M	SD
Lesson 1	.39	.19
Lesson 2	5.46	13.30

Table 3.
The ANOVA Repeated Measures Test Result for the Ratios of Self-learning Activity Levels per a Click on the Coach Button.

Source	SS	df	MS	F	p
Within cells	3267.51	37	88.31		
Lesson	489.85	1	489.85	5.55	.02

An additional significant effect of CAI on the efforts in learning was detected. The pre-service teachers in the cognitive apprenticeship hypermedia CAI environment showed significantly higher efforts in learning than those in the totally learner-controlled hypermedia CAI environment: $F(1,71)=22.27, p<.01$, for the lesson completion levels, and $F(1,71)=17.47, p<.01$, for the time spent for learning. That is, the cognitive apprenticeship hypermedia CAI group spent significantly more time in learning ($M=139.05$) and accomplished significantly more lesson items ($M=95.61$) than the totally learner-controlled hypermedia CAI group ($M=110.84$ and $M=75.48$, respectively).

Discussion

The findings of this study support Clark's argument (1983, 1985, 1994) that computers themselves are merely delivery tools and do not influence learning. Computers are not a guarantee of effectiveness (Pea, 1987). Adapting the new hypermedia technology to instruction does not cause effective learning. Research designs that select different delivery media as independent variables and measure the effectiveness of delivery media on learning outcomes as dependent variables have been criticized for confounding independent variables. The effectiveness of instruction does not depend on the selection of delivery tools but relies on the use of effective instructional strategies.

In this study, enhancement of learning responsibilities and expertise shift was proved to be due to the effective instructional method that was appropriately selected and employed in the hypermedia CAI environments. This intra-media research study used computers as the instructional delivery media and revealed that use of an appropriate instructional strategy such as the cognitive apprenticeship method was the critical factor (Salomon, 1988; Salomon, Perkins, & Globerson, 1991). In particular, the hypermedia CAI environment that incorporated a cognitive "coach" encouraged the pre-service teachers to employ behavioral SRL skills that helped them become self-responsible learners. Effects of using the cognitive apprenticeship method in hypermedia CAI environments on other SRL skills such as self-efficacy and self-evaluation skills were not significant in this study. A possible explanation for this is the difficulty in designing instruments to measure those categories. The instruments used to measure the self-efficacy and self-evaluation levels in this study may need to be reconstructed for improved validity. Another possible explanation is that human overt behaviors (i.e., the self-learning activity levels) were more easily manipulated by the explicit modeling provided by the coach than the cognitive, metacognitive, and affective behaviors (i.e., the academic achievement levels, self-evaluation levels, and self-efficacy levels). The interactivity of personal factor as impulsivity or reflectivity with the two different hypermedia CAI environments was not significant. This could be due to the small sample size or the homogeneous sample selection. Recommendations for future research are a larger sample with a longer period of treatment and a careful design of instruments.

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Using ISTE Guidelines to Assess Students' Perceptions of Computer Literacy Learning

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The International Society for Technology in Education (ISTE) has developed a set of content guidelines to be incorporated into courses for initial computer/technology literacy certification. The three major instructional areas addressed in the guidelines are: 1) prerequisite preparation, 2) specialty content preparation, and 3) professional preparation. These guidelines can be used to provide structure and guidance for course curriculum development to insure that teachers have the competencies to effectively teach students with technology.

ISTE's guidelines provide one definition of computer literacy. Kay (1992) and Woodrow (1992) found a plethora of definitions of computer literacy. Kay's review of the literature found that definitions of computer literacy paralleled the stages of development of hardware and software and asserts that this has led to defining computer literacy based on the personal needs of the computer user. The individual user determines what is needed to be personally computer literate. Personal definitions of computer literacy are influence not only by the personal needs of the user but also the technology available to the user, access to that technology, and the support needed to use the technology. Overbaugh (1993) proposes that the critical elements of computer literacy for teachers should include the knowledge to effectively use the technology available in their classrooms. They must apply their knowledge of technology to make it personally meaningful and useful in their current situation. Kay contends that these changes require educators to "help students learn how to apply the computer" (p. 454), rather than learn to use the computer.

The ISTE guidelines provide a framework for the development of computer literacy endorsement courses, but within this framework teachers must also develop their own personal definition of computer literacy. They must construct their own knowledge of and add personal meaning to it. Only then will they become competent, confident technology users who can teach effectively.

A survey was developed to determine the extent to which the three courses in the computer/technology literacy sequence at one university are meeting ISTE guidelines and preparing teachers to become competent, confident technology users. The results of the survey are being used to determine if the students feel the courses prepare them to be effective teachers based on the guidelines.

Methodology

Survey methodology was used in this study to determine the students' perceptions of the courses' content as an aid to further course development.

Participants

The participants were ten students who completed a three course sequence for computer literacy endorsement in the summer of 1996 at Louisiana Tech University. Of the fourteen students enrolled in the course, only 10 responded, or 71%. One participant was male and the other nine female. Seven of these participants took the course for graduate credit and were practicing K - 12 teachers. One participant was a graduate student with limited teaching experience. The other two participants graduated in May, had not been admitted to graduate school, and would begin teaching in the fall.

Instrument

The instrument used was a researcher designed survey based on the ISTE matrix guidelines for initial computer/technology literacy endorsement program. The survey consists of 55 items measured on a five-point Likert scale. Items were constructed from the three major instructional areas addressed in the guidelines: 1) prerequisite preparation, 2) specialty content preparation in computer/technology literacy, and 3) profession preparation. Prerequisite preparation includes a foundation of fundamental concepts and proficiencies. Specialty content preparation encompasses an in-depth knowledge of technology operation and impact, programming, application tools, information access and delivery tools, and hardware/software selection and support. Professional preparation is concerned with teaching methodology specific to using technology. Each guideline was rewritten to reflect an individual personal response and to facilitate accurate responses. For example, guideline 1.1.12

states "Use computer-based technologies to access information to enhance personal and professional productivity." It was rewritten as follows: 1.1.12a "I can use computer-based technologies to access information to enhance personal productivity," and 1.1.12b "I can use computer-based technologies to access information to enhance professional productivity."

Procedure

The computer literacy endorsement sequence involves three courses EDUC 445 Using the Microcomputer in the Classroom, EDUC 447 Software Applications and Teaching Methods, and EDUC 448 Instructional Software Design and Development. In recent years, EDUC 445 has been taught in the fall, winter, spring, and summer quarters with EDUC 447 and 448 taught only in the summer quarter.

Prior to the last class period the purpose of the survey was explained to the students. They were told that their responses would facilitate course revisions as well as provide a measure of the effectiveness of the course. The surveys were mailed to the students in late August with a consent form and a cover letter explaining the purpose of the survey. Two return address envelopes were included, so that the consent form and survey could be returned separately to help assure anonymity of their responses. On the survey respondents were asked to indicate the degree to which they agreed or disagreed with each statement by circling the appropriate letter(s) to the right of each statement. A five-point Lickert scale, Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree, was used in this survey.

A follow-up mailing of the surveys was done in late September which resulted in additional surveys being returned. As changes are made in the courses and additional students complete the courses, the survey will be readministered as an ongoing assessment of the program.

Results

The first area examined in the survey dealt with prerequisite preparation which includes building a foundation for the use of technology in education. Responses to 16 of the 19 statements in this section elicited either strongly agree or agree. As noted in Table 1, one respondent answered undecided to three of the statements. Forty percent of the students strongly agreed and sixty percent agreed with the statement "I can use telecommunications to support instruction." This was the only instance in this section when the majority of the respondents selected agree over strongly agree. Since the college of education is not wired for Internet access, telecommunications usage was limited to a total of ten hours over five days during which we had access to a computer lab with Internet access. This lab was located across campus in the College of Engineering. The lack of readily available Internet access is further noted to responses in Table 5.

Table 1.
Responses to Section 1 Prerequisite Preparation Foundation in Percentages

Statement	SA	A	U	D	SD
I can operate a computer system in order to successfully utilize software.	.80	.20			
I can use technology to support the instructional process.	.90	.10			
I can evaluate technology needed to support the instructional process.	.60	.30	.10		
I can apply current instructional principles related to the use of technology.	.60	.40			
I can evaluate computer/technology-based materials.	.50	.50			
I can use computers for a variety of purposes.	.80	.20			
I can develop student learning activities that integrate technology for a diverse student population.	.80	.20			
I can integrate technology into my classroom curriculum.	.80	.10	.10		
I can use multimedia to support instruction.	.90	.10			
I can use telecommunications to support instruction.	.40	.60			
I can use productivity tools such as Microsoft Works.	.90	.10			
I am aware of ethical issues involved in the use of technology.	.90	.10			
I am aware of human issues involved in the use of technology.	.50	.50			
I am aware of legal issues involved in the use of technology.	.60	.30	.10		
I am aware of resources for staying current in educational technology.	.50	.50			
I can use computer-based technologies to access information to enhance personal productivity.	.70	.30			
I can use computer-based technologies to access information to enhance professional productivity.	.70	.30			
I can use technology to facilitate emerging roles of the learner.	.70	.30			
I can use technology to facilitate emerging roles of the educator.	.70	.30			

The second area of the guidelines matrix focuses on specialty content preparation which is subdivided into four subsections. Subsection 1 deals with providing in-depth knowledge for teaching about computers and related technologies. Students responded to ten items in this subsection. Four items were marked undecided by at least one respondent. (see Table 2). Regarding their awareness of future directions in technology, 30% of the respondents strongly agreed and 70% agreed. This is reflective of the students' lack of access to current materials regarding technology developments. Fifty percent of the students marked strongly agree or agree to the second statement in this section regarding having a functional knowledge of technology terms. Students did not feel completely comfortable with technology vocabulary.

Table 2.
Responses to Section 2, Subsection 1 Concerning General Content Preparation in Percentages

	SA	A	U	D	SD
I am aware of the uses of technology in society.	.60	.40			
I have a functional knowledge of technology terminology.	.50	.50			
I am aware of future directions in technology.	.30	.70			
I model appropriate behaviors with regard to ethical issues related to technology.	.80	.10	.10		
I model appropriate behaviors with regard to legal issues related to technology.	.80	.10	.10		
I model appropriate behaviors with regard to human related to technology.	.80	.10	.10		
I model appropriate behaviors with regard to equity issues related to technology.	.70	.20	.10		
I use sources of technology information for professional development.	.60	.40			
I participate in student support activities related to computer technology.	.70	.30			
I model appropriate keyboarding skills.	.70	.30			

Subsection 2, Section 2 examines programming and problem solving abilities. Students felt the most unsure of their abilities in this area. (see Table 3) Programming was only presented in the last course of the sequence and involved teacher modeling and the completion of ten classwork exercises requiring students to use Logo in HyperStudio stacks. Students worked in groups to complete these exercises. Only three of the students in the class had previous programming experience. Prior to the start of the summer session two students expressed concern about learning programming and were hesitant to take the class because of the programming component.

Table 3.
Responses to Section 2, Subsection 2 Concerning Programming and Problem Solving in Percentages

	SA	A	U	D	SD
I have a functional knowledge of at least one programming language such as Logo or Basic.	.40	.60			
I have a functional knowledge of structured programming concepts.	.30	.50	.20		
I have a functional knowledge of program debugging techniques.	.40	.30	.30		
I have a knowledge of programming skills to support the development of problem-solving skills.	.30	.20	.40	.10	
I have an awareness of other authoring environments.	.30	.60	.10		

Subsection 3 looked at students perceptions concerning application tools. (see Table 4) Students were required to use and evaluate teacher utility tools, such as gradebooks and paint programs. These are important tools for teachers that need more emphasis in the classes as reflected in the responses.

Table 4.
Responses to Section 2, Subsection 3 Concerning Application Tools in Percentages

	SA	A	U	D	SD
I have a functional knowledge of teacher utility tools.	.50	.50			
I have a knowledge of utilization of applications tools to support the curriculum.	.60	.40			

Subsection 4 addresses students use of information access and delivery tools. (see Table 5) During the last two courses in the sequence students worked in groups or alone to create HyperStudio stacks incorporating images, graphics, audio, video, and laser discs. This emphasis is reflected in their responses to their knowledge of multimedia resources. Once again the lack of Internet access in the college is reflected in answers to this portion of the survey. Only two students had Internet access in their homes and used it on a regular basis. Students enjoyed their Internet explorations and had little difficulty completing classwork assignments using the Internet. However, the limited access prohibited them from becoming proficient users.

Table 5.
Responses to Section 2, Subsection 4 Concerning Information Access and Delivery Tools in Percentages

	SA	A	U	D	SD
I have a functional knowledge of telecommunications resources.	.30	.60	.10		
I have a functional knowledge of the utilization of telecommunications for information sharing.	.40	.50	.10		
I have a functional knowledge of multimedia resources.	.70	.30			
I have a knowledge of the application of information access tools to use to develop problem solving skills.	.50	.40		.10	

Hardware/software selection, installation, and maintenance is the focus of Subsection 5. (see Table 6) The first course in the sequence focused on the Windows platform. During the last two courses, the students had a choice of platforms, Windows or Macintosh, for many of the activities. However, in these courses students were required to use a scanner, a QuickTake camera, a QuickCam, and a laser disc player connected to Macintosh computers, hence, they spent more time on Macintosh computers. These peripheral devices were new to the students. They also had opportunities to work with a Newton MessagePad 130 during the last two courses. As reflected in their responses, six weeks is not enough time to become expert users of this technology, nor to feel comfortable with maintenance of the technology.

Table 6.
Responses to Section 2, Subsection 5 Concerning Hardware/Software Selection, Installation, and Maintenance in Percentages

	SA	A	U	D	SD
I have a knowledge of the configuration of technology systems for instructional arrangements.	.50	.30	.20		
I have the knowledge to support the development of laboratory policies.	.60	.20	.20		
I have a functional knowledge of how to evaluate software to support the curriculum.	.70	.30			
I have a knowledge of how to evaluate technology for purchasing.	.50	.40	.10		
I have a knowledge of procedures for the organization of hardware.	.60	.30			
I have a functional knowledge of basic technology troubleshooting.	.30	.70			
I have a functional knowledge of basic technology maintenance.	.20	.80			
I have a knowledge of networked systems.	.40	.60			

The third section of the guidelines addresses professional preparation. As noted in the responses, all of the participants realize the need to continually update the curriculum to reflect changes in technology. Students do not feel comfortable with their ability to plan technology lessons reflective of changing teacher/learner roles including using technology to teach problem solving.

Table 7.
Responses to Section 3 Concerning Professional Preparation in Percentages

	SA	A	U	D	SD
I have a functional knowledge of methods for teaching general computer skills.	.60	.40			
I have a functional knowledge of methods for teaching problem solving principles with technology.	.40	.40	.20		
I have a functional knowledge of methods for teaching the use of application tools.	.60	.40			
I have a functional knowledge of methods for teaching the use of information access tools.	.40	.50	.10		
I have observed computers being used in a classroom or lab.	.90	.10			
I am aware of the ongoing need to update the computer/technology literacy curriculum to reflect changes in technology.	1.00				
I have had experiences in planning computer/technology literacy teaching activities that reflect the changes in the teacher/learner roles.	.60	.10	.20	.10	

Discussion

Marcinkiewicz (1993-94) found that self-competence and innovativeness were variables effecting elementary teachers use or avoidance of computers. Mindful of these findings it is imperative that technology courses for teachers focus on building their self-competence and encouraging their innovativeness. Technology courses need to be evaluated by the preservice and inservice teachers they are designed for in order to meet their needs and insure that they use technology for their personal benefit and to benefit their students. Results of this survey indicate that there are areas that need strengthening in the computer literacy sequence.

The results of the analysis of responses indicate that additional emphasis should be placed on the evaluation of technology and awareness of human issues related to technology. Students' responses regarding their knowledge of the resources available for staying current in technology are reflected in their uncertainty of the future directions of technology. Additionally, students seem to be unsure of their knowledge of technology terminology. The inclusion of additional readings on technology would make students aware of the resources available for staying current in technology, provide them with information on future directions, and increase technology vocabulary.

Regarding programming and problem solving, students did not feel comfortable with their competence in this area. Woodrow (1992) briefly explores three different views on the need to teach programming in computer literacy courses. Some advocate that teachers should be proficient programmers, others argue that only a general understanding of programming is required, and a third group contends that teachers do not need to know programming to be computer literate. However, since compliance with ISTE guidelines are required for NCATE accreditation, programming will continue to be taught in these classes with modifications to lessen teacher anxiety and increase their competency.

Responses to questions concerning teacher utility tools and applications tools indicate that perhaps more emphasis should be placed on these software programs. However, students used all modules of Microsoft Works in one class, and evaluated and used teacher utility tools in all of the classes to complete classroom specific activities. Since students indicated their uncertainty with technology vocabulary, perhaps they were unsure of what was meant by application and utility tools.

Students' perceptions of their lack of competence in using information access and delivery tools should be alleviated when the College of Education computer lab is wired for Internet access in the next few months. Students in future class will be able to spend more time exploring the Internet. Students' Internet projects reflected an understanding of the Internet and demonstrated their ability to use the Internet to enhance their own learning. However, they lack the confidence and experiences needed to use the Internet to enhance student learning.

Students responses to the questions on the selection, installation, and maintenance of hardware and software indicate that they did not feel competent in all of these areas. Since many of the surrounding school districts lack technology support personnel, it is imperative that the students have more experiences in these areas. The development of a support system among the students would also be of use to them. Most of the respondents took the computer literacy sequence in a nine week summer session. They were overwhelmed by a collection of peripheral devices they had never used. The next group of students to take the computer literacy sequence will have taken the courses over three quarters during the academic year. It will be interesting to note if long term exposure to technology enables them to feel more competent in their abilities.

Responses to the last section on professional preparation indicates that more emphasis should be directed toward helping teachers learn to teach with technology. They need to practice teaching with technology in these courses if they are to feel confident to teach their own students with technology. Students need to practice teaching with problem solving activities that emphasize critical thinking and higher order learning using the same technology available to them in their classrooms. It is interesting to note that all of the students realized the need to continually update the computer/technology literacy curriculum.

The results of this survey are generalizable only to the specific courses in which these participants were enrolled. However, the survey does provide a useful tool for other Colleges of Education interested in determining how students' perceptions of their learning match the ISTE guidelines. Also, the survey provides some information regarding the teachers' development of their own personal definitions of computer literacy. The results of this survey provide useful information that is being used to make changes in the courses to insure that the students are computer literate.

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Preservice Teachers' Perceived Computer Competencies Compared to Demonstrated Skills

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The post-industrial/information age is profoundly effecting the field of education, primarily due to changes in technol ogy. Technology is effecting education in two ways that are symmetric. It is changing the content and methods that teachers use to instruct and it is changing the methods by which students learn.

In order to produce students with the skills and knowledge they will need for the 21st century, many states throughout the nation are revising their K-12 they are also establishing competency standards so that teachers become more effective through the use of technology. One of the areas is covered in these revisions is evidenced in a survey of Minnesota and North Carolina curriculums. It is in computer competencies (Minnesota Department of Children, Families, and Learning, 1996; North Carolina Department of Public Instruction, 1993). K-12 schools have approximately 4,278,958 computers for instruction with a ratio of 12 students per computer (Peterson's Guides, 1995). This number is growing. National education organizations such as the National Council for Accreditation of Teacher Education (NCATE) and International Society for Technology in Education (ISTE) are supporting this trend by establishing computer technology standards for their constituents (ISTE Accreditation and Professional Standards Committee, 1995). In addition, educational organizations such as the National Education Association (NEA), American Federation of Teachers (AFT), ISTE, the National Parent Teachers Association (PTA), the American Association of Community Colleges (AACC)) and NCATE are supporting a Presidential initiative to develop staff development programs for 21st century schools (Milone, 1996). As a result, teachers will need more competency with computers to effectively teach their students.

Currently, most teachers using computers feel the need for more training (Seigel, 1995; Tenth Planet, 1995). Nearly half of all elementary school teachers are not comfortable using computers (Tenth Planet, 1995). These figures are based upon surveys of practicing teachers. As educators know, self-reporting of knowledge and skills is not always accurate. Objective measurement is usually a preferred form of assessment. This type of measurement could indicate the extent of training programs required for the to two main groups of teachers, in-service teachers and preservice teachers.

This study is concerned with the preservice teacher group. Research on preservice teacher programs indicates that most curriculums do not integrate much computer technology into the training (Hunt, 1994; Office of Educational Research and Improvement, 1986). The programs that do require a technology component tend to rely on minimal courses (Office of Educational Research and Improvement, 1986). One however, given the rapidly growing use of technology and reasonable cost of computers, this may change since one of the major barriers to integration of computer technology into teacher education programs is the availability of computers in higher education. The American Association for Higher Education's Teaching, Learning, and Technology Roundtable program also addresses faculty computer compency as another area of concern.

Since qualitative research is more common than quanitative research for program eval This study has attempted to develop a quantitative tool for measuring very basic computer competencies. To extend the application of this tool, the results have been compared to two also used. These surveys were self-evaluations of the subjects' competencies and their expectations of future needs as teachers. This may permit the extrapolation or extension of other surveys into performance prediction. Further study may also permit the extension of this tool for competency testing in other educational levels, for example, in-service, and K-12 groups.

Methodology

Participants

Participants were juniors, seniors, or graduate students enrolled in one of two required courses. One course is in the Special Education Department and the other course is in the Education Department. These are courses at Winona State University (WSU), a medium-size comprehensive state university in southeastern Minnesota.

Instruments and Procedures

An interview questionnaire, two surveys, and a performance-based assessment were developed and used for this study. Prospective participants were interviewed to gather some demographic data and to determine their microcomputer operating system experience and preferences. Due to the focus of this study, only students who felt comfortable using the Macintosh operating system were invited to participate. A pilot study using the steps described was completed resulting in minor changes to the content and the length of time students were allowed for completion of the performance-based assessment.

Interviewees who were selected to participate in the study were then surveyed to determine their perceived computer competencies in four areas: word processing, spreadsheets, data bases, and electronic mail (e-mail). A parallel survey was also given to obtain info on te level of teachers' computer skills. A performance-based test in four areas: word processing, spreadsheet creation and computation, database creation and management, and e-mail. Comparisons were made between the students' perceived level of competence, their expected level of competence for practicing teachers, and their demonstrated level of performance. Both surveys used a 5-point Likert scale for responses. A score of one equaled no skills while a score of five equaled proficient skills.

To insure reliability, the participants used the ClarisWorks 2.1 software package for the Macintosh. ClarisWorks is an application that includes word processing, database management, spreadsheet computation, and communications. It is the integrated software package installed in the College of Education computer lab at WSU and therefore the students were more likely to be acquainted with this program. It is also one of the most widely-used packages in K-12. User's guides for ClarisWorks 2.1 were made available to participants for reference.

Participating students scheduled appointments to take the performance-based assessment. The students were each given a booklet of exercises and exhibits, and a diskette with a file they needed to edit. The booklet was divided into three sections: word processing, spreadsheets, and data bases. The exercises required the students to complete certain tasks in each section, print their work, and save their work on diskette. When the students finished, their completion time was recorded.

The word processing section required students to demonstrate their skills in several basic tasks. These included creating a word processed document, retrieving and editing a file, setting new margins, changing the size, type, and style of fonts, and aligning text. They were instructed to change a document's line spacing, center a line of text, move text, and insert or delete text where necessary. The final tasks were to correct all typographical errors using the spell check, print the documents, and save them as files on the diskette.

To demonstrate competence with spreadsheets, students were asked to create a . Information for the data was provided. After the spreadsheet was created, the students had to increase the width of a column, edit a cell, use a function to calculate the average, add a title, and create a bar graph. The students were to print a copy of the spreadsheet and a copy of the bar graph before saving their work on the diskette.

The database section required the students to create, edit, and sort a database of records. Students were directed to create a database using the fields and data that were provided. They were then instructed to edit a record, delete a record, sort the database according to specified criteria, and print the records. The students were then asked to create and print a report and save their databases on the diskette.

Following completion of the booklet practices, the students were given an exercise to demonstrate their competency in using e-mail. They were asked to send the project administrator a message using an e-mail account created expressly for this study. In the body of the message, they were to identify the client server (e-mail program) that they used, and make comments about the performance portion of the study.

After the e-mail materials were received, the participants' performance-based assessment was scored. For this initial study, all tasks were assumed to be of equal value (weight). The score for a particular task (for example, setting new margins) was assigned based upon the percent of occurrences performed accurately. The range of possible scores was a five-point scale to permit easy comparison with the surveys. The range of possible scores for a particular task will be based upon the complexity and importance of the task.

Results

Results and discussion of this study will be presented at the Conference. Preliminary results indicate that students who were taught to use productivity software were likely to forget what they learned if the skills were not utilized throughout their coursework. Results from the pilot indicate competency tests must be set within a time frame. Students do not have unlimited time to complete their tasks. An intervening factor might be the timing of when the participants took the test vis-a-vis the academic term. It appears that students taking the test earlier in the term spent more time on the test . It is conjectured that this is a function of the time available to the students based upon the demands of their coursework.

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Educational Technology: Preservice Elementary Teachers' Self-Concepts

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The past decade has spawned a host of studies devoted to issues of gender and technology (Sutton, 1991; Sanders, 1985; Turkle, 1984). During this same period, research on self-concept and math education has revealed significant differences between males and females (Reyes, 1984; Meyer & Fennema, 1988). Despite evidence that teachers feel unprepared and resist the integration of computers, a common exemplar of technology, into their instruction (Heinich, 1991; Piña & Harris, 1993), there is little in the current research that examines preservice elementary teachers' experiences learning technology, explores their self-concepts with regard to technology, or investigates how these self-concepts emerged.

While studies of self-concept have generally primarily employed quantitative methods (McLeod, 1992), this study utilized a qualitative research framework to explore the nature of preservice elementary teachers' experiences in learning and utilizing technology. The use of a qualitative research framework illuminated the perspectives of the preservice teachers and enabled the researcher to gain an understanding of the nature of the ways in which they constructed and utilized technology. Specifically, this qualitative study was designed to: (a) examine the nature of preservice elementary teachers' experiences in learning and utilizing technology; (b) probe the formulation of their technology self-concepts; and (c) determine what factors influence the formation those self-concepts.

Theoretical Framework

The prevailing image of technology represents it as an abstract, formal discipline, conceptually linked to the domains of mathematics and science. It has been suggested that the field of educational technology has been designed on a male model of hierarchy and scientific objectivity (Damarin, 1990). Because of its perceived association with the "masculine" disciplines of mathematics and science, there is a common perception that female students are less likely to be interested in technology than their male counterparts (Laboratory of Comparative Human Cognition, 1989; Jones, 1987). While some researchers offer biological explanations for gender differences in mathematics (Benbow & Stanley, 1980; Benbow, 1992), others advance sociocultural explanations, suggesting that societal expectations of gender identity and sex roles play a greater role than biology in influencing such differences among male and female students (Woods and Hammersley, 1993; Meece, Parsons, Kaczala, Goff and Futterman, 1982).

Males are more likely to exhibit greater confidence in their mathematics and science abilities, view themselves as mathematics learners, and have higher expectations of future mathematics courses (Linn and Hyde, 1989). Research has determined a positive relationship between self-concept and achievement in mathematics (Marsh, 1986; Marsh, 1992). Self-concept, a generalization of confidence in learning (Reyes, 1984), is a person's perception of self constructed through experience with the environment and influenced by both environmental reinforcements and the reinforcement of significant others (Shavelson, Hubner & Stanton, 1976). In symbolic interactionist terms, people actively construct and reconstruct their self-concepts within limits set by social norms (Shott, 1979). Given the relationship between teacher self-concept and student achievement (Midgley, Feldlaufer & Eccles, 1989; McLeod, 1992), and the pivotal role that teachers play in implementing technology in the classroom, it is possible that preservice teachers with low technology self-concepts may have a negative influence upon their own students' formulation of technology self-concept.

Methods and Data Sources

A symbolic interactionist theoretical framework provided a basis to consider the nature of preservice teachers' technology self-concepts. The methodological underpinning of this study is derived largely from orientations to research that draw attention to the importance of detailed qualitative fieldwork and the observation and analysis of preservice teachers in context. Consistent with the purposes of the study, qualitative methods were utilized to explore the preservice teachers' responses to technology, distinguish the processes by which these responses are mediated, probe the formulation of their self-concepts in technology; and identify how these might inhibit, repress, or constrain their ability to effectively utilize instructional technology in their own classrooms.

Setting and Participants

The participants were fifteen preservice teachers (twelve women, three men), seniors, 21 to 24 years old, enrolled in the elementary education program at a large, public research university located in the northwestern United States. Three theoretical and practical criteria were employed for the selection of the preservice elementary teachers to include in the study. The criteria were established to insure that the preservice teachers who participated in the study were: (a) elementary education majors, admitted to the teacher certification program; (b) enrolled in an educational technology course designed for K-8 preservice teachers; and (c) had no social or personal ties to the researcher.

The eight-week educational technology course, a requirement for all K-8 preservice teachers, emphasized multimedia authoring, virtual environments, and telecommunications. In addition to attending weekly one-hour lectures, the preservice teachers participated in weekly four-hour computer labs. Course components included working with general-purpose and educational software packages, utilizing e-mail, navigating the Internet, creating homepages, participating in online discussion groups and learning communities, and designing on-line learning experiences for K-8 learners.

Procedures and Data Collection

Data were gathered by three methods: (1) semi-structured, open-ended interviews; (2) observations of the technology classes; and (3) examination of classroom artifacts, including the students' on-line assignments, projects, and final exams. Information about the preservice teachers' educational background and prior experiences with technology were collected through individual interviews. Additionally, during the course of conversations, personal demographic and biographic data were gathered from each participant.

In-depth interviews, each lasting between one and two hours, were conducted with six of the preservice teachers (four women, two men). The interviews, which took place over a four-week period, were tape-recorded, transcribed, and supplemented with the field notes. The participants' own words provided an insider's view of the world of a sample of preservice teachers, offering insight into their experiences with technology.

Data Analysis

The researcher's approach to data collection and analysis was iterative: data were analyzed as they were collected and emerging themes were identified and utilized to guide further data collection. An iterative design was selected in order to ensure the credibility of the research. As the study proceeded, the data collection/analysis cycles informed subsequent questions. During the course of the interviews, new questions emerged and existing ones were redesigned. The iterative design allowed for the testing of concepts, themes and theories throughout the study. In addition, the researcher triangulated the data via multiple sources of evidence including informants, events, and documents. As the study progressed, the researcher's thoughts, reactions, and assumptions were recorded in a journal in an effort to identify the researcher's own preconceptions, biases, and conflicts (Henry, 1996, p. 34).

Theory in this study was emergent and arose from the experiences and understandings of the participants. Theory was grounded in the details, evidence, and examples of the data generated during the course of the research; it followed rather than preceded the research (Glaser & Strauss, 1967). Initially, the interviews with the preservice teachers were relatively open-ended. As themes and theories emerged from the interviews, the research questions became more focused. In order to elicit in-depth responses related to the research questions, the interviewer introduced a topic then guided the discussion by formulating more focused questions. As the data were collected and analyzed, the preservice teachers separated into two distinct categories of participants: those with high technology self-concept (1 woman, 1 man) and those with low technology self-concept (11 women, 2 men). The anticipated gender differences between male and female participants' self-concepts did not emerge. It is possible that the large number of low technology self-concept participants, male and female, may be a result of the relatively low levels of mathematics and science knowledge possessed by preservice elementary teachers (Leinhardt, Putnam, Stein, & Baxter, 1991).

Results

During the analysis of transcripts and field notes, the lines of text were counted and coded for the most salient themes. Of the four most salient broad categories discovered and coded in the data, the themes that emerged were focused on: (a) gender beliefs; (b) technology beliefs; (c) perceived control; and, (d) educational background. This constellation of four variables appears to have played a role in the formulation of the participants' technology self-concepts.

Gender Beliefs

In the present study, the perception that computers appeal more to males than females was shared by all of the participants, both male and female, low- and high self-concept. However, the participants' responses were mediated by statements which suggest sociocultural explanations for gender differences.

I think that technology is probably like math - you might have guys who are more interested and are going to do better - but I think it's basically because girls are probably going to want to do something else - not sit at a computer. I think that some guys expect that girls just aren't going to know as much about computers as them - you find this attitude with teachers also - it's funny because when a girl does do well - it's a big surprise to everyone - the boys *and* the teacher! (Interview, Female, low self-concept).

It may seem stereotyped, but I think that you just expect males to be more interested and better in technology and computers and fewer females who are - this just increases at higher levels of computing. I'm not saying that females just don't have what it takes, it could be that something goes wrong somewhere along the way - you know, the girls are encouraged into other areas (Interview, Male, high self-concept).

Guys seem to *like* technology better than girls and they do better than girls [pause] but I think there is more to it [pause] when I watched the kids at Roosevelt [elementary school], it was the boys who were always crowded around the computers - the girls couldn't get a chance in (Interview, Female, low self-concept).

I think you will always find that girls will be more interested in things like writing or art, those areas, the boys will always like doing things with machines, science-type stuff. Who knows why? You just have to watch little kids and the kinds of games they choose - the boys go for computer games, Nintendo, action heroes - where are the girls? - with the dolls - they just naturally end up not doing as well with computers (Interview, Female, low self-concept).

Technology Beliefs

Beliefs about the nature of technology appear to play a critical role in the formulation of self-concept. Technology was pedagogically and conceptually associated with mathematics by the majority of the preservice teachers. Both low- and high self-concept participants expressed a belief that success in technology results from a prerequisite talent or competency in mathematics.

Math and technology go hand in hand. If you're like me and always had terrible experiences in math, facing a computer is a lot harder. I think that if you don't have a math brain, this is all going to be much, much harder. It sort of gives me the same feelings I had in math class, definitely (Interview, Male, low self-concept).

I think you can say that you're going to find the same kind of people that you find in math in technology. It's the same for teachers - you find they have a different attitude about their students - they know if you're the kind of student whose going to do well in those areas. It's just something about those subjects, they just go together, I don't know, I can't really explain it any clearer, but I think it's true based on my experiences, that connection is real (Interview, Female, high self-concept).

In addition to expressing a belief that technology was related to mathematics, several of the low self-concept preservice teachers articulated a belief that the presence of technology in the classroom could be problematic for both teacher and student.

It is possible that computers might make things difficult for children who struggle with technology. I know that I will have to consider ways to help students who find technology confusing (Interview, Male, low self-concept).

Well, computers in the class definitely make things different for the teacher. She is going to have to know a lot more about computers so the kids don't get ahead of her. As a future teacher, I know this is going to be a big challenge for me in my future teaching (Interview, Female, low-self concept).

Perceived Control

Perceived control, developed from the concepts of perceived self-efficacy (Bandura, 1982) and locus of control (Rotter, 1966), is the perceived ease or difficulty of performing a particular behavior (Ajzen, 1988). Low self-concept preservice teachers' were more likely than their high self-concept peers to express a lack of control with regard to the technology.

Things move so fast - and once you're behind, if you need to go back - no one waits for you - you have to catch it the first time - and if you don't, you know, you think, you really don't fit in this - this whole computer thing. I just shake my head, ok, I'm into something I can do but it's moving along too fast for me, I can't take the time to really understand it (Interview, Male, low self-concept).

My main thing with computers is that they're so unforgiving [pause] it's not that I expect it to know what I want to do, but there is something missing [pause] I don't trust it - it bombs suddenly, 'error!' - what is it? - 'an unexpected error has occurred' Sometimes, it's I think that I have to know how to think for it - to me, there is nothing logical in what it does (Interview, Female, low self-concept).

What I really hate is having to do stuff over and over. I have no control here - I get messages, it wants this, tells me to do that, that's not how I work - it doesn't cooperate (Interview, Male, low self-concept).

Educational Experiences

Prior educational experiences appear to play a significant role in the development of technology self-concept. The majority of low self-concept participants had negative experiences with school mathematics and believed that these negative experiences adversely impacted their ability to learn and utilize technology.

All of my experiences with math have been horrible. I have come to believe that I'm not good in math so I just don't see myself as being good in technology either (Interview, Female, low self-concept).

I didn't get a chance to take any computer classes in high school. The way it was, if your grades weren't high enough and you didn't have a strong math background, which I didn't - I was a 'two-oh' in math - you were shut out of taking any computer classes (Interview, Female, low self-concept).

For me, I would say that all of my experiences in technology have pretty much been like my experiences in math. Both have been very scary for me. I don't feel comfortable in class or asking questions. I also have a feeling of constantly being lost and not really knowing exactly what is going on (Interview, Female, low self-concept).

Significance

Like the discipline of mathematics, technology is commonly presumed to be culture and value-neutral, independent of social intentions, power, and privilege (Apple, 1989). However, technology reflects the society out of which it came and is open to shaping by social structures and cultural meanings (Harding, 1986). Because teachers bring their own self-concepts about technology into their classrooms, they not only teach content, but also implicitly transmit their own attitudes and understandings about technology to their students. Teachers' self-concepts mediate not only what they teach but also influence the ways in which their students develop their own self-concepts.

The present study began with an examination of preservice elementary teachers' technology self-concepts. The mission statement of the teacher preparation program in this study reflects its commitment to guiding preservice teachers toward an understanding of the benefits of multiple instructional strategies, including educational technology. Although preparing preservice teachers to effectively meet the educational needs of all students through a variety of instructional strategies is a key component of the teacher preparation program's strategic plan, the data from this study offer little evidence that the preservice teachers who participated in this study feel confident about implementing technology in their own classrooms.

By providing insights into preservice elementary teachers' technology self-concepts, the present study has theoretical, substantive, and practical significance. At a theoretical level, the study contributes to the knowledge base concerning preservice elementary teachers' technology self-concepts. At the substantive level, the study adds to the literature concerned with the ways in preservice elementary teachers perceive the nature of technology and their attitudes toward teaching and learning with technology. At a practical level, the study provides some guidance to university faculty and staff seeking to design programs to enhance preservice elementary teachers' technology self-concepts.

It is possible that a teaching force composed of low technology self-concept teachers will result in the reproduction of low technology self-concept among learners. For those concerned with the improvement of teacher preparation programs, it appears that there are three crucial issues: (a) a recognition of the significant number of low technology self-concept preservice elementary teachers; (b) an awareness of the impact of low technology self-concept teachers on learners; and, (c) an understanding of the roles that educational background, perceived control, and gender and technology beliefs play in the development of preservice elementary teachers' technology self-concepts.

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BASIC TECHNOLOGY COMPETENCIES FOR EDUCATORS: A SELF-ASSESSMENT INSTRUMENT

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Technology can succeed in schools only if it is built into the curriculum as an essential element of the instructional delivery system. Before this can occur, it is imperative that teachers become proficient in the use of technical tools. Teacher education programs must be able to assess students' level of technical competency in order to evaluate the curriculum and implement changes. The purpose of this paper is to introduce an instrument for assessing basic technology competencies that are needed by educators.

Background Information

In 1995 the North Carolina University System and the North Carolina State Department of Education announced a major initiative to develop a comprehensive plan for addressing the technology-related professional development needs of the state's current education workforce.

A regional delivery structure was proposed to bring together community colleges, public schools, and constituent institutions of the University of North Carolina to plan and organize a program that would work best for each region.

Out of this technology initiative came a mandate that all graduates of teacher education programs in the state of North Carolina be technology competent. At the end of the 1997-98 academic year, initial licensure of teachers and administrators will require demonstration of basic and advanced competencies, the former by means of a state test and the latter by means of a portfolio assessment.

The University of North Carolina at Charlotte responded to the state technology initiative by forming a steering committee to design, implement, and evaluate activities related to seven implementation objectives: (a) clarify and refine technology competencies, (b) articulate curriculum linkages, (c) acquire necessary resources, (d) develop faculty competence, (e) evaluate faculty competence, (f) develop student competence, and (g) assess student competence. This paper discusses the last objective, the assessment of student competence.

An instrument, *Technology Competency Self-Assessment Instrument for Educators*, was developed for assessing the technical competency level of preservice teachers. This information will serve as a "needs assessment" and baseline for deciding appropriate methods needed to develop and implement programs, activities, materials, and other mechanisms of integrating technology into the teacher education curriculum. The same protocols and procedures will be used for assessing and documenting the degree to which preservice teachers at The University of North Carolina at Charlotte have and use the basic and advanced technology competencies in their professional education courses and in their own teaching.

Technology Competency Self-Assessment Instrument for Educators

The Association for Educational Communications and Technology (AECT) and the International Society for Technology in Education (ISTE) have identified fundamental concepts and skills for applying a range of information technologies in educational settings. Using these identified concepts and skills, two clusters of technology competencies were defined and adopted by both The North Carolina State Board of Education and The University of North Carolina Board of Governors. *Basic competencies* are essentially entry-level skills related to basic computer operation, word processing, spreadsheets, graphics, databases, other media, and multi-media production. *Advanced competencies* deal with the application of basic competencies in teaching, administration, and counseling and in other professional activities of both students and faculty. A total of 207 skills were identified.

The *Technology Competency Self-Assessment Instrument for Educators* is currently being pilot-tested at The University of North Carolina at Charlotte. The original 207 skills were divided into nine competency domains: 1) basic computer operation skills; 2) setup, maintenance, and troubleshooting of equipment; 3) word processing; 4) spreadsheets; 5) databases; 6) networking; 7) telecommunication; 8) media communication; and 9) social, legal, and ethical issues. Within each domain, four competencies are sampled, reducing the original 207 competencies to 36 items. The competencies were chosen to represent an easy to difficult progression within each domain. In addition, the participants are asked to give an overall rating of their competency within each of the nine domains. Participants are instructed to self-assess using a four-point Likert scale ("Very competent" to "Not competent"). Below are the 45 items on the instrument.

Basic Computer Operation Skills:
1. Insert and eject floppy diskette
2. Store files in a folder/subdirectory
3. Access information on CD-ROM, floppy drive, and hard drive
4. Create and delete folders/subdirectories
5. Overall rating of basic computer operation skills

Setup, Maintenance, and Troubleshooting of Equipment:
6. Protection of floppy diskettes
7. Virus protection
8. Connecting peripheral devices
9. Managing memory
10. Overall rating of ability to setup, maintain, and troubleshoot equipment

Word Processing:
11. Set Margins
12. Change font size and type
13. Cut, copy, and paste in and between documents
14. Insert files, graphics, and tables in a document
15. Overall rating of word processing ability

Spreadsheets:
16. Enter data in cells
17. Move data within a spreadsheet
18. Use formulas
19. Create charts
20. Overall rating of spreadsheet management ability

Databases:
21. Enter data in a database
22. Sort and search in a database
23. Produce a report in a database
24. Queries using "and" and "or"
25. Overall rating of competencies using a database

Networking:
26. Logging on a network
27. Working in a network environment
28. File sharing
29. Knowledge of advantages of server
30. Overall rating of networking skills

Telecommunication:
31. Send and receive email
32. Navigate the WWW
33. Subscribe to a list-serve
34. Develop programs in Hypercard/Hyperstudio
35. Overall rating of telecommunication

Media Communication:
36. Use an overhead
37. Develop an electronic slide show
38. Develop an interactive electronic slide show
39. Develop a presentation utilizing graphics and sound
40. Overall rating of media communication skills

Social, legal, and ethical issues:
41. Knowledge of copyright laws
42. Knowledge concerning shareware
43. Knowledge of software piracy
44. Knowledge of intellectual property rights
45. Overall rating of social, legal, and ethical issues

The above portion of the assessment attempts to measure technical competencies. Since the instrument is self-report, the validity is related to the honesty of the respondent. To detect intentional attempts to respond dishonestly, an additional scale has been developed to assess "faking good." A four-point Likert scale ("Strongly agree" to "Strongly disagree") was provided. Below are the items on the "faking good" scale.

46. Only teachers who use technical tools can be effective in the classroom.
47. Technology can make a drastic improvement in the educational system.
48. All classes need a technical component incorporated into the lessons.
49. Students will not succeed in society without technical skills.
50. Technology can solve most of the world's problems.

Validity and Reliability

The validity and reliability studies are scheduled to be completed in February, 1997, before the 1997 SITE conference. The results will be presented at the conference. Reliability will be reported using coefficients of stability (i.e., test-retest) and internal consistency (i.e., coefficient alpha). A variety of activities are planned for the validity study. Initially, participants will be administered the *Technology Competency Self-Assessment Instrument for Educators*. The participants will then be given a performance-based assessment of selected competencies. The scores on the performance-based assessment will be correlated with the participants' scores on the *Technology Competency Self-Assessment Instrument for Educators*. Results from the "faking good" scale will be used to determine if this response bias has a relationship with the participants' discrepancy score (i.e., difference between performance-based assessment and *Technology Competency Self-Assessment Instrument for Educators*).

Conclusions

What began as a state mandated initiative has developed into a valuable change process for The University of North Carolina at Charlotte. This paper presents only one of the many activities that are being utilized to help produce technically proficient educators. Only by being aware of students' technical proficiency levels can teacher preparation programs develop and implement curricula which will produce effective teachers.

Technology offers great potential in the educational environment. Before technology can achieve its fullest potential in the classroom, teachers must possess basic and advanced technical competencies. The *Technology Competency Self-Assessment Instrument for Educators* can provide valuable information to professional teacher preparation programs that are working to build these competencies.

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How Teachers Use and Learn To Use Computers

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There is a strong emphasis today on computer integration into the classroom with a usual focus on the available technologies (Barron & Orwig, 1995), effects on traditional classroom design and operation (Heide & Henderson, 1994), and the student learner (Dockterman, 1991). Unfortunately, there is little concern for what prerequisites or training is needed for teachers themselves. What training or experiences do teachers need in order to be ready to integrate technology into teaching? How do teachers actually use technology? And, how do educators learn to use and adopt technology? This information is generally missing in today's research as well as from integration literature.

There are many elaborate planning models with protocols designed to yield successful technology growth and integration for schools. Heide and Henderson (1994) describe a number of classroom designs for the integration of technology. They describe the advantages and disadvantages of the one-computer classroom, the lab or shared classroom, and a specialized multimedia or highly-developed technology room. They even outline a so-called well-mannered and safe technology classroom. Their planning guide also addresses evaluating student progress and students with special needs. However, while this integration guide is typical of most, severely neglected are the important areas of preparing novice teachers to adopt technology to use in teaching students.

Virtually all models include a component for staff development with general suggestions for support, but how well are such models based on how educators actually learn to use technology? Typically, such models primarily emphasize the principle of planning and focus little on the nature of the educators who must implement the plan. For example, if teachers benefit from inservice programs over formal college courses then that fact should influence the nature of staff development programs and planning for integration. If teachers would benefit more from working one-on-one directly with a mentor then resources should be planned for that approach.

Indeed, far too often integration programs are started with little or no planning, let alone an informed approach which takes into account facts about how teachers learn to use technology. Bailey and Lumley (1994) say "...one major problem stands as a stumbling block in the path of the impending technology revolution in education - lack of planning." (p. 35). They do stress the value of inservice training for staff development but with an emphasis on skills and the notion of training. There is virtually no mention of a more general education or development of a conceptual understanding of computing which might enable a teacher to adapt to changing and emerging technologies.

New and emerging technologies are as plentiful as there are ways to use them (unfortunately, sometimes more plentiful). An excellent review of technologies can be found in Barron and Orwig (1995) who outline in some detail a variety of technologies from audio to video, from hypermedia to CD-ROM, from networking to teleconferencing. However, the vast majority of teachers are, if not beginners, nevertheless still working to develop value and efficiency in the facility of computing. Teachers often feel thankful to have access to a word processor. For most, the many technologies available today are still an unknown and planning must take this into account.

As school districts plan for support for technical personnel, inservice programs and other training for teachers as well as guidance on computer integration into the curriculum, coordinators and committees must consider how teachers are actually learning and using computers. It is important not only to examine what teachers do with computers but also to consider how teachers learn those skills.

Methodology

Teachers and administrators of school districts across Northwest Indiana responded to surveys on their use of computers. The surveys targeted how teachers use computers, what kinds of software, frequency of use, and other aspects of their teaching experience. Questions specifically addressed personal and professional uses (for the teacher's needs or interests) as compared to planning for, assisting with, teaching with or directing students' learning with computers.

Personal and professional uses would include any use for managing projects or information, producing printed materials such as letters, flyers, charts. Also, teachers might prepare graphic images for use in anything from hobbies to professional organization materials. Teachers may have avocations which call for record keeping or the generation of letters and other materials. Certainly, the profession of teaching generates such needs. These personal and professional uses of technology were distinguished from the instructional application of technology to students.

Using computers with students involved everything from administering typical drill and practice software on some particular topic to more generic activites designed to enhance students' problem solving skills and such. Also included would be the use of technologies used to deliver instructional information, to present audio or video information and to demonstrate software applications for students to adopt. This category of use even included activities directed toward assisting or managing students' use of software and technology.

Other questions specifically categorized applications with which teachers regularly work: word processing, database, spreadsheet, graphics, desktop publishing, programming & hypermedia authoring systems, multimedia involvement, telecommunications, and work with operating systems or other applications unspecified. Teachers were invited to submit separate entries for each title/type/use of software with which they were involved. They documented their frequency of use. Of specific interest in the survey was how teachers had learned to use computers and the various software applications. Categories of training and education included college courses, technical schools, seminars, workshops, commercial classes, inservice programs, assistance from colleagues, personal study of texts and manuals, and even simple trial and error experimentation.

Results and Discussion

A total of 92 teachers and administrators responded to the survey not all of whom were computer-users. They had a variety of backgrounds and years of experience in education ranging from 1 to 35 years. The overall average number of years for the whole group was 18 years teaching experience. Approximately 66 percent owned their own computer compared with approximately 17 percent owning none (17 percent no response to this question). Although there were almost 4 times as many who owned their own computer as not, computer ownership was spread evenly across the range of years of teaching experience.

Respondents had experience across the curriculum including a small number of administrators. Table 1 illustrates the percentage of respondents per each of the subject areas reported. As the table shows, aside from those who tended to teach all subject areas (primarily elementary school teachers), language arts teachers were most plentiful with computer science teachers the least.

Table 1.
Subject area categories taught by respondents.

Subject Areas Taught	**% of Respondents**
All subjects...	32.6
Language arts / spch / writing / debate / lit / spel / read...	25
Science / bio / chem / phys / earth & environ sci...	18.5
Mathematics / algebra / trig / calculus...	18.5
Other / miscellaneous...	6.5
Administration*...	2
Computer Science...	2

*Note. *Administration represents principals, etc.*

Clearly, the most used application of computing was word processing, generally twice as much, if not 3 to 1, over the next highest categories, dedicated educational software and graphics. As shown in Table 2, this was true for all categories except software used on only a monthly basis where graphics usage was equally high.

Very surprising, it seems that for educators using computers with students database activities are almost never included. In fact, with the exception of the primary 3, it seems that students are exposed to very little. The application areas of spreadsheet, multimedia, desktop publishing, programming, hypermedia, telecommunications and more, all seem relatively neglected for students. The personal and professional uses of computers, on the other hand, seem somewhat more diverse and possibly further developed. There were almost twice as many entries or accounts of software usage on a weekly basis as compared with daily or monthly usage. The significance of this is unclear although teachers' and students' access to computing equipment might account for this time difference.

Table 2.
Types and levels of software usage by educators.

Software Type	**General**	**Daily**	**Weekly**	**Monthly**	**Teaching Students**	**Personl. & Prof.**
Word processing	42	50	42	21	34	43
Educational software	17	24	18	16	27	11
Graphics	15	5	14	21	16	9
Database	6	4	5	9		11
Spreadsheet	5		7	5	2	8
Multimedia	4	4	5	9	6	5
Desktop publishing	3			9	3	4
Telecommunications	3				2	3
Progrmng / hypermedia	3				5	2
Miscellaneous / other	2	16	10	10	4	
Total entries *	92	85	152	58	173	148

*Note. *All values shown in chart are percentages of total entries per category. Blanks illustrate zero or insufficient response to register in that cell.*

One of the more interesting discoveries from the survey was that most teachers had not learned to use computers from courses, seminars or workshops, inservice programs or college courses. Only 17% of respondents accounted for learning computing from all external sources. Over 83% of respondents taught themselves to use computers and to use the various software applications. This seems significant since virtually none of today's integration planning models seem to take this phenomenon into account.

For example, learning to effectively use computers may be similar to learning the backhand shot in tennis. No matter how many videos are watched, no matter how many tennis matches one observes, no matter how many seminars one attends, it is inevitable that personal study, repetitive practice and some trial and error will be required. One learns for oneself over time exactly what works and what does not work - longer for some, shorter for others.

The final important area of inquiry addressed whether teachers integrate computer technology into use with their students with no commitment to and experience in using computers personally and professionally. It is not uncommon in this author's experience to be asked to train teachers to use computers with students. Unfortunately, the participants often don't know which side of the keyboard to type on. After being told that there are no funds to support teacher training, the activity is expected to produce teachers ready to integrate equipment and creative activities into student experience.

The notion of *primary use* in this study was defined as over 70 percent of one's time, computing activities and energies devoted to one particular type of use. Table 3 illustrates the primary focus (not exclusive focus) of these respondents and how over 75% have a commitment to personal and professional usage of computers. It is significant that one does not tend to find teachers using computers with students who do not also have a real commitment to using computers themselves in their personal and professional lives. The majority of respondents used computers with their students to varying degress but less than 10 precent did so without also having a significant personal involvement with computing. And, 15 percent of respondents did not use computers at all.

Table 3.
Computer usage by educators: Personal/prof. vs. instructional.

Primary Focus *	% of Respondents	Total % of Use Includes Per & Pro
Personal/Professional	56	76
< mixed evenly >	20	
Instructional w/ Students	09	
No Computer Usage	15	

* Note. *Primary focus is defined as at least 70% of computing time devoted to one type or area of use.*

The two most striking results from this study are (a) that educators learn to use computers primarily on their own, and (b) that it is unlikely that teachers will integrate computer technology into classroom instruction without the inclusion of personal and professional usage. It seems that planning models and integration programs should consider these factors more heavily when addressing teacher training.

Educators should emphasize the importance of a personal commitment from teachers who are learning to use computers or who intend to use computers in teaching. Whose responsibility is it when a teacher must adapt to and master the skills of using computers? Ultimately, its everyone's problem in different ways. But, in addition to the inservice training programs which school districts tend to support and the traditional courses which colleges tend to provide, maybe teachers should be supported more directly in their own efforts to learn computing. Maybe support should be directed toward helping teachers acquire personal machines or provide technical support for completing the kinds of tasks we face in our personal lives which can be adapted to student activities as well.

Even though computer use with students still includes a large focus on dedicated educational software, future computing is moving toward more diverse multimedia work stations. Teachers and students alike all face the need for increased productivity using multimedia computers and access to telecommunications in personal and professional computing. The educational computing activities for students are more and more the same activities of everyone's personal and professional lives.

In any event, it seems clear that non-computer-using teachers will be less likely to accomplish a successful integration of technology into teaching. Teachers should alone assume the responsibility and make a personal commitment to incorporating computer technology into all aspects of their lives which will then flow more readily into their instructional programs.

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The Comparison of Inservice and Preservice Teachers' Attitudes Toward Educational Computing in Taiwan

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The fact that teachers are reluctant to use the technology resources such as computers, due to lack of training and experience is not unique in America (Carlson, Lambert, 1995). A similar situation is found in Taiwan. Teachers in Taiwan usually complain that they are willing to learn new technology, but the government does not provide adequate inservice training. On the other hand, with a limited educational budget, the educational policymakers in Taiwan must spend money carefully. They are confused about whether to provide more technology-related training in preservice teacher education, or to provide training to inservice teachers. Do teachers really have high motivation to learn new technology if adequate training opportunities are provided? If this is not the case then work may be required prior to graduation. There is no simple solution for this problem, but understanding inservice and preservice teachers ' attitudes and perceptions about educational computing may provide some information which can help the policy makers reach an appropriate decision. Other variables such as gender may also need to be addressed in order to investigate the affect these variables have on inservice or preservice teachers attitudes.

The major purpose of the present study was to compare inservice and preservice teachers ' attitudes and perceptions about educational computing in Taiwan. More specifically, this study attempted to examine the effects of groups (i.e., preservice and inservice), (b) gender (i.e., male and female), (c) level (i.e., currently a freshman, sophomore, junior, and senior) on teachers ' attitudes and perceptions about educational computing.

Method

Subjects

There were two groups of subjects. The first group included 947 inservice elementary-school teachers (including 160 kindergarten teachers) and the second group included 1247 preservice teachers. These inservice teachers enrolled in the summer session at a national teachers college located in the North of Taiwan. The 4-year summer program was designed specifically for the inservice elementary-school teachers who would like to pursue a bachelor degree in education. The total number of inservice teachers enrolled in the summer program at a teachers college in 1994 was 1,779. They were divided into 43 classes. Then 26 classes were randomly selected from the 43 classes.

The 1247 preservice teachers were randomly selected from all nine teachers colleges in Taiwan. Subjects for both groups were selected from 9 different educational departments (e.g., Department of early childhood education, Elementary Education, and Art Education). The subjects selected at each department represented a broad spectrum of backgrounds and academic interests. The background characteristics of the participants are shown in the Table 1.

Table 1.
Background Characteristics of Subjects

Variables	N	%
Group		
Inservice	947	43.2
Preservice	1247	56.8
Gender		
Male	891	40.6
Female	1303	59.4
Grade		
First	698	31.8
Second	653	29.8
Third	401	18.3
Fourth	442	20.1
Major areas		
Art ed.	146	6.7
Early childhood ed.	271	12.4
Elementary ed.	504	23.0
Language art ed.	277	12.6
Math & science ed.	241	11.0
Music ed.	79	3.6
Physical ed.	240	10.9
Social studies ed.	309	14.1
Special ed.	127	5.8

Instrument

Two surveys, *The Teacher Computer Attitude Scale* (Violata, Marini, & Hunter, 1989) and *The Ability Differences in Computer Use* (Waxman, Huang, & Padron, 1992), were integrated into one instrument. A Chinese language version was administered to all subjects in the present study. The Teacher Computer Attitude Scale consists of four scales: (a) Sex Differences — teachers' perception of gender-related differences in working with computers; (b) Comfort — teachers' level of comfort in using computers; (c) Value — teachers' perception of the value of computers; and (d) Liking — teachers' liking for using computers. The Ability Differences in Computer Use has five items on a teachers' view of ability-related differences in their students' computer utilization. All the scales use a 5-point Likert rating with 5 indicating strongly agree and 1 indicating strongly disagree (Huang, Waxman, & Padron, 1995).

Every attempt was made to provided a Chinese version that was a faithful representation of the English version. Once the Chinese version was prepared, two other Chinese colleagues, both from the English Department, were requested to verify the instrument and compare it to the English version. A few minor changes in the Chinese wording resulted in the final version of the Chinese instrument. A section on background characteristics was also included on the final instrument.

The instrument's reliability, each scale's internal consistency reliability (alpha coefficient) ,was calculated using 466 preservice teachers as sample. These scales presented adequate reliability (with alpha coefficients ranging from .71 to .91). Table 2 displays the internal consistency reliability for each scale.

Table 2.
Internal Consistency Reliability

Scale	No. items	Alpha reliability
Sex-dif.	05	.71
Comfort	10	.91
Value	07	.80
Liking	10	.87
Ability-dif.	05	.72
Total	37	.90

Procedures

Participants were selected and administered the instrument at two stages. At the beginning of the Spring academic semester, 1994, 1800 preservice teachers were randomly selected (200 for each of the nine teachers colleges) and were administered the instrument. A total of 1323 (74%) surveys were collected and, of them, 1247 (69%) were complete and coded. The inservice group was administered the instrument at the beginning of the summer session, 1994. The instrument took approximately 30 minutes to complete. The data was collected and coded.

For the data analysis, a 2 x 2 x 4 Factorial analysis of variance (ANOVA) was used to investigate if there were any statistically significant differences (at .05 level) on teachers' attitude toward computers: (a) between groups (i.e., inservice and preservice), (b) between gender (i.e., male and female), (c) among different levels (i.e., years in the college program coded as first, second, third, and fourth), and (d) the interactions among these factors (i.e., groups, gender, and grades).

Table 3.
Summary of Means and Standard Deviations for Variables

	Attitudes									
	Sex diff.		Comfort		Value		Liking		Ability diff.	
Variables	X	SD	X	SD	X	SD	X	SD	X	SD
Group										
Inservice	2.39a	0.61	3.44	0.69	4.06	0.47	3.64	0.54	3.06	0.71
Preservice	2.32	0.65	3.35	0.72	4.05	0.54	3.55	0.55	2.84	0.67
Gender										
Male	2.49	0.67	3.56	0.70	4.06	0.57	3.67	0.58	2.98	0.71
Female	2.26	0.59	3.28	0.69	4.05	0.46	3.53	0.51	2.90	0.69
Grade										
First	2.29	0.63	3.37	0.70	4.05	0.53	3.59	0.55	2.90	0.68
Second	2.38	0.63	3.34	0.70	4.07	0.50	3.59	0.55	2.93	0.68
Third	2.37	0.62	3.40	0.70	4.01	0.50	3.56	0.53	2.98	0.69
Fourth	2.38	0.65	3.49	0.73	4.06	0.49	3.61	0.56	2.96	0.75
Total2.36	0.63	3.39	0.71	4.05	0.51	3.59	0.55	2.93	0.70	

Note. *a The maximum score for each scale is 5.*

Table 4.
Summary of the Three-Factor-ANOVAs

Variables	df	Sex-dif. F	Comfort F	Value F	Liking F	Ability-dif. F
Group (A)	1	4.273*	14.530***	1.592	23.820***	58.741***
Gender (B)	1	58.792***	88.228***	1.261	49.045***	7.614**
Grade (C)	3	3.593*	2.978*	1.169	0.776	1.126
A x B	1	26.399***	0.349	6.662**	1.359	2.160
A x C	3	0.963	0.837	0.190	0.469	2.049
B x C	3	0.404	1.293	0.343	0.808	0.140
A x B x C	3	4.520**	2.811*	1.400	3.449*	0.160
Residual	2178					

*p<.05 **p<.01 ***p<.001

Results

Table 3 displays the means and standard deviations for variables on each scale. In general, descriptive results from the present study indicated that teachers in Taiwan valued educational computing highly (M=4.05, SD=0.51). Their ranking of liking was positive (M=3.59, SD=0.55) and feelings about computers were quite comfortable (M=3.39, SD=0.71). Their perceptions of differences in computer use between low- and high- achieving students were mild (M=2.93, SD=0.70). However, their perceptions of gender-related differences in computer use were low (M=2.36, SD=0.63). Results of the three-way ANOVAs indicated that there were significant main effects (a) between groups on sex difference, F(1,2178)=4.27, p<.05, comfort, F(1,2178)=14.53, P<.001, liking, F(1,2178)=23.82, p<.001, and ability difference, F(1,2178)=58.74, p<.001, (b) between gender on sex difference, F(1,2178)=58.79, p<.001, comfort, F(1,2178)=88.23, p<.001, liking, F(1,2178)=49.05, and ability difference, F(1,2178)=7.61, p<.01, and (c) among grades on sex difference, F(3,2178)=3.59, p<.05, and comfort, F(3,2178)=2.98, p<.05. Table 4 displays the summary of the three-way ANOVAs.

Significant interactions were obtained (a) between groups and gender on sex difference, F(1,2178)=26.4, p<.001 (see figure 1.), and value, F(1,2178)=6.66, p<.01 (see Figure 2.), and (b) among groups, gender, and grades on sex difference, F(3,2178)=4.52, p<.01 (see Figure 3.), comfort, F(3,2178)=2.81, p<.05 (see Figure 4.), and liking, F(3,2178)=3.45, p<.05 (see Figure 5.). No other main effects and interactions were found.

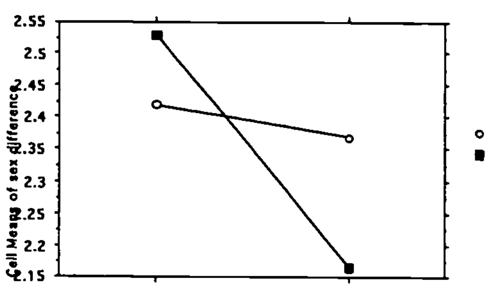

Figure 1. Interaction Between Group and Gender on Sex Difference

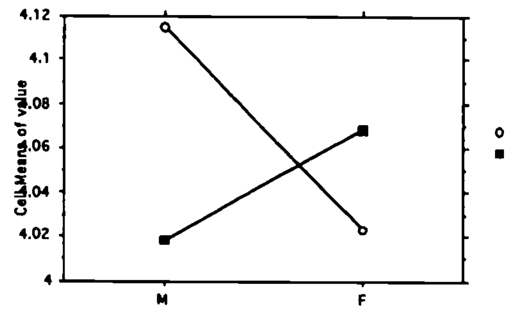

Figure 2. Interaction between Group and Gender on Value.

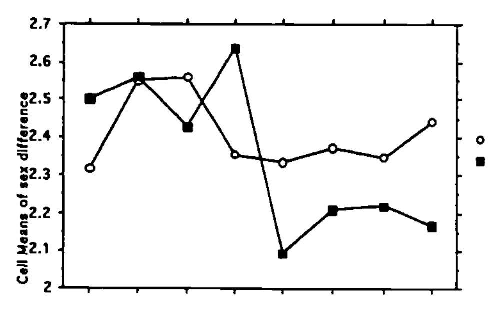

Figure 3. Interactions among Group, Gender, and Grade on Sex Difference.

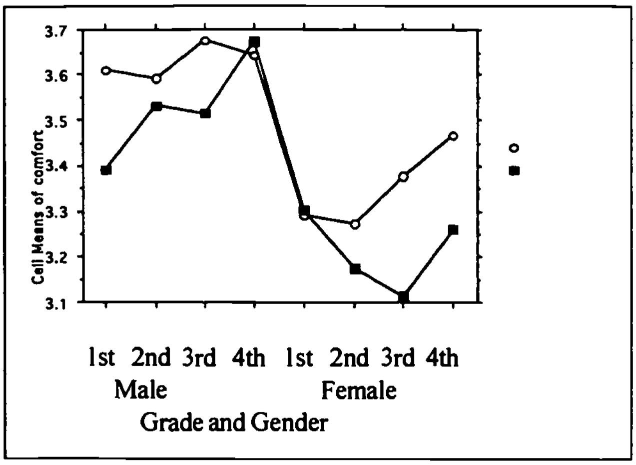

Figure 4. Interactions among Group, Gender, and Grade on Comfort.

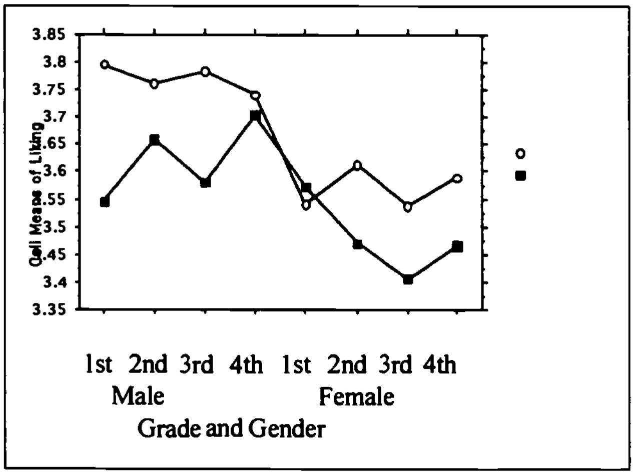

Figure 5. Interactions among Group, Gender, and Grade on Liking.

Follow-up analyses were performed for each significant main effect and interaction. The results showed that for group, inservice teachers scored significantly higher than preservice teachers on all scales except value. For gender, results showed that male subjects scored significantly higher than female subjects on all scales except value. For level (grade), results showed that first-year subjects scored significantly lower than other subjects on sex difference; fourth-year subjects scored significantly higher than second-year subjects on comfort.

The significant interactions between group and gender on sex difference show that male preservice teachers ' perceptions of gender-related differences in computer use were significantly higher than those of female preservice teachers. In addition, male inservice teachers valued educational computing significantly higher than male preservice teachers and female inservice teachers. Finally the significant 3-way interactions on sex differences, comfort, and liking indicated that, overall, preservice teachers had more varied perceptions of gender-related differences, degrees of comfort and liking in using computers than inservice teachers.

Discussion and Conclusion

The findings of the present study indicated that, in general, inservice teachers in Taiwan valued educational computing very high, felt quite comfortable with computers and liked to work with computers. Previous studies reported that teacher education students in Taiwan had mild positive attitudes in terms of low anxiety, high confidence and liking toward computers (Liao, 1993; 1995). Results from the present study were partially consistent with previous research. However, when comparing the group differences, results obtained in the present study in which inservice teachers scored higher than preservice teachers on the comfort and liking scales suggests that inservice teachers in Taiwan seem to have more positive attitudes toward educational computing than preservice teachers. This may be because inservice teachers realize the needs for using technology in instruction. On the other hand, the fact that inservice teachers ' perceptions of gender- or ability-related differences were higher than preservice teachers is somehow atypical. Padron (1993) in her study of teacher education students' attitudes toward equity issues in technology found that these students did not view gender or ability level as an issue in terms of students being able to learn and enjoy computer applications. A study on teacher education students' attitudes toward educational computing by Huang, Waxman, and Padron (1995) also reported that a majority of prospective teachers did not perceive any differences in computer use between males and females nor between low- and high- achieving students. Further research needs to be conducted to explre why the results of the present study differed from the American studies.

Gender differences were also found in the present study. Male teachers scored significantly higher than females on all five scales except value. Collis and Williams (1987) reported that there were fewer gender differences among Chinese students in attitudes toward their computers. Obviously, the results of the present study did not agree with their findings. A possible explanation for this is that students in Taiwan are strongly affected by society's reinforcement of sexual stereotypes. Most people in Taiwan, for instance, view technology/science majors in colleges (e.g., electronic engineering, physics, chemistry) as male domains while literature/art types of majors (e.g., Chinese literature, English literature, and arts) are seen as female domains. This cultural bias may therefore result in gender differences for teachers in viewing gender-related and ability-related differences, feeling comfortable, and ranking of liking in using computers, when the computer has been viewed as a male domain. The study by Collis and Williams (1987) did not use subjects in Taiwan and that may therefore be one reason for the different outcomes.

Grade differences were obtained only on sex difference and comfort. The results suggest that first-year teachers in the program seem to view gender or ability differences less than senior teachers in the program. In addition, the finding that fourth-year teachers felt more comfortable than the second-year teachers in using computers was probably because the seniors have more computer experiences.

The significant interactions between group and gender on sex difference and value were interesting. Male preservice teachers valued educational computing lower than female preservice teachers but their perceptions about gender-related difference were significantly more than their female peers. On the other hand, although male inservice teachers also perceived gender-related differences significantly more than female inservice teachers, they valued educational computing as high as their female peers. Apparently, male teachers seem to be affected by the cultural bias of sexual stereotypes more than females.

The results of this study suggest that, although the technology-relate training for preservice teachers should not be ignored, the educational policy-makers need to allocate more funds for training for inservice teachers. Computer-using-educators in teacher training institutions also need to address the important role of technology in instruction to preservice teachers. In addition, the equity issues in technology in terms of perceptions of gender- or ability-related differences ought to be emphasized in the educational computing curriculum for all teachers to reduce the influence of sexual stereotypes.

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DIFFERENCES IN PROSPECTIVE TEACHERS' PERCEPTIONS OF COMPUTERS: A CROSS-NATIONAL STUDY

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In the past few decades, there has been a growing body of literature on preservice teacher perceptions of computers and educational technology. A number of these studies focused on strategies to reduce anxiety and increase preservice teachers' confidence in using computers in education (Byrum & Cashman, 1993; Handler, 1992; Handler, 1993; Pina & Harris 1993; Petrakis, 1992; Stephen & Ryan, 1992). Others dealt with the development and validation of attitude instruments (Delcourt & Kinzie, 1993; Kay, 1993; Kim, 1994). It is important to examine this issue because research has found that teachers who were comfortable with technology use and aware of ways it could help them do their job better (Sheingold & Hadley, 1990).

Cross-national or cross-cultural studies on computers in education have also gained considerable attention. The questions pursued tend to center on (a) comparing college students' computer attitudes with respect to gender difference, confidence, and anxiety (Leuter & Weinsier, 1994; Marakis, 1992; Marcoulides & Wang, 1990; Sensales & Greenfield, 1995), and (b) assessing computer in education at elementary and secondary schools (Pelgrum, 1992; Pelgrum & Plomp, 1993). Very little research has specifically investigated cross-nationally preservice teachers' perceptions of computers.

The present study takes the cross-national approach to investigate prospective teachers' perceptions of computers in education in the United States and in Taiwan. The rationale for this approach includes: (a) testing the generalizability of preservice teacher attitudes toward computers originated in the United States, (b) broadening the perspective of researchers and thus helping to strengthen our sensibility for idiosyncratic features of our own educational system, (c) contributing to a better understanding of the relative influence of some significant variables on educational computing, and (d) looking for universal variables and relationship between variables that are cross-culturally valid (Wubbels, 1993). Consequently, the purpose of this study is to examine cross-nationally prospective teachers' perceptions of computers in the dimensions of liking, comfort, value, their beliefs in gender- and ability-related differences in computer use, and the variables that significantly associate with their perceptions. More specifically, the present study addresses the following research questions:

1. Are there significant differences in computer perceptions between prospective teachers in the United States and Taiwan?
2. Are there significant differences in demographic compositions between these two groups of prospective teachers?
3. Are any teacher characteristics significantly related to their perceptions of computers? If so, are the relationships vary by nation?

Methods

Subjects

The participants in the study were 360 teacher education students in their junior or senior year of study. Among them, 180 enrolled in teacher education institutions in Taiwan, and 180 in universities in a southern state of the United States. Among these prospective teachers, 21% were male and 79% were female. Over 72% of them were between the ages of 18 and 25, 21% were between 26 and 35, and 7% were beyond 35 years old. Nearly 6% of them had never used a computer, and over 40% had used computer(s) for more than two years. However, the two groups of prospective teachers varied greatly in the compositions of these demographic variables.

In the aspect of formal computer education, a computer course has been mandated as a teaching certification requirement in the southern state of the United States, and a "computer literacy" course was offered at the undergraduate level. In Taiwan, although a computer course has not been mandated, an "introduction to computer science" was provided as an elective course for undergraduates, and about 70% of the prospective teachers took this course as part of their educational plan.

Instruments

Two instruments were integrated into one survey: The Teacher Computer Attitude Scale (Violata, Marini, & Hunter, 1989), and the Ability Differences in Computer Use (Waxman, Huang, & Padron, 1992). The Teacher Computer Attitude Scale consists of four scales: (a) Liking — Teachers' liking for using computers; (b) Comfort — teachers' level of comfort in using computers; (c) Value — teachers' perception of the value of computers; and (d) Gender Differences — teachers' perception of differences between males and females in working with computers. The Ability Differences in Computer Use consists of five items on teachers' view of ability-related differences in computer utilization. All the scales are on a 5-point Likert rating with 5 indicating "strongly agree" and 1 indicating "strongly disagree." A brief section on these prospective teachers' background characteristics was also included in the final instrument.

The survey instrument was translated into Chinese t0 be usable by subjects in Taiwan. Verification of the content validity of the Chinese version was done by reversing translation of it into English by English teachers in Taiwan who had not seen the English version. As a result, a few minor changes were made to make it most adaptable to the two cultures.

The survey instrument has been found to be reliable and valid in prior studies (Huang, Waxman, & Padron, 1995). For the present study, the internal consistency reliability (alpha coefficients) ranged from .72 to .92 for the five scales for both subject groups, and ranged from .70 to. 95 for separate groups. This suggests that the instrument is reliable in measuring computer perceptions of these future teachers in both the United States and Taiwan.

Procedures and Analysis

The survey instrument was administered at the beginning of the academic year to the prospective teachers by experienced researchers in both nations. Prospective teachers responded anonymously. A multivariate analysis was conducted to determine whether there were significant differences between prospective teachers from the United States and Taiwan in their perceptions of computers. Chi-square analyses were performed to reveal if there were significant differences in the demographic variables between the two groups. Finally, a series of multiple regression was used to determine the relationship between demographic and perception valuables of the two teacher groups.

Results

The MANOVA results reveal that there were significant differences between the two groups of prospective teachers' computer perceptions (F=47.57, df(5,354), p<.001). Table 1 presents the follow-up analysis of variance (ANOVA) results, means, and standard deviations of the two groups on the five scales. In general, prospective teachers from both groups perceived positively of computers in education. All responded with a mean value greater than 3.00 in Liking, Comfort, and Value of computers, and a mean value lower than 3.00 in Gender- or Ability-Related Differences. The ANOVA results, however, indicated that prospective teachers in the United States perceived greater comfort and value than prospective teachers in Taiwan. They also liked to use computers more than their counterparts in Taiwan. On the other hand, prospective teachers in Taiwan indicated significantly higher concern about gender-related and ability-related differences in students' computer utilization.

Table 1.
The Means, Standard Deviations, and ANOVA Results of the Five Scales by Nation.

Scales	Pros. teachers in USA (n=180)		Pros. teachers in in Taiwan(n=180)		ANOVA
	M	SD	M	SD	F
Liking	3.58	0.69	3.43	0.60	5.25*
Comfort	3.82	0.85	3.31	0.72	37.25***
Value	4.23	0.46	4.07	0.51	9.83**
Sex-rel. differences	1.46	0.51	2.19	0.63	146.93***
Ability-rel. differences	1.85	0.68	2.82	0.76	160.15***

*p < .05. **p < .01. ***p < .001.

Table 2 shows the chi-square results. The results indicate that the two groups also differed significantly in the demographic and computer experience variables (all had p<.001). There were five times more males among the prospective teachers in Taiwan than in the United States. The ages of prospective teachers in Taiwan were generally lower than those in the United States. Nonetheless, prospective teachers in the United States had more experience in computers than those in Taiwan, with over three times of them having longer than two years' of computer experience.

Table 3 presents the multiple regression results. The results reveal similarities and differences of the effects of gender, age, and computer experience on computer perceptions of the two groups of prospective teachers. In the United States, computer experience was related positively with these prospective teachers' comfort, liking, and value of computers (p<.001). Older prospective teachers tend to like computers more than younger ones. In addition, gender and computer experience were related significantly with prospective teachers' perception of gender-related differences in working with computers. In other words, females and prospective teachers of longer computer experience disfavored the view that males work better with computers than females.

Table 2.
The Chi-square Results Comparing Demographic Variables Between the Two Groups

Variables	Pros. teachers in US		Pros. teachers in Taiwan		
	f	%	f	%	Chi-square
Gender					48.64***
Male	11	6.11	65	36.11	
Female	169	92.89	115	63.89	
Age					36.44***
18-25 years old	105	58.33	153	85.00	
26-35 years old	51	28.33	25	13.89	
36 and older	24	13.33	2	1.11	
Computer experience					101.42***
Never used	2	1.11	19	10.56	
0-6months	15	8.33	53	29.44	
6-12months	9	5.00	38	21.11	
1-2 years	40	22.22	38	21.11	
2 years or longer	114	63.33	32	17.78	

***$p < .001$.

In Taiwan, computer experience was also related positively with these teachers' comfort, liking, and value of computers. Female prospective teachers also disfavored the view that males work better with computers than females, but unlike their counterparts in the Unites States, their views of sex-related differences in computer utilization were not associated with computer experience. Above all, none of the gender, age, or computer experience variable was related significantly with prospective teachers' perceptions of ability-related differences for either group.

Discussion

Findings of this study indicate that, in general, prospective teachers in the United States had more positive perceptions of computers than their counterparts from Taiwan. They felt more comfortable with computers, valued computers higher, and like to use computer more than prospective teachers in Taiwan. These findings echo Kim's (1994) results from his comparison of computer attitudes between college students from the United States and South Korea.

Prospective teachers in the United States were less likely to believe that there were gender- or ability-related differences in computer use than prospective teachers in Taiwan. In other words, prospective teachers in Taiwan were more inclined to feel that using a computer is more important and enjoyable and easier for males than females. Plausible explanations of the discrepancy in their perceptions of sex-

Table 3.
The Multiple Regression Results of Demographic Variables on Computer Perceptions

Variables	Pros. teachers in US			Pros. teachers in Taiwan		
	B	*B*	*R2*	B	*B*	R^2
Liking			0.19			0.07
Gender	-0.25	-0.09		-0.12	-0.10	
Age	0.18	0.19**		0.11	0.07	
Computer experience	0.27	0.39***		0.11	0.25**	
Comfort			0.25			0.16
Gender	-0.20	-0.06		-0.19	-0.13	
Age	0.07	0.06		0.05	0.03	
Computer experience	0.43	0.49***		0.20	0.37***	
Value			0.10			0.05
Gender	0.13	0.07		-0.12	-0.11	
Age	0.07	0.11		-0.04	-0.03	
Computer experience	0.14	0.31***	0.07	0.17*		
Sex-related differences			0.10			0.07
Gender	-0.51	-0.24***		-0.30	-0.23**	
Age	-0.10	-0.14		0.21	0.13	
Computer experience	-0.09	-0.17*		0.00	-0.01	
Ability-related differences			0.02			0.03
Gender	-0.11	-0.04		-0.02	-0.01	
Age	-0.10	-0.11		0.12	0.06	
Computer experience	-0.05	-0.07		-0.08	-0.14	

Note. B = Standardized *Beta*. *$p < .05$. **$p < .01$. ***$p < .001$.

related differences may include that (1) Sociocultural concepts and stereotypes differ between the two countries, (2) more prospective teachers in the United State had longer computer experience and thus less likely to stress the role gender plays in working with computers, and (3) more males were presented in the participants from Taiwan than from the United States. As shown in the regression results, females prospective teachers from both groups were less likely to think males do better with computers.

Length of computer use is the predominant factor that determines prospective teachers' perceptions of computers for both groups. The longer they had been using computers, the greater they liked, valued, and felt comfortably with computers. This finding supports previous research that found that increasing computer experience corresponded to more positive attitudes toward computers (Liao, 1995).

Prospective teachers in Taiwan were also tend to believe that working with computer is easier and more enjoyable for high achieving students than low achieving students. Computer experience, however, like age and gender, did not affect prospective teachers' view of ability-related difference. Thus, the difference between prospective teachers in the United States and Taiwan in this regard may be attributed to distinctive educational philosophy, cultural, social, and other variables.

Findings from this cross-national studies have provided information leading to better understanding of teachers' perceptions of computers across countries and identified some universal variables related to prospective teachers' perceptions of computers. For future research, educator may need to (a) examine other factors that are significantly related with prospective teachers' computer perceptions in the United States and Taiwan, (b) include in-service teachers, and (c) include other countries for comparison.

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Factors that Affect Preservice and Inservice Teachers' Learning about Computers

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Many teachers choose to take computer courses for recertification or for advanced degrees as a means for individual enhancement or professional development. However, the teacher-oriented computer application courses offered in teacher education programs are facing various obstacles to meet the inservice or preservice teachers' needs. The most common obstacles are listed below:

- insufficient technology resources are allocated to show teachers what is current in the leading edge computer technology
- incompatible resources are provided for participating teachers as compared with resources used in the school
- inadequate access to computer labs is provided to students in terms of time, resources, etc.
- time spent on computer tasks is insufficient to establish a solid computer literacy background
- students have diverse backgrounds, interests, needs, and skill levels and this makes the computer courses difficult to have a clear focus on specific tasks
- inappropriate hardware and software are provided due to lack of funding for update and maintenance
- insufficient time and resources for faculty to keep current with the emerging technology and provide leadership to school teachers

All these obstacles require the faculty of the teacher education program to take another look at the existing computer courses. Some adjustments are needed for restructuring the technology components in the teacher education programs to address teachers' needs appropriately.

Computer Tasks in the Computer Courses

The content covered in the computer courses taught by the authors include a wide range of computer literacy tasks: 1) knowledge about computer hardware and software, 2) skills of using and exploring programs, 3) ability to apply software features to produce the desired result, and 4) integration of individual elements to develop a large scale project.

To meet students' needs, a wide array of activities are included to address the skills and knowledge. Specifically, these activities are as follows.

- Exploring the Internet (e.g., using the WWW and e-mail)
- Using hypermedia (e.g., recording audio and video segments, creating multimedia elements, preparing images from scanning or screen capturing, organizing a hypermedia presentation)
- Using productivity tools (e.g., creating a document using word processing, spreadsheet, database, and graphics tools)
- Teaching content subjects with computers

Through these computer tasks, students are to establish a solid background for their computer literacy. They should also be able to develop meaningful projects to satisfy practical needs at work, such as producing handouts, writing newsletters, generating reports, and organizing student portfolios.

The computer application classes are structured so that participants are engaged in hands-on activities to gain insights about how computers can be used to improve teachers' efficiency and productivity, and can be integrated into the curriculum. Once the participating teachers became accustomed to the new technology, they would continue to use technology and grow with the future expansion.

A Survey of Factors that Affects Computer Learning

To further examine what may contribute to successful learning for the preservice and inservice teachers, and how to increase their appreciation of computers in education, the researchers administered an informal survey and interviewed with a number of students. This provided a perspective about possible decisive factors and how the students felt these factors affected their computer learning experience in the courses. Descriptive data were collected from 34 undergraduate and 43 graduate students in two semesters. The survey questions contained items concerning students' attitude toward computers, their perception about the learning tasks, instructor's teaching approaches, logistic issues, their preferences, their attitude towards computer application tasks, their access to the computer outside the classroom, student background, and their appreciation of the class. The instructors' evaluation of students' computer performances was used as a reference in the study.

Findings

Novice vs. Experienced computer Users

There is an obvious gap between experienced and novice computer users in all the computer courses. Some students do not even know how to turn on a computer but other students already had extensive professional experiences working with computers, e.g., trouble-shooting, developing computer-related projects, or working as computer consultants. As the semester goes, the "fast" learners may easily feel bored while the "slow" learner are still struggling and seeking help for rudimentary tasks.

Seventeen or about 40% of the inservice teachers were novice computer users, and five or about 15% of the preservice teachers were novice computer users. However, both novice and experienced computer users expressed positive attitudes towards the power of computers and value of using computers in education.

Preservice versus Inservice Students

From the authors' observations of students' computer performance, assumptions were formulated about what students may need. The researchers often make predictions about what computer application topics are useful to students, what difficulties they may encounter, what strategies may work to inspire students to learn more, and so on. Very often, it was found that there were two extremes in the class: some found the learning material too easy and others found it too difficult; some felt the class is exciting and others felt it boring; some considered the learning tasks useful and others considered them useless; some students were very creative in carrying out the computer assignments and others felt at a loss and needed more help; some students appreciated the power of existing instructional software for teaching, and others did not appreciate it as much.

There were a number of differences between preservice and inservice teachers in our computer classes. Most of the preservice teachers were registered in the undergraduate teacher education programs. Most of the inservice students were school teachers registered in the graduate teacher education programs. Most inservice teachers were between 30 and 40 years old. Most preservice teachers were in their early 20's. Most preservice teachers tended to be flexible about what to learn and which platforms to use. Most inservice teachers, to the contrary, prefered to learn things that they could use for their work and preferred to use only the computer platforms that are compatible with their school machines.

Most inservice teachers seemed to have stronger motivation than preservice teachers. They found the computer tasks interesting and useful, and showed higher appreciation of the computer resources and the instructors' efforts. Most preservice teachers, although they could get their computer assignments completed faster than inservice teachers, seemed to lack enthusiasm in their computer tasks.

Inservice teachers also seemed more creative than perservice teachers. The students saw demonstrations of some features of a word processing program for developing newsletters and were shown some examples created with those features. When asked to produce a similar project for the school settings, the majority of the inservice teachers produced a significant project accordingly. The preservice teachers, however, found it difficult and requested more examples and even asked for permission to duplicate in their project the examples provided.

Most Teachers do not Have Concrete Ideas about What Computers Can Do for Them

Most teachers strongly believe that computers can help teachers do a better job. However, when they are asked to name a few things that they think computers can help teachers do better, most teachers fail to make a significant list. Ideally, if the computer learning tasks are linked to what teachers are doing everyday, the learning tasks would become more meaningful and motivating to them. Since most teachers were not able provide a concrete list with items to address in the computer classes, the researchers asked of the question-"What tasks do you do everyday in the school?", instead of another question-"How can computers help with your job?". A list was derived from the practicing teachers' answers to the question. From the teachers' responses, the researchers included task items such as calendars, newsletters, lunch count, memo, grades, database, and searching for electronic resources. These tasks were then recognized by some teachers as the most valuable part of the class.

Understanding the Computer Task Procedures Helps Teachers Master the Tasks

After these teachers were introduced to the basic features of a program, they could accomplish simple tasks as required. However, when they were asked to produce a complex project which involved many simple tasks and features that they had accomplished before, they became anxious and frustrated. Taking graphics as an example, after these teachers had learned how to create basic shapes (such as square, lines, polygons, etc.) with computer drawing tools, they were asked to create a stop sign which involves putting a few different shapes together. Even after the task was demonstrated a few times, many students, especial the older or the inexperienced ones, still felt unclear about how to carry out the project.

To improve such a situation, participating teachers were asked to do some think-through exercises. They worked together in pairs to think (and talk) through the detailed steps to organize a project. After the think-through exercise, the abstraction level for the task was reduced. Most novice users then became more comfortable with the intended tasks and were able to carry out the project by themselves.

Prior Teaching Experience Can Contribute to More Meaningful Learning

Most inservice teachers were older but less experienced with computers than preservice teachers. However, they showed better attitudes toward computer tasks and they came up with good ideas to apply what they learned in the computer class and demonstrated higher appreciation of the possibilities of computers. The preservice students, on the other hand, did not seem to appreciate the computer experience as much, and seemed less creative in applying what they learned to projects in real school settings.

When engaged in some practical tasks for productivity purposes, such as computer supported gradebooks, lunch counts, on-line tests, and monthly calendars, many inservice teachers would express great excitement. For example, one teacher said, "I really appreciate the gradebook. From now on, I am going to put all my students' grades on the computer." Another teacher commented, "Using computer for lunch count is a fantastic idea. It can simplify my daily task so much. I can even have one of my students do it for me." However, most preservice teachers' reactions were not as fervent. They seemed to treat the class tasks just as requirements they needed to fulfill.

The preservice teachers did not have the practical school experience which may be why they did not understand the urgent needs to improve their work with computers compared to the inservice teachers. The inservice teachers' positive attitudes helped contribute to more meaningful learning and higher appreciation about the computer tasks.

It Takes Time and Patience to Master Computer Tasks

The time required for tasks varies. Tasks that take some users ten minutes may require others to spend hours to complete. However, there was no denying that time and practice are the crucial elements for mastering intended computer tasks. In the computer classes, those who did not have access to computers after the class tended to have difficulty keeping up with the rest of the class. Almost all the preservice students had access to the campus computers on a frequent basis. Eleven, or about 25%, of the inservice teachers did not have an easy access at their school and choose not to come to the campus computer lab. These teachers had serious difficulty in keeping up with the class. They were persuaded to secure a computer by purchasing, loaning, or borrowing one. Almost all the teachers agreed that spending sufficient time on the computers was crucial for teachers to consolidate the skills. It was especially true for novice users.

Cooperative Learning is Desirable

Both inservice teachers and preservice teachers enjoyed learning on a computer with their peers. Their peer's good performance could trigger their creativity. Learning in a cooperative (or sometimes competitive) setting was fun. Teachers found the learning tasks challenging and interesting. Novice users felt encouraged when they saw their peer produce quality products. They also developed good rapport with each other through learning with computers.

Detailed Step-by-Step Written Instruction is not Always Necessary

Students learned about computer tasks mostly through hands-on activities. Most teachers learned to use software and trouble-shoot problems via exploration and logical thinking. Only a few teachers tended to rely on the software manuals. As to detailed step-by-step written instructions, most experienced computer users didn't consider it necessary at all. However, novice users, especially the older teachers, who felt nervous about computer tasks, demanded detailed written instruction at the early stage of the computer classes. After they became accustomed to the general features of the computer and had used a few computer programs, they could handle the hands-on tasks without detailed written instructions.

Students' preferences

Below is a list of items that represent students' preference of the desired characteristics in the computer courses.

- Having sufficient time to work on computer tasks on their own
- Being shown good ideas of how to integrate useful features for computer projects
- Learning cooperatively — learning from each other
- Using open-ended software such as storybook maker or simulation programs
- Using hypermedia applications for project development
- Learning at their own paces
- Having hands-on approach to learn about computer programs
- Learning about things that they can do on a computer at home or in the school

Suggestions

Based on the findings in this study, some suggestions about how to construct appropriate approaches for effective computer courses are as follows:

- Provide concrete examples that can address their needs. If the computer tasks can connect to students' daily work, they become more interested.
- Address the tasks which are compatible to the school platforms so that students can carry out the tasks when they return to school.
- Provide practical tasks and challenges to the preservice students to provide insight about what can be done to meet the reality needs in the future.

- Minimize the differences between students by setting pre-requisites for the course so that students can have a similar start.
- Provide a wide variety of activities to satisfy the "fast" students. Provide sufficient challenges to inspire those students who are able to accomplish more.
- Encourage cooperative learning to bridge the gap between novice and experience computer users.
- Encourage students to gain sufficient access and time on computer tasks. Encourage them to acquire their own computer.
- Address issues about how to use computers to become efficient and productive as well as for effective teaching.

Conclusion

Learning about computers is becoming crucial for school teachers. There are many issues that instructors should consider in order to provide better computers courses to address teachers' needs. This paper examine many factors (such as age level, prior computer experience, prior teaching experience, individual learning preferences, access to the computers, etc.) related to meaningful learning of the computer tasks.

From the survey of 77 inservice and preservice teachers, it was concluded that students learn about the computer tasks best through hands-on activities, cooperation from peers, sufficient time for practice, adequate models/examples, appropriate procedures to analyze and to synthesize information for projects. The computer course should provide a meaningful experience for teachers so that they can continue to grow in the future. To improve educators' computer literacy and to prepare them to use computers for productivity and for content area instruction, the technology courses offered should address the teachers' practical needs. The hardware and software selected should be compatible with the school settings. The contents and tasks covered in the course should be made useful for teachers' daily work. Once teachers learned how easy and practical technology can be to their work, they would continue to use them.

In this study, it was learned that inservice teachers hold stronger motivation and more positive attitudes and appreciation towards computer tasks than the preservice students. This suggests that the preservice students' lack of real classroom experience and practical needs to apply computers in the school settings may explain why they don't perform and appreciate as well as the inservice students. Teachers can learn to use computers better if they can relate their learning experiences to their work. The practical experiences of the inservice students should be used to provide the insights to the inexperienced preservice students. Thus, the computer components for teacher productivity and effective teaching should be incorporated into various stages of students' field and clinical experiences.

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Gender Differences in Preservice Teachers' Computer and Internet Attitudes

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Educators at all levels are rushing to integrate computers into instruction. While there are exciting and appealing applications, we must be careful to assure that these activities are equally appropriate for male and female students. It is important to consider the computer in the context of the content, the pedagogy, and the characteristics of the students to be taught. There is a need for more research examining teachers' attitudes toward computers and the use of computers in their classrooms.

Equity issues have received considerable attention in the research in recent years. The differences between male and female students in mathematics, science and technology are long-standing and well-documented. Identifying the causes and solutions to these problems is more problematic. Males typically have more experiences with computers and more positive attitudes toward technology and they continue to outperform females on computer skills (Grossman & Grossman, 1994). Research has identified the background of this male-dominance as including computer experience and computer course-taking (Arch & Cummins, 1989; Levin & Gordon, 1989; Martin, Heller & Mahmoud, 1992; Massoud, 1991).

Studies have found gender differences in attitudes, defined as being more confident, having less anxiety, having a higher self efficacy, liking computers more, or having more interest in computers. In a study of 902 boys and 828 girls in high school, Shashaani (1994) reported more boys than girls intended to take addtional computer classes, 35% to 20% respectively. In the same study, on a scale of 1 to 5, with a higher score meaning a higher interest, boys scored a 4.1 and girls a 2.6. Two studies (Busch, 1995; Colley, Gale & Harris, 1994) found that males not only had lower computer anxiety, but also higher computer confidence and greater liking of computers than did females. Therefore, because females do not get encouragement from their friends, they do not see their mothers as equal computer role models, their computer teachers are mainly males and the computer software they use is predominantly masculine, the typical female attitude toward computers is not positive (McGrath, Thurston, McLellan, Stone & Tischhauser, 1992).

It is important to consider the attitudes of teachers who will interact with male and female students as they learn about computers. There are pervasive stereotypical beliefs that computers are more appropriate for males than females (Grossman & Grossman, 1994). This attitude is particularly dangerous when held by teachers because it influences their interactions with students. In part, students learn their attitudes toward computers from their teachers (Fennema, 1990). Sanders (1995) writes that teachers' inadvertent biased behavior lowers girls' achievement, aspirations, and persistence in computing. Similarly, girls need female role models who enjoy working with computers. Only when teachers are competent and comfortable working with computers can they model behavior that will empower their female as well as male students (Campbell, 1995).

Hakkinen (1994) evaluated how a computer course affected the anxiety level, computer attitude, and feelings about computers of 29 first-year education majors (25 females and 4 males). Results indicated that as familiarity with the computer increased, computer anxiety levels decreased and attitudes improved. A related study compared education students in a computer course with a control group (McInerney, McInerney & Sinclair, 1994). The students who had taken the computer course had lower anxiety scores and higher self-perceived ability than those who had not.

Okinaka (1992) provided information on teachers' attitudes toward computer use and examined gender differences. The 92 education students in the study reported some prior computer use, but most were not regular computer users. However, most of them felt confident using the computer in the classroom, even with limited experience. Males and females did not differ on attitude issues except on the measure of pursuing further computing courses. Males were significantly more interested in taking additional computer courses than females.

Even though there is considerable research on computer attitudes, there is not yet evidence of attitudes toward the internet. Additionally, there is a need for additional information about computer and internet attitudes of male and female teachers.

Methods

The purpose of this study was to investigate male and female preservice teachers' attitudes toward computers, toward the internet, and toward computer and internet use in the classroom. These attitudes included personal attitudes and also the application of those attitudes to teaching situations. The study examined the computer attitudes of thirty-six preservice secondary education students before and after an intensive three-week computer course. Further, these attitudes were studied in relationship to gender, major, and prior computer experience.

The pretest and posttest included a semantic differential section which was divided into three specific questions. The students were asked how they felt about (1) computers, (2) the Internet, and (3) using computers in their classroom (See Figure 1). The test also asked other relevant questions, including self-reports of proficiency and likelihood of use of computers in teaching.

ATTITUDE ABOUT COMPUTERS

Please mark an X on the line which closest indicates your choice

How do you feel about computers?

Nervous___:___:___:___:___Confident
Good___:___:___:___:___Bad
Hard___:___:___:___:___Easy
Uninterested___:___:___:___:___Excited
Important___:___:___:___:___Unimportant

How do you feel about the internet?

Nervous___:___:___:___:___Confident
Good___:___:___:___:___Bad
Hard___:___:___:___:___Easy
Uninterested___:___:___:___:___Excited
Important___:___:___:___:___Unimportant

How do you feel about using the computer in your classroom?

Nervous___:___:___:___:___Confident
Good___:___:___:___:___Bad
Hard___:___:___:___:___Easy
Uninterested___:___:___:___:___Excited
Important___:___:___:___:___Unimportant

COMPUTER EXPERIENCE

On a scale of 1-10, one being very little, how proficient are you in using a computer? _____

2. On a scale of 1-10, one being not likely, how likely are you to use a computer in your teaching, if they are available? _____

Figure 1. Post Computer Questionnaire

The required computer course was taught in a computer lab by an experienced computer instructor. Topics included graphics, word processing, database, spreadsheet, presentation program, location of internet resources, lesson planning integrating internet resources, and construction of a personal internet homepage. Ten assignments were required:

Graphics Handout. A one-page handout for use with high school students, prepared with *KidPix*.

Abstracts. Read two current journal articles, one dealing with general computer education issues, and one dealing with your particular discipline. Each one-page abstract must be word processed and include a reference in APA format, a one paragraph summary, and a one paragraph reaction.

Email. Send an email message to the instructor, talking about feelings about the use of computers in teaching.

Newsgroup. Locate one newsgroup related to teaching. Read at least 10 posts and summarize (one page) the topic.

WebSites. Locate ten WWW sites that could be used in secondary teaching of your subject. Record URL, Title, Subject, Description, and Teaching Idea in the class data base (*ClarisWorks)*.

Lesson Plan. Plan a complete lesson in your subject area which requires students to use the WWW as an integral part of the lesson.

Gradebook. Set up a gradebook on a spreadsheet (*ClarisWorks)*.

Group Presentation. In randomly assigned groups of 3-4, choose some aspect of social issues of computer use, and prepare and present to class using *PowerPoint*.

WebPage. Design and publish a personal homepage, including text, graphics, and links.

Quiz. Computer vocabulary.

Following this treatment, the posttest was given to all participants, and the data were analyzed.

Results and Conclusions

Results revealed that 26 of 36 students owned a computer, 82% of females (24 of 29) and 29% of males (2 of 7). Females reported a slightly higher number of average hours per week of prior computer use than the males, but the difference was not significant ($t(32) = 0.561, p > .05$). This data may be affected by the disproportionate numbers of males and females in the sample. Of the 36 students, only 7 were male. While these numbers are somewhat representative of gender proportions in the teaching profession, the small number of males in the sample opens up the question of whether this small sample is representative.

Three different attitudes were examined: attitudes toward computers, attitudes toward the internet, and attitudes toward the use of computers in the classroom. After the three-week class, students showed positive increases in all three aspects of attitudes. There were significant increases in attitudes toward computers ($F(1,32) = 4.630, p < .05$) and in attitudes toward the internet computers ($F(1,32) = 7.597$, $p < .05$). There was a positive, but nonsignificant, improvement in attitude toward use of computers in the classroom computers ($F(1,32) = 1.053, p > .05$). There were no gender differences in attitude, either before or after the treatment. See Tables 1, 2 and 3. This suggests that the experience in the class was positive, and improved the attitudes of the preservice teachers. However, there was no differential improvement for males and females.

Table 1.
Analysis of Variance for Attitude Toward Computers

Source	df	F	p
Gender	1	3.110	.082
Pre/Post	1	4.630	.035*
Interaction	1	0.320	.573

*p < .05

Table 2.
Analysis of Variance for Attitude Toward the Internet

Source	df	F	p
Gender	1	1.000	.321
Pre/Post	1	7.597	.007*
Interaction	1	0.767	.384

*p < .05

Table 3.
Analysis of Variance for Attitude Toward Use of Computers in the Classroom

Source	df	F	p
Gender	1	1.645	.204
Pre/Post	1	1.053	.309
Interaction	1	1.053	.309

*all n.s.

Table 4.
Analysis of Variance for Self-Reported Computer Proficiency

Source	df	F	p
Gender	1	0.742	.392
Pre/Post	1	5.310	.024*
Interaction	1	0.006	.939

*p < .05

The self report of computer proficiency for the total group was significantly increased after the class, and there were no gender differences. See Table 4. After the treatment, the students' reported likelihood of using a computer in the classroom was slightly higher for females, though this difference was not significant ($t(7) = 1.206, p > .05$). This difference may have been partially due to the differences in major for the males and females. The seven males were all either mathematics or social studies majors, and the computer may have more appeal for these subjects than for the larger number of females in English, science, and second languages.

Implications

This study found that after an introductory technology course, both female and male preservice teachers showed a significant increase in positive attitude toward computers. Even though further study is recommended to explore the causes and treatments of gender differences, these results support the inclusion of an extensive technology course as a means to improve attitudes of all students toward computers.

1. In addition to providing positive computer experiences for preservice teacher, Jo Sanders provides seven principles for educators to help counteract the "computing is male" message sent to girls.
2. Teach technology as a tool to solve real-life problems rather than as a glitzy toy.
3. Do not permit sexist materials, "jokes," or behavior in your classroom, ever.
4. Notice the girls who hang back and pull them in, and make sure that girls take their turns at more than keyboarding and note taking.
5. Encourage girls to participate in friendship groups at the computer.
6. Eliminate biased teaching behaviors you may have by becoming conscious of them.
7. Make a point of praising girls for real achievements and urging them to develop their skills further. Urge the especially talented ones to consider careers in technology.
8. Be aware of little, picky, trivial things and keep them from adding up. Teach your colleagues how to recognize them too (Sanders, 1995, p.157).

In conclusion, our world is a world of computers. The internet is a key component of that world. In order to be sure that our students, both female and male, are successful in this computer world, all teachers <u>must</u> become confident and competent computer and internet users.

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Internal Consistency Reliabilities for 14 Computer Attitude Scales

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A compendium of 14 previously-published instruments for assessing teachers' attitudes toward computers was administered to 621 educators in Texas, Florida, New York, and California during 1995-96. A total of 284 items extracted from 14 previously-published instruments, and falling on 32 Likert subscales, were included on the instrument entitled the Teachers' Attitude Toward Computers Questionnaire (TAC). Since many of the subscales were a decade old, one initial question to be resolved was whether the scales as originally published were still reliable. This paper focuses on that question.

Positive teacher attitudes toward computers are widely recognized as a necessary condition for effective use of information technology in the classroom (Woodrow, 1992). At least fourteen instruments with acceptable measurement properties have been reported in the literature over the past decade (Woodrow, 1991; Chu & Spires, 1991; D'Souza, 1992; Francis, 1993; Gardner et. al, 1993; Kay, 1993; Knezek & Miyashita 1994; Pelgrum, Janssen Reinen & Plomp, 1993; Loyd & Gressard, 1984). This paper contains a description of how well each instrument measures what it claims to assess. The question is addressed for three related groups, notably: a) preservice teachers, b) practicing K-12 teachers, and c) teacher educators.

Instrumentation

The Teachers Attitudes Toward Computers Questionnaire (TAC) was used for this research. It is a 10-part composite instrument including 284 items spanning 32 Likert subscales. The following 14 computer attitude questionnaires contributed to the TAC:

Computer Attitude Scale (Gressard and Loyd, 1986)
- •confidence, liking, anxiety, and usefulness

The Computer Use Questionnaire (Griswold, 1983)
- •awareness

Attitudes Toward Computers Scale (Reece & Gable, 1982)
- •general attitudes toward computers

The Computer Survey Scale (Stevens, 1982)
- •efficacy and anxiety

Computer Anxiety Rating Scale (CARS) (Heinssen, et al.,1987)
- •technical capability, appeal of learning and using computers, being controlled by computers, learning computer skills, traits to overcome anxiety

ATC (Attitudes Toward Computers) (Raub, 1981)
- •computer usage, computer appreciation, societal impact

CAIN (Computer Anxiety Index) (Maurer & Simonson, 1983)
- •examines avoidance of, negative attitudes toward, caution with, and disinterest in computers (anxiety and comfort)

BELCAT (Blombert-Erickson-Lowery Computer Attitude Task) (Erickson, 1987)
- •attitudes toward learning about computers and towards computers themselves

Attitude Toward Computer Scale (Francis, 1993)
- •affective domain

Computer Attitude Measure (CAM) (Kay, 1993)
- •cognitive (student, personal, general), affective, behavioral (classroom and home), and perceived control components of computer attitudes

Computer Attitude Questionnaire (CAQ) (Knezek & Miyashita, 1993)
- •computer importance, computer enjoyment, computer anxiety, computer seclusion

Computer Attitude Items (Pelgrum, Reinen, & Plomp, 1993)
- •computer relevance, computer enjoyment

Computer Attitudes Scale for Secondary Students (CASS) (Jones & Clarke, 1994)
- •cognitive, affective and behavioral attitudes

E-Mail (D'Souza, 1992)
- •attitudes toward e-mail

Results

Table 1 lists the name, place of origin, 1995-96 combined internal consistency reliability and alpha by K-12 teacher, preservice teacher, and teacher educator group, plus the original reliability (if published) for 32 Likert subscales included on the TAC. Results indicate that most of the attitudinal subscales that were originally strong have held up well over time. However, there are notable exceptions, such as the widely-used Loyd & Gressard Confidence subscale, with an internal consistency reliability of .86 reported in 1986, but an average alpha of .75 (which is still respectable) in 1995-96.

Several lesser-known attitudinal subscales would appear to warrant wider use. Examples are Email, CAM, ENJ, KT, Anxiety, and CASA, all of which exhibit high internal consistency reliability across the three groups examined, and each of which includes no more than 11 items. The items for these 6 subscales are listed in the Appendix. A rank ordering of the top 9 subscales independent of number of items used, is provided in Table 2.

Table 1.
Internal consistency reliabilities for 32 TAC subscales

Scale	#items	Combined n=621	K-12 tchrs n=436	Preservice n=34	Faculty	Average	Original
I (Knezek & Miyashita Importance)	7	.81	.84	.77	.67	.76	.82#
J (Knezek & Miyashita Enjoyment)	9	.84	.87	.81	.60	.76	.82#
Anxiety (Knezek & Miyashita Enjoyment)	8	.91	.91	.91	.85	.89	.84#
CAM (Computer Attitude Measure)	10	.93	.93	.92	.95	.93	.88~
CASA (Loyd & Gressard Anxiety)	9	.91	.91	.91	.84	.89	.80* .90^
CASC (Loyd & Gressard Confidence)	10	.81	.81	.70	.75	.75	.86* .89^
CASL (Loyd & Gressard Liking)	10	.89	.90	.85	.86	.87	.85* .89^
CASU (Loyd & Gressard Usefulness)	10	.85	.85	.81	.77	.81	.82^
REL (Pelgrum & Plomp Relevance)	7	.81	.81	.79	.81	.80	.64□
ENJ (Pelgrum & Plomp Enjoyment)	9	.89	.88	.88	.94	.90	.73□
CA (Computer Anxiety)	20	.95	.95	.94	.95	.95	
U (Utility)	7	.87	.88	.82	.74	.81	
MD (Male Domain)	6	.78	.78	.79	.89	.82	
S (Success)	4	.78	.77	.79	.85	.80	
NI (Negative Impact)	6	.77	.77	.79	.72	.76	
MOT (Motivation)	4	.82	.82		.81	.81	.81
PI (Productivity Importance)	4	.87	.88	.81	.86	.85	
CUQ (Computer Use Questionnaire)	14	.72	.73	.65	.77	.72	.66*
CSS (Computer Survey Scale)	8	.73	.75	.63	.61	.66	.56*
ATC (Francis Attitude Toward Computers)	16	.91	.92	.90	.90	.91	.96½
KS (Kay CAM Student)	5	.87	.89	.77	.88	.85	.73~
KT (Kay CAM Teacher)	5	.91	.93	.87	.86	.89	.77~
CARSA (Technical Capability)	6	.73	.74	.68	.67	.70	
CARSB (Appeal of learning about using computers)	4	.82	.85	.74	.56	.72	
CARSC (Being controlled by computers)	3	.59	.60	.49	.57	.55	
CARSD (Learning computer skills)	3	.68	.71	.61	.44	.59	
CARSE (Traits to overcome anxiety)	2	.46	.50	.32	.58	.47	
CASSA (Affective)	15	.94	.94	.93	.93	.93	.95"
CASSB (Behavioral)	10	.79	.79	.81	.81	.80	.71"
CASSC (Cognitive)	14	.69	.70	.63	.60	.64	.88"
ATCS (Raub Attitude Toward Computer Scale)	8	.87	.88	.86	.87	.87	.87
EMAIL	11	.95	.96	.94	.92	.94	.81'

**Woodrow, 1992 ^Loyd & Gressard, 1986 #Knezek & Miyashita, 1994 "Jones & Clarke, 1994 ~Kay, 1993 'D'Souza, 1992 ½Francis, 1993 □Pelgrum & Plomp, 1993*

Table 2.
Top Nine of 32 Attitudinal Scales

Scale	Avg. Alpha	#items
CA	.95	20
Email	.94	11
CAM	.93	10
CASSA	.93	15
ATC	.91	16
ENJ	.90	9
KT	.89	5
Anxiety	.89	8
CASA	.89	9

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Appendix

EMAIL subscale
from D'Souza, 1992

1. Email is an effective means of disseminating class information and assignments.
2. I prefer Email to traditional class handouts as an information disseminator.
3. More courses should use Email to disseminate class information and assignments.
4. Email provides better access to the instructor.
5. The use of Email creates more interaction between students enrolled in the course.
6. The use of Email creates more interaction between student and instructor.
7. The use of Email increases motivation for the course.
8. The use of Email makes the course more interesting.
9. The use of Email makes the student feel more involved.
10. The use of Email helps the student to learn more.

11. The use of Email helps provide a better learning experience.

CAM subscale
from The Computer Attitude Measure (CAM), Kay, 1993

Computers are:
1. Unlikable _ _ _ _ _ _ _ Likable
2. Unhappy _ _ _ _ _ _ _ Happy
3. Bad _ _ _ _ _ _ _ Good
4. Unpleasant _ _ _ _ _ _ _ Pleasant
5. Tense _ _ _ _ _ _ _ Calm
6. Uncomfortable _ _ _ _ _ _ _ Comfortable
7. Artificial _ _ _ _ _ _ _ Natural
8. Empty _ _ _ _ _ _ _ Full
9. Dull _ _ _ _ _ _ _ Exciting
10. Suffocating _ _ _ _ _ _ _ Fresh

ENJ subscale
from Pelgrum & Plomp, 1989
1. I like to talk to others about computers.
2. Computers can be exciting.
3. I like reading about computers.
4. A job using computers would be very interesting.
5. Computer lessons are a favorite subject for me.
6. I want to learn a lot about computers.
7. I like to scan computer journals.
8. When I pass a computer shop, usually I stop for a while.
9. Computers interest me little.

KT subscale from CAM, Kay, 1993
1. Computers would help me organize my work.
2. Computers would increase my productivity.
3. Computers would save me time.
4. Computers would help me learn.
5. Computers would help me organize my finances.

Anxiety subscale
from Computer Attitude Questionnaire, Knezek & Miyashita, 1994
1. I think that it takes a long time to finish when I use a computer.
2. I think that computers are very easy to use.
3. I get a sinking feeling when I think of trying to use a computer.
4. Working with a computer makes me very nervous.
5. Using a computer is very frustrating.
6. I will do as little work with computers as possible.
7. Computers are difficult to use.
8. Computers do not scare me at all.

CASA subscale
from Computer Attitude Scale, Loyd & Gressard, 1984
1. Computers do not scare me at all.
2. Working with a computer would make me very nervous.
3. I do not feel threatened when others talk about computers.
4. I feel aggressive and hostile toward computers.
5. It wouldn't bother me at all to take computer courses.
6. I would feel at ease in a computer class.
7. I get a sinking feeling when I think of trying to use a computer.
8. I would feel comfortable working with a computer.
9. Computers make me feel uneasy and confused.

Putting Educational Technology in Perspective: The Question of Learning Effectiveness

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In today's information-driven society, the call for resources required to maintain the impetus of technological use receives much attention. This is no less evident in the realm of education, where significant effort (time and cost) is invested in identifying and bringing to the arena the latest in technology-based products for application in the instruction/ learning process — educational technology.

Educational technology has historically played a central role in the delivery of instruction in the classroom. Over the years, teachers have used books, televisions, projectors, and many types of lab equipment as tools to help them transfer knowledge to their students (Hawkins, 1993). In the past decade, computers have been added to teacher's technology toolbox. Like no other technology, it has been able to capture the imagination of educators. Today, computers can be frequently found in classrooms and laboratories throughout our schools, colleges, and other educational and training institutions.

In the classroom, the applications of computers have evolved from the provision of drill and practice for remediation, to later providing structured curriculum and instruction. Today, the computer is often used for knowledge explorations and construction (Jonassen, 1993). On the technological front, during the past decade, the computer has evolved from being a command-line instructional machine. Graphical and friendlier user interfaces have made human-computer interaction much easier and more effective.

Today, computers inexpensively and easily provide highly interactive multimedia information (text, sound, images, and video) to its users. Furthermore, these interactive multimedia systems may now be programmed to deliver hypermedia — multimedia information stored in networks of nodes connected by links (Dede, 1992). These systems come in a variety of formats (CD-ROM, authoring software, etc.). However, the most popular hypermedia technology within many educational institutions is the Internet's World Wide Web. The wide reach of the Internet network (global in scope), coupled with the multimedia capabilities of the computers it interconnects, have made the World Wide Web a truly international and highly distributed hypermedia system. Today, the Web is increasingly being used for a multitude of educational applications, most notably "distance learning".

The above technological capabilities have not come cheap. Recently published analysis of key U.S. Department of Education national studies reveal that:

- In the 1994-1995 school year, schools spent approximately \$3.3 billion on educational technology.
- Today, there are an estimated 5.8 million computers for instructional use, approximately one computer for every nine students.
- Between 1989 and 1992 alone, K-12 schools increased their computer inventory by nearly 50%, jumping from 2.4 million units to 3.5 million units.

It is worthwhile to note that the above numbers are for basic educational institutions only (K-12), and do not include investments made by higher-educational institutions (Fulton, 1996).

However, after more than a decade of significant technology investments by America's schools (as described above), many educational administrators and policy-makers are asking the questions, "Do computers and other related technologies make a difference in learning? Do they improve achievement and performance scores?" The brief answer to these questions, based on scientific research, seem to be mixed and inconclusive. Many reasons are given as to why this is the case. Some researchers claim that evaluation of educational technology effectiveness is not easily captured by the use of current standardized tests (Hawkins 1993, Rockman, 1993). Still others claim that a major reason why educational technology has not had a more positive effect on learning outcomes is that appropriate staff development has not taken place (Fulton, 1996).

On campuses of all levels today, the cry is for more money to support the investment in technology. The resultant investments are often made at the expense of other resources. There is an obvious economic trade-off required by the sharing of limited resources, in this case funding for other educational initiatives. This trade-off, currently weighed towards technology, is often supported by bodies oblivious to their applications and use in their particular domains. Regardless of the reasons why, as we approach a second decade of educational technology applications and infusion, it is important to pause and assess the research focus (or lack of) presently given to educational technology effectiveness by the academic community.

Research Question

In this paper, we attempt to question the research associated with the adoption of technology in the educational environment based on the question of learning effectiveness, and the degree to which this effectiveness issue has been demonstrated in technology adoption. In the context of this analysis, we define educational technology research in a broader scope as not only including the latest hardware, but also the various software products being made available for the classroom, along with the various research studies undertaken to develop the environments of teaching and learning.

We also look at the use of technology in the context of providing a communication channel or conduit for the dissemination of the educational process. This is distinguished from the use of technology as a "subject matter" or course content (i.e., technology education). We are interested in the effectiveness of technology as a substitute, or partial substitute for traditional teaching/learning methods.

We question the outright adoption and acceptance of technology, and the associated expenditures, based on current research results in this domain. We present a meta-analysis of the research literature in the domain of educational technology. We classify the literature according to their research content. Content areas identified are as follows: Technology, Analysis & Applications, Design, Implementation, Educational Issues, Instructional Process Evaluation, and Learning Performance Evaluation.

Our intent is to identify the weighting and attention given by the research community to the last classification item (Learning Performance Evaluation). Classifications reflect the visibility and work accomplished on testing, measuring, and comparing results from differing educational delivery channels which incorporate technology. Furthermore, we identify the emphasis within these classifications by addressing research concerned with high-level educational outcomes, versus those associated with specific variables within these high-level models. The study is a review of nine major educational technology journal publications, spanning the last three-year time period, and includes the classification of almost one-thousand articles.

Our paper includes the results of this meta-analysis indicating the breakdown of publication content into the specified research categories. We intend to investigate the percentage of work that is directed at measuring the learning effectiveness with technology as it is currently used or is proposed to be used, and contrast this with the acceptance of technology adoption. Furthermore, we test the content of that limited amount of research concentrating on learning outcomes measurements by identifying those subcomponents that address high-level variables versus domain-specific model variables. Lastly, weaknesses in present technology adoption decisions are discussed, along with a call for an increased emphasis on learning outcomes and/or development of more effective educational measurements.

It is our intention that the results of this study will stimulate discussion of this issue among all parties involved in education and educational delivery systems, including all levels of academia as well as educational institutions and private corporations. This includes administrators as well as private practitioners and policy-makers, since the issues raised pertain not only to the application of educational technology, but also to the policy issues addressed at the highest levels of decision-making.

Research and Data

Our research was derived from a review of nine major refereed journals addressing technology in education. We attempted to cover a consecutive three year time span for each journal. Consequently, the dates covered by the review range from 1991 through summer 1996, due to the availability of the articles and journals. This resulted in a review of 932 individual journal articles. The journals reviewed were:

Journal of Educational Technology Systems
Computers and Education
Journal of Research on Computing in Education
Computers in the Schools
Educational Technology
Educational Technology Research and Development
International Journal of Instructional Media
Journal of Educational Computing Research
Journal of Research on Computing in Education

Each article was reviewed and categorized according to its major content. The categories used were developed from the framework used for classifying papers by the Association for the Advancement of Computing in Education (AACE) at the Ed-Media & Ed-Telecom, 1996 Conference. Our intent was to identify the percentage of journal articles that specifically addressed the impact on *learning outcomes* of a particular technology or combination of technologies. The categories used for classifying the articles were:

Technology (TEC): explanations and introduction of new and developing technologies (as distinguished from application development - see APP below).

Applications (APP): applications of technology including analysis of applications.

Development (DEV): development of educational technology design methods including evaluation of methodologies, models, guidelines, frameworks and taxonomies.

Implementation (IMP): implementation of educational technology including case studies, organizational, management, and personnel issues (e.g. gender, minority, age issues).

Pedagogy (PED): discussion of pedagogical, learning and other issues.

Evaluation of instructional process (EIP): quantitative and qualitative assessment of instructional processes and outcomes.

Evaluation of learning and performance outcomes (ELO): quantitative and qualitative assessment of affective, cognitive and physiological outcomes.

The final category listed above (ELO) was the category of interest. In addition to the broad analysis, we further subdivided the articles in the category of interest, "evaluation of learning outcomes", into two further subcategories, quantitative and qualitative. This was done in an attempt to further quantify the empirical research being undertaken, and to identify specifically that percentage directed at learning outcomes from the use of educational technologies.

Table 1.
Distribution of Articles by Category

	Number	Percentage
Technology	22	2.4
Applications	183	19.6
Development	175	18.8
Implementation	150	16.1
Pedagogy	132	14.1
Eval. of instructional process	82	8.8
Eval. of leaming outcomes	188	20.2

Our overall strategy was to gage the research effort being applied to assessing learning outcomes from the application of technology and make some comparison against the level of expenditures in this area. This was to provide us with a basis for raising questions and/or answers as to the applicability of the groundswell of support for technology in education. To achieve this, we conducted a meta-study of the literature to identify what percentage of research, and potentially the types of research, that support the adoption of technology. We hypothesized that there exists a lack of significant research to substantiate the level of technology expenditures and adoption.

We observe from the results in Table 1 above that 20% of the research is directed at identifying the learning outcomes derived from utilizing technology in education. While this may seem like a significant proportion, we compare this with over 50% which is directed at developing methodologies, applications and installing those same technologies. Additionally, when we further investigate the research category aimed specifically at learning outcomes (Table 2), we find that approximately 20% of this research is subjective (qualitative). When this percentage is applied back to the original analysis, we estimate that only 16% (78.8 * 20.2) of work is of a quantitative and objective nature.

Table 2.
Distribution of Articles within the "Evaluation of learning outcomes" Category

	#	%
Eval. of learning outcomes - qualitative	38	20.2
Eval. of learning outcomes - quantitative	150	78.8

One additional issue to consider in the questions raised here is not fully documented from our review, but is added in terms of subjective observation; much of the quantitative research is aimed at specific channels of technology and very specific content domains. For example, empirical studies included measurements of attitudes towards technology in particular disciplines; the effects of computers on anxiety; the addition of computer-aided instruction (CAI) to traditional delivery methods; measurements of communications among students using E-mail. While studies such as these have their place in the research arena, and individually can be considered aspects of the learning process, they add little when questions are raised regarding the cost/benefits associated with the massive expenditures on educational technology when compared with student achievement. In summary we conclude that approximately only 16% of total research being published is associated with quantitative documentation of learning outcomes and achievement, which we deem the *effectiveness* of the technologies being adopted. Our observations suggest that approximately 5% of total research is conducted using formal methods such as control groups with *comparative* learning outcomes (i.e. experimental).

Conclusion

When we consider the broader issues of the learning effectiveness of technology, we see a large discrepancy between the scale on which the expenditures are being made and the level at which the research is being conducted. To a large extent, the expenditures and adoption of technology are discussed at a policy level whereas the research being conducted is at an individual variable level. Our point here is that the research is not of a sufficiently high (complex) and formal level to support conclusions being made by technology adopters when learning outcomes are considered.

What are the implications of this? The answer probably lies in the perspective from which education is viewed, and possibly what position is held regarding the future of education and the direction in which education delivery should take. Perhaps the first issues to be raised must the purpose and definition of education. Whatever they may be, we believe that the level of student achievement and learning outcomes are of central importance. Many argue, already, that the quality of U.S. education received at any level has already declined, not only with respect to historical levels, but also with respect to other nations, worldwide. Surely then, it is incumbent on the education system to establish that future delivery methods provide some added value without possibly contributing to any further decline.

Certainly many questions surround the quality and methodologies of current education. The answers to these questions tend to be in the form of intuitive expressions from individuals, and work which supports those answers tends to be in qualitative form with little formal research support. We emphasize here the distinction of formal research directed at learning outcomes from other types of assessment concerning technology adoption. Many individuals, groups and institutions claim quantitative support for adoption of various technologies. However, these tend to be in the form of superficial assessments indicating little more than satisfaction for the delivery channel used, and again provide little input to the question of "technology effectiveness".

In response to these issues we maintain that a missing component is the establishment of research agendas utilizing formal experimental methodologies. We argue that we must be able to demonstrate that quantifiable learning outcomes can be achieved and sustained through technology adoption. This can only be established through research methodologies. It is reasonable to expect "educational technology delivery" models, with recognized variables (e.g. delivery channels, content types, etc.) and quantifiable dependents (learning outcomes).

With this lack of a formal and quantifiable approach to the introduction of technology, few if any measures or guidelines exist which help in distinguishing which types of technological delivery channels are suitable and effective for the various contents found at differing levels of education. If indeed, there is no formal support for the various technologies, is it not valid to question the expenditures of resources on the scale on which we are progressing? Is it not also valid to question the motivation for these expenditures if the motivation is coming from a source other than educational learning outcomes? Should we compromise outcomes (however defined) for the sake of other factors and if so, do we have, as educators, some obligation to make this fact apparent to all interested stakeholders (students, employers, parents, teachers, etc.)?

The questions of technology's' place in education are not new. Apple (1991) has previously stated:

> Whose idea of progress? Progress for what? And fundamentally, who benefits? These questions may seem rather weighty ones to be asking about schools and the curricular and teaching practices that now go on in them or are being proposed. Yet, we are in the midst of one of those many educational bandwagons that governments, industry, and others so like to ride. This wagon is pulled in the direction of a technological workplace, and carries with it a heavy load of computers. (Apple, 1991, p. 59)

While Apple goes on to discuss the potential social impact resulting from the adoption of technology, our aim is to question the foundation on which these initial technology adoption decisions are based. Our work raises questions regarding the quantifiable support for the adoption of technology in educational delivery when considered from a learning outcomes perspective. Our preliminary data indicates that this support does not exist to the extent that justifies our expenditures and adoption strategies. Ultimately, we believe that technology must be appropriately combined with content to provide the most cost effective combinations for delivery. These combinations will be driven by a number of different factors which themselves have various combinations; but we can find little evidence that the cost/effectiveness of combinations is being addressed in any formal and acceptable research agenda.

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CONCEPTUAL SOFTWARE IN HYPERMEDIA ENVIRONMENT - COOPERATIVE LEARNING IN ELECTRONIC DISTANCE EDUCATION (EDE)

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In the electronic distance education approach described in this paper, the emphasis is on developing a more interactive interface for smoother communications among humans and computers by introducing the concept of hypermedia and a pen tablet similar to conventional pen and paper most people are comfortable using. This enables the realisation of bidirectional cooperative learning in an easier manner and is expected to remove the boundaries between learning and teaching.

Regardless of the arrival of the information age, most of educational systems are based on the indoctrination method. This is derived from both the curricula (as exemplified by the concept of *way of* or *doh* in Japanese) and from the conventional one-sided information giving (knowledge imparting) in education. However, as the end of this century approaches, a wide range of philosophies, concepts, and paradigms are being reviewed in educational systems, both as frameworks for evaluating the current situation and as frameworks for thinking about future prospects. A number of frameworks have significant implications for a very important question that is increasingly relevant when the use of technology in education is discussed: How can an electronic community be realised in a stricter sense so that it overcomes space-time dimensions?

Computer Media and Education

The author has studied electronics from a variety of angles in areas such as computer graphics (Hosaka,1974), computer architecture, Very Large Scale Integration (VLSI) semiconductors, Fifth-Generation Computer Systems (FGCS) for knowledge information processing, multimedia technologies in research and development, and science education. So far, many advantages in using electronics have been discussed for educational applications. Moreover, not only companies, research laboratories and universities, but in Japan various schools are already equipped with advanced personal computers for higher training and education and for elementary/middle education. However, it cannot be said that we are maximising the use of electronics in our daily life. One of the main reasons for this is the communication interface between humans and computers. In short, most people are reluctant to use personal computers even if a Graphical User Interface (GUI) is introduced. For computers to become a part of our daily life, the widespread distribution of such personal computers to offices and private homes is required. It is more important, however, to be able to maximise their use in a similar fashion as other conventional electronic equipment. The same applies to wider use in education. In fact, some investigators in Japan believe that the Japanese are not so adept in using the current personal computers as our European and American counterparts are, especially in the educational area.

Basic Schemes

In this research, the emphasis is on achieving a more interactive interface in order to improve communications between humans and computers by introducing the hypermedia concept and a pen tablet similar to conventional pen and paper which are frequently used without reluctance. Since computer graphics was initially advocated here in the 1960s (Hosaka,1974), interactive technologies have been researched and developed for various kinds of educational situations (Kommers,1993; Ichiko,Yamamoto & Hanano,1994). Especially in educational environments it should be noted that one of the most important matters to be improved is communication. Both learners and teachers need ways to share their mutual information space through more convenient individual communication-channels. Information space sharing involves interaction based on many types of personal knowledge such as experience, expertise, and even wisdom. Cooperative learning environments which are oriented toward multimedia computing are expected to be one of the most feasible solutions. From this point of view the author has been studying electronic distance education

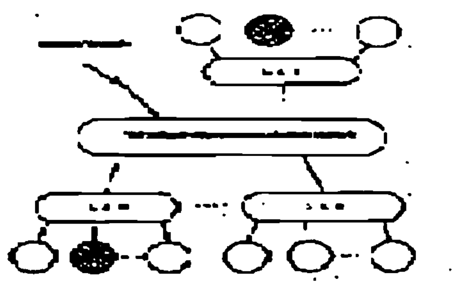

Figure 1. Interactive Communications Network for Multimedia Computing

environments that incorporate easy-to-use communications tools. Educational hypermedia means hypertexts with multimedia databases. Figure 1. shows an example of the overall final environment. The individual circles represent personal participants (learners and/or teachers). Here, the scale of the environment can be assumed to be flexibly constructed according to the learning situation.

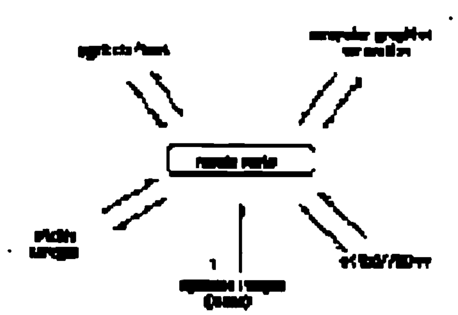

Figure 2. An Example of Instructional Materials in a Media-integrated Environment.

Figure 2 shows one form of the substantial parts of the media in a multimedia-integrated environment. Media may be as simple as text and as complex as video. Media that is difficult to transmit using current local area and wide area network technology, such as dynamic images (video), are reduced to static line-based ones by extracting graphical features to make processing and communicating over distances easier. This enables the realisation of bidirectional cooperative learning in an easier manner and is eventually expected to remove the boundaries between learning and teaching.

Cooperative Learning Environments

In this cooperative learning environment the instructional materials are originally prepared beginning with a constructive database utilising various forms of information media such as symbols/text, sound/voices, graphics and images (e.g., video-based dynamic image). Of course, gradual enrichment of the instructional materials is always possible using the input/output facilities (e.g., pen tablet, scanner, microphone and so on) of a multimedia-oriented computing system. If desired such materials can be transferred to be newly integrated at a distance. This environment can be assumed at the final R&D phase, not in the form of conventional CAI which generally runs on a simple personal computer or local area network, but in an up-to-date multimedia-enhanced network with a greater integration and parallelising/multiplexing of information media and professional collaboration. The requirement of conventional professional skills in computing, media and education will be less, not only for operation /activity, but also for multicontextual manipulation, as compared to that in the conventional environment.

Figure 3. shows the contextual orientation from upper to lower conceptual refinement through pen-based communications. This facilitates the processing of instructional classification, association, exploration, generalisation, and so on, in the participants' basic concept formation in a field. It enables learning and the maintenance of attention through cooperation among the participants of a network in research

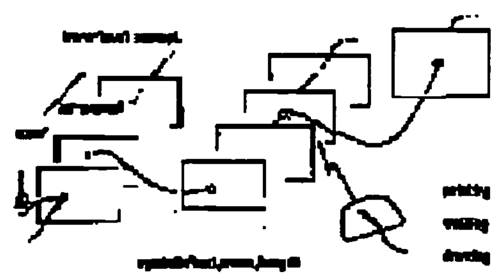

Figure 3. Hypermedia through Pen-based Communications.

environments. They can think through some aspects of a certain concept in a handwritten manner (Togashi,1992). Not only is browsing, but also various digressions are feasible in a more interactive manner in this multimedia computing environment. On the other hand, formal conceptual expression with semantics of concept entities can be introduced into the cooperative learning situation. This also contributes to semantic expression in a meaningful way and the integration of meta information/knowledge in an efficient manner (Ichiko,Takeuchi and Nango,1989).

Examples of Application

For example, assume that individual participants having different potential in the environment are mutually trying to understand the concept of AI (artificial intelligence) for higher science education. At first some information about the difference between human and artificial intelligence based on logic and neural network can be obtained, if desired, from instructional materials composed of a card image component network with links and nodes.

Figure 4. shows an example of the contents of an instructional unit. In this material many kinds of information (symbols/text,figures, sound and so on) are included and

can be linked to the compositional texts and images in the instructional database. A sound button gives a preliminary explanation in human voice. Individual nodes containing instructional multimedia such as symbols/text, graphics, sound/voices, images, and other hybrid forms of information media are connected by links which enable arbitrary manipulation in such a network and generate semantics with multicontexts by using a more interactive interface between humans and computers. Moreover, this environment is equipped with a communications ability (expandable on the basis of LAN and WAN) and cooperative learning is also feasible at a distance through handwriting in the form of the participants' pointing, writing, drawing and creating graphics.

Figure 5. shows an example of artificial intelligence (AI) computing. If the button is pushed by a pen the participant can go into the next, more refined, information space dealing with neural network applications and can learn more detail there (Togashi,1992). In this case, if they cannot find the desired information and learning process by their manipulation, they can communicate with other participants, sharing ideas and suggestions in this cooperative environment. Such cooperative learning processes can be stored and integrated into the existing information media/instructional materials for further improvements. Some examples of practical applications can be given in the basic concept formation and gradual refinement of the cooperative learning process (on the basis of screen-sharing).

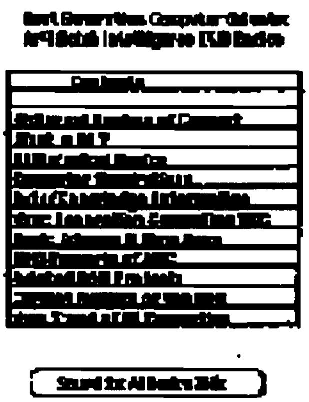

Figure 4. An Example of the Contents of Instructional Materials.

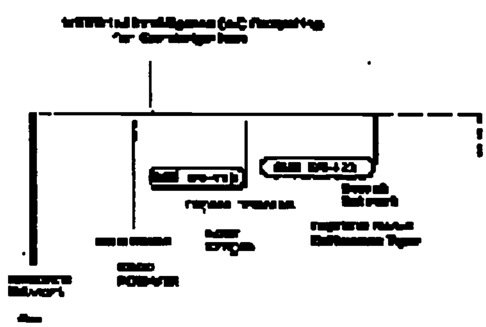

Figure 5. An Example of Artificial Intelligence Computing

Fig.6 shows an example of the result of person-to-person communications for the participants' concept formation by using handwritten multimedia information such as characters, symbols/text, images (static/dynamic) and so on. Sound-based communications are more convenient for better understanding in this cooperative learning. Originally, many different kinds of information/knowledge (e.g., principal, experimental, functional/structural, and also every day knowledge) in the range of ordinary intelligence to scientific knowledge in various levels can be found in the participants' brain. Formal paradigms prepared in an educational environment are not enough in order to grasp more in-depth knowledge in a network, and therefore, a device like the pen tablet which is convenient for humans enables the flexible formation and dynamic tracking of human recognition. Of course, it should be noted that in the near future further research into the better matching between/among different kinds of media will be undertaken.

Concluding Remarks

This paper described an example of cooperative learning in electronic distance education. The result of our research is expected to be one of the next-generation schemes in cooperative learning in order to improve upon the conventional one-sided indoctrination style teaching/learning that dominates many educational systems today.

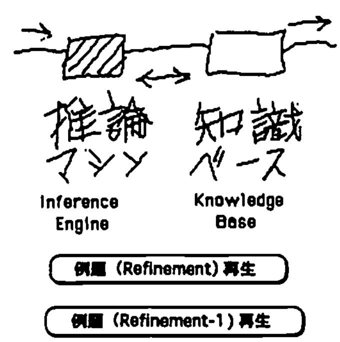

Figure 6. Personal Communications by Using Handwritten Information in a Multimedia-computing Environment.

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Navigating in Hypermedia - Interfaces and Individual Differences

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The 1990's has seen an explosion of increasingly sophisticated computer based information applications such as multimedia and hypermedia, both in general education areas such as history, art and medicine and more commercially oriented applications such as information kiosks. Teachers will encounter hypermedia applications both in their training and in the classroom. Despite the many perceived advantages of hypermedia, there is evidence of significant problems. Some of these problems are present with all computer based applications - such as the widespread dislike of reading large pieces of text on a screen. Other problems are unique to hypermedia. The ability to jump in a non-sequential way around a hypermedia application often results in significant user disorientation and cognitive overload. (Edwards & Hardman,1989, Wright, 1991). A tendency for some users to spend their time in cursory and non-directed browsing, has also been identified, and shown to result in shallow processing, few elaborations, and poor retention (Hammond, 1993). Knowledge of these potential difficulties is an important addition to the education of teachers at all levels.

Many studies have found wide variation in the ability to utilize computer interfaces effectively. In a review of research on human-computer interaction, Egan (1988) described performance differences as high as 20 to 1 in tasks such as searching an application for specific information. Using any computer interface involves the development of a cognitive model representing the structural and procedural properties of the system. Previous research has indicated that individual differences such as spatial ability and cognitive style may affect the development of a useable cognitive model of a complex system. Conflicting evidence has emerged as to the role of interface tools and training in catering to individual preferences and abilities. Some investigators have reported that the provision of appropriate interface tools compensates for the differences between individuals in areas such as verbal and spatial ability. Others have reported a consistent disadvantage experienced by low spatial ability users which still needs to be addressed by further interface refinement.

Despite a considerable body of both theoretical and experimental work dealing with the problem of navigation in hypermedia, there has been very little research actually investigating individual differences. This paper presents a review of recent research in this field, and reports the results of two recent studies investigating the relationship between spatial ability and navigation through a hypermedia application.

Psychological Theory and Navigation in Hypermedia

It has been suggested (Wright, 1991) that excessive cognitive load is the cause of the disorientation and frustration experienced when using hypermedia applications. Apart from learning new material, the user of a hypermedia application is engaged in other complex cognitive processes including:

- using the interface (e.g., determining which button brings up the index)
- trying to establish the size and complexity of the information available
- determining their current position and maintaining a sense of that position, and
- remembering what sections/screens have already been visited

Wright demonstrated that using hypertext jumps was easy for the designer but tended to disrupt the users train of thought and therefore their capacity to fully assimilate the material. Two adjoining pages frequently constitute an important semantic link - but hypermedia applications deliberately allow (even encourage) the learner to disrupt this link by jumping to another section. Navigating back to the original screen may involve complex cognitive processing, thereby disrupting the main information thread

The users of a computer based application will have some sort of existing schema involving both the content and structure of such applications, based on past experience.

Cognitive models and maps are developed for more specific instances of a schema. Carroll and Olson (1988, p. 51). describe a mental model as "a rich and elaborate structure, reflecting the user's understanding of what the system contains, how it works, and why it works that way." A cognitive map may be thought of as a subset of the mental model, dealing specifically with the structural properties of some environment or system.

A computer application may be considered to evoke both a cognitive model (how the application works, what this button does etc) and also some sort of mental map of its structure (ie the structure of the information contained in it, such as sections, subsections, relationships between them, total size). It will also connect with the users basic schema of computers and information presentation, and may utilise metaphors such as a book metaphor. However, hypermedia removes the spatial relationships between pages/sections which are implied by metaphors such as books and conventions such as screen numbering. Keeping track of relative position will involve using tools such as maps which often require significant cognitive processing.

Navigation in Space and Hyperspace

The very use of the term navigation to describe the process of using a hypermedia application indicates the potential involvement of the spatial processing system. Some writers have drawn parallels between navigation in the physical environment and navigation in hypermedia. In a study of navigation strategies in the physical environment, Streeter & Vitello (1986) found that many of their subjects had difficulty reading maps and preferred to navigate using landmarks and verbal instructions regarding the route. Dillon, McKnight & Richardson (1990) proposed that route knowledge, because of its predominantly verbal form, might suit individuals with higher verbal than spatial abilities. Individuals with higher spatial ability may be well suited to make use of survey or overview knowledge provided by maps. However, reliance on route knowledge (a remembered set of directions), can cause problems when a wrong turn is made (or in hypermedia, when a hypertext jump is made to a new section). If other familiar landmarks are lost, the user applying only route knowledge may have to return all the way to the start screen (the only known landmark accessible to them). Returning to the start screen is a common strategy for users who become lost in hypermedia (Norman, 1994).

Spatial ability seems particularly relevant to both hypermedia and the problem of cognitive map and model development in computer use generally. However, it is widely recognized that individuals vary widely in their ability to process spatial and verbal information. Paivio (1971) proposed a now widely accepted dual code theory of memory, in which verbal and visual information are separately processed and encoded in memory, and individuals vary in their ability and tendency to think in one of these modes.

Visualization or spatial ability is represented in most tests of general ability or aptitude. Tests developed to assess spatial ability tend to involve either mental rotation of objects, the imagined construction of an object from a pattern, or a combination of these. Logie (1991) cites convincing evidence for the involvement of the visuo-spatial system in navigation through the physical environment and in the traversal of an imaginary matrix. It seems reasonable to suggest that this same system is engaged when moving around a complex computer application structure. One contributing factor to the disorientation frequently experienced by users of hypermedia applications may be the difficulty of maintaining a sense of position using the visuo-spatial system, when that same system is also being used for other tasks involving the application such as scanning the screen. Users may also unconsciously choose to focus attention on the content of the new screen and hence have no cognitive resources available to address the problem of where they are now in relation to the overall structure.

Using a computer interface - whether it involves understanding icons, maintaining a sense of position in a hierarchical database or navigating through a complex information space such as hypermedia - involves the visuo-spatial system and the construction and manipulation of a cognitive model and map. Spatial ability has been shown to be closely related to the formation of cognitive maps by a substantial body of research, both in the field of real world navigation and in conventional computer interface studies. Thorndyke & Goldin (1981) divided subjects into good and bad cognitive mappers on the basis of the accuracy of their spatial knowledge of their environment. The major difference in characteristics found between the two groups was spatial ability. They tested these subjects' ability to use related skills such as interpreting maps, spatial judgements based on remembered maps, and navigation in the environment. They found that while there was little difference in the ability of subjects to use a map effectively, good cognitive mappers were much better at encoding, maintaining and manipulating an internal representation of spatial information.

Jennings, Benyon & Murray (1991) examined individual performances on 5 different interfaces to a computer database system in relation to subjects scores on 5 aspects of cognitive ability and personality - spatial ability, verbal ability, field dependence, logical-intuitive cognitive style and short term memory capacity. Interestingly, the only interface where high spatial ability users showed a significantly better performance than lower spatial ability users was on the command line interface, in which there were no overt spatial elements involved such as a graphical interface, map or hierarchy diagram. However, the navigation tasks were implicit and involved maintaining a sense of position in the system, as different system levels exist which required different syntactic interactions. There were no onscreen cues indicating these levels, meaning the user had to be able to maintain and manipulate some representation of this information in an abstract form.

Vicente, Hayes & Williges (1987) investigated the effects of a number of individual differences on performance of a search task in a hierarchical database. Only computer experience, verbal ability and spatial ability were found to be related to task performance, with spatial ability being the largest single factor. Low spatial ability subjects took substantially longer to perform set search tasks, and tended to use larger numbers and more varied commands in the search task. Vicente et al concluded that low spatial ability subjects were becoming lost in the hierarchy. Further, they concluded that experience was related to performance only because most of the experienced group also scored high on spatial ability, suggesting a connection between spatial ability and computer use - either as a cause or effect.

In a subsequent study, Vincente & Willeges (1988) found that while the provision of tools such as maps and hierarchy traversal tools increased the performance of both high and low spatial ability groups, the gap in performance between the two groups remained essentially unchanged. This implied that the spatial information provided such tools did not substitute adequately for the mental mapping ability of the high spatial ability subjects. However, a series of studies by Sein, Olfman, Bostrom and Davis (1993) found evidence to the contrary. Training materials including the provision of conceptual models and a visual interface design improved the performance of low spatial ability subjects to the point of matching the performance of high spatial ability subjects.

Choice of interface tools represents another area of potential difference between high and low spatial ability users. However, the study by Jennings et al (1991) indicated that high spatial ability subjects showed superior performance over low spatial ability subjects using a text based command line interface. This indicates the need for caution in equating the use of apparently verbal or spatial tools with underlying verbal or spatial processes. The more highly developed cognitive map and model of a high spatial ability users will facilitate the choice of the most appropriate and efficient tool for any particular task. This method may be a text based search rather than spatially oriented tools such as a map. High spatial ability users with a well developed cognitive map of the application may find a map largely obsolete. However, hierarchy traversal tools seem more innately spatial in nature and their use may more closely reflect an underlying sense of the structure. The other major contributing factor to choice of interface tools is their saliency, particularly for inexperienced users. If tools are not visible until additional actions such as pointing and clicking bring them onto screen, users may never take the time to discover their relative efficiency.

There is conflicting evidence then, regarding the importance of interface tools, training and experience in countering the spatial ability factor. Familiarity with the tools and methods of navigating the information space may mean an experienced subject is able to compensate for lower spatial ability. A well developed cognitive model which draws on past experience with similar systems may allow efficient use of the system even without a easily manipulated structural map of the system. However, none of these previous studies used a hypermedia system as the testing software, where the navigational and orientation complexity is potentially of a much greater order due to the facility of hyperjumping.

Report on Recent Studies

These studies examined the relationship between spatial ability, computer expertise and a number of variables including navigation efficiency, subjective measures of disorientation and sense of structural organization, and the use of various search and navigation tools. The application used in the studies was an hypermedia educational program on HIV, developed by the Monash University Medical Informatics Unit for use by students and medical professionals. It includes just over 1000 screens, comprising text, some short animations and a substantial number of medical images. Users' interactions with the application were recorded by logging the subjects path through the application screen by screen, and a summary count of accesses to each of the major navigation and search tools was produced at the completion of the session.

The method chosen to measure navigation efficiency, and thereby cognitive model/map development, was error based rather than time based. It is assumed that if the user fully understood the structure and tools available, they would choose an optimum route. Users who are unsure either of where they are or how to get to the next place of interest frequently backtrack over old ground to reach a recognisable screen (landmark) or simply jump back to the beginning to reorient themselves and restart a search from there.

Many users of hypermedia report disorientation as they move through the application. However, there have been few attempts to quantify this sense, or to examine its relationship to variables such as spatial ability. Measures of a subjective sense of disorientation and the subjects reported confidence in understanding the logical organisation were used to provide additional measures of the degree of success in constructing a useable cognitive map.

The navigation measures made were:

1. the steps taken to access specified parts of the media.
2. user accesses to tools such as the map, hierarchy traversal button
3. subjective disorientation using Likert scale questionnaire.
4. subjective sense of understanding underlying structure

5. subjective impression of usefulness of tools using Likert scale questionnaire.

Results

Screen by screen analysis revealed that subjects generally made use of the hierarchical text based menu structure, hot words and sidelinks when browsing in the application. Very few subjects used the map or index to navigate at all, even though they represent a very efficient way of moving around and maintaining a sense of current position. Subjects generally only used the full text search facility when completing the structured search task. Most subjects moved through the application in an apparently systematic way, often exploring a particular area in depth rather than browsing at shallow levels for the allocated time.

Means and standard deviations of spatial ability for each experiment group were calculated. Pearson product moment correlation coefficients were calculated between the subjects scores on spatial ability and the variables of navigation tool choices, navigation efficiency and the subjective sense of disorientation, underlying structure and usefulness of tools. Finally, the group was partitioned into high and low spatial ability subgroups using the median split method. Independent t-tests were then used to examine the relationship between spatial ability and those variables where correlations had indicated a possible relationship.

Non-computer Expert Group

The results show a strong positive correlation between spatial ability and navigation efficiency. The only other variable which approaches a significant correlation was the subjective sense of underlying structure of the application, as shown below.

Table 1.
Correlations between DAT scores and navigation variables

	Navigation Efficiency	Subjective Structure	Spatial tools count	Subjective value tools	Subjective disorient'n
DAT score	.67	.41	-.29	-.14	-.21
p=	.004	.112	.28	.59	.42

Table 2.
Correlations between DAT scores and navigation variables

	Navigation Efficiency	Subjective Structure	Spatial tools count	Subjective value tools	Subjective disorient'n
DAT score	.26	.55	.62	.46	-.47
p=	.41	.06	.03	.13	.12

T-tests indicated a significant difference in navigation efficiency between high and low spatial ability subjects ($t = 3.38$, $df = 14$, $p < .005$) and in the subjective sense of underlying structure ($t = 2.3$, $df = 14$, $p = .025$).

Computer Expert Group

The results indicate moderate positive correlations between spatial ability and some of the navigation measures, as shown below. However, the correlation between navigation efficiency and spatial ability in this group was much weaker.

The only t-test to reach .05 level of significance was for subjects reported disorientation ($t = -2.54$, $df = 10$, $p = .03$).

Discussion.

In the experiment using non-expert subjects, there was strong support for the major hypothesis that high spatial ability is related to greater navigation efficiency. Higher spatial ability appears to increase the ability to formulate and use a cognitive map of the hypermedia application even when the user has a limited model of computer systems in general, and even when extensive tools such as full-text search, map and index are provided. These findings are consistent with previous research using non-expert subjects which has established a link between spatial ability and computer task efficiency.

In the experiment using expert computer users, experience did appear to compensate for lower spatial ability when engaged in navigation tasks. This finding is consistent with the study by Sein et al (1993) which found that the performance of subjects with lower spatial ability can match that of high spatial ability subjects if training such as cognitive models of the system are provided. However, the differences in navigation efficiency between high and low spatial ability subjects, although not reaching statistical significance, did indicate at least a tendency for greater efficiency by high spatial ability subjects which would warrant further investigation. The subjects in the expert group showed a wide range of spatial ability from below average to very high. This is of interest in itself, in that all of the expert group were involved by choice in computing as a profession. Low spatial ability had apparently not deterred any of the group from this choice.

The strength of the relationship found here between navigation efficiency and spatial ability, at least for the non-expert group, may be a reflection of the additional load being placed on the spatial system by the unique navigation difficulties caused by the hypermedia application. High spatial ability may confer an even greater advantage in hypermedia navigation than it does for a more conventional computer interface. Lower spatial ability subjects in both experiments had a greater tendency to use inefficient strategies such as going back to the start, or backtracking screen by screen to reach the beginning of a section again. They did not appear to have confidence in traversing the hierarchical structure, or commencing a search from wherever they currently were in that structure. This is consistent with the behaviour that would be expected if users had a poorly developed cognitive model of how the application worked, and a poorly developed mental representation of its structure and their position in that structure. However, it appears that spatial ability may be of less importance in navigation and task performance when the subject is an expert computer user. The general cognitive models and elaborate schema developed by expert computer users can apparently compensate for the effects of low spatial ability, by providing a well developed foundation on which to construct models and maps of the new system. However, the provision of interface tools such as maps, position marker and a history trace provided in the HIV system did not remove performance differences due to spatial ability in the non-expert study group. Design factors associated with the specific interface may be more or less effective in making tools salient, and communicating a useful cognitive model.

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Network - Based Learning and Future Educators

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Although Bulgaria is passing through a major economic crisis and the education budget is insufficient. However, due to the efforts of local and international sponsors an increasing number of schools and universities are being connected to the Internet. Unfortunately, the Internet in school is so new, there is "little systematic understanding of the issues which shape its implementation, adoption and use in that environment" (Eurich-Fulcer & Schofield, 1995, p. 211). Presently, teacher education institutions have not done enough to support and encourage this innovation in the teaching and learning process.

As a minimum, future teachers need to learn and understand how the Internet can become a part of their professional work; and they should be supported in identifying, acquiring, and evaluating sources of information that can facilitate their teaching. The problem is how future teachers will take advantage of Internet educational potential.

The study which was carried out in the Technical University of Varna in the past three years was aimed at answering the following questions concerning Internet connectivity:

- How is the Internet used among future educators?
- What factors contribute to the use or lack of use of the Internet connection?
- What compelling pedagogical reasons are there for using the Internet?
- What special problems or barriers do educators encounter in using the Internet?
- What role or behavioural changes do future educators experience from using the Internet?
- In what ways does the Internet affect future educators views on education?

Method of Research

"Effective evaluation should encompass both the scientific and naturalistic paradigms, with emphasis placed upon the interactions between the programme and its context" (Hose, 1991, p.2). This view of enquiry is significant for the study of technology in distance education since many of the issues and questions which need to be addressed cannot be answered by assessing individual programs in isolation from the broader understanding of the field.

Sampling and Subjects

As the idea was to include future educators and to identify information-rich sources, the target group included 30 students from the faculties of sciences and education which were frequent Internet users. By "frequency" it was meant that they should have Intenet interaction at leas 5-6 hours per week. Information about users was taken from the e-mail addresses and from the Computing Centre.

Data Collection and Analysis

Primary data collection methods included personal reports and a standardised open-ended interview format. The interview process was conducted after receiving the completed personal report. All data collection occurred on-site at the University at times that were convenient to the subjects. Transcripts of all data sources were thoroughly searched for key patterns or themes (i.e. common occurrences of concepts) from the data, and labels were assigned to them. In reviewing and searching for patterns and themes, data analysis included "participant verification", that is going back to the respondents with tentative results and refining them in the light of their reactions.

Results

The findings of this investigation were categorised into four primary domains:

1) situations in which student-users used the Internet;
2) factors that influenced student-users' connections to the Internet;
3) problems student-users encountered when using the Internet;
4) changes student-users experienced as a result of using the Internet.

Types of Usage

The types of Internet usage varied according to the student-users' interests. There was, however, a trend toward using the Intrnet more as a research tool for identifying relevant literature and for communicating with peers and experts in their research fields. The most frequently cited

897

functions were: e-mail, ftp, telnet, Word Wide Web (WWW), and IRC. Of the e-mail programs available, Eudora and Trumpet were singled out as the two widely used, while Netscape was mostly used for the WWW. Some of the participants were members of various lists and discussion groups according to their own interests. A small group of participants began to explore ways of designing simple WWW applications through HTML.

The time profile for each application ranged from 5 to 12 hours per week. Evidence shows that the amount of time devoted to different functions will be accelerating. It is worth pointing out that the application usage was more easy to ascertain than the time profile, perhaps due to different concepts of access and time usage. It seems that two different concepts of use can be constructed: the 'actual time' use and the 'access time'. The first refers to the productive time devoted to a certain task, and the second, to the total time spent accessing and fetching the information.

Factors Influencing Use

The factors that were perceived to influence participants in getting involved on the Internet can be classified into intrinsic and extrinsic. Among the intrinsic factors, the most common reasons reported were: curiosity, excitement, addiction, empowerment and emancipation. Curiosity seems to be the first motivating factor. As they got involved, curiosity changed to excitement, due to the vast amount of information available on the Internet and the way it was presented. For some respondents excitement became addiction. As one respondent metaphorically stated: "If I miss the Internet, I feel like a smoker without cigars".

Among the extrinsic factors attributed to the Internet, the data analysis and interpretation suggested the following concepts: the 'super highway of learning' and the 'global village'. The first is explained by the vast amount of the information available, and the second by the potential of the Internet to reduce isolation and build a sense of global interrelation.

Problems

The problems encountered by the respondents derived from three main sources: educational, technical and administrative. From an educational point of view, most respondents cited the lack of guidelines concerning the use of the Internet as an educational tool. Technical problems were related to the low speed and hardware configuration. Participants also agreed that the problems associated with the support of the Net could be minimised if there were more personnel. Clearly, without a robust network system, the educational potential of computer networking cannot be realised.

Changes

There was a relatively clear consensus about needed changes concerning new technologies, the teaching and learning process, and the new roles assigned to educators. Respondents indicated an attitudinal transition from teachers as passive receivers of information to teachers as investigators or active information seekers was needed. Access and use of the Internent encouraged respondents to think of learning as a collaborative process and of educators as facilitators of teaching rather than transmitters of information and knowledge.

Conclusion

The Internet is used to retrieve information from a wide range of sources, to exchange information and messages, to discuss topics of mutual interest with people all over the world, and much more. This study indicates that a new vision of learning is emerging in educational establishments that have integrated the Internet as a communication and education tool.

Similarly, a new mode of human mobility that may be called 'virtual mobility' emerged which seems to add significantly to the globalization and internationalisation of information and knowledge. The Internet challenges the traditional flow of information and knowledge from the 'centres' to the 'peripheries'. This implies that under-represented people and cultures have the opportunity to contribute to this 'highway of information'. "In such open and flexible learning environments the emphasis is placed on the importance of constructing personal meaning" (Guba, 1990, p.19). "The collaborative nature of learning can expand the student's collective intelligence "(Idrus, 1993, p.181).

The Internet is emerging as a new motivational, enabling, and empowering tool for teaching, learning and research. However, the problem is that future educators need help in learning how to use this technology and how to apply it to teaching and learning. For educators, technology should be a means to new ends, to more dynamic learning, but technology in itself should not be the issue. Technical support is required to establish and maintain a robust connectivity, while curriculum support is necessary to make pedagogically relevant usage possible and meaningful. It must be stressed that the Internet by itself is not a panacea for educational reform. The Internet can enhance classroom activities and professional development by creating global awareness, providing access to the latest information and enabling communication on a large scale, but we cannot just connect the Internet into an educational institution and to expect change to occur automatically.

The teachers need educational programs that are rich in use of media and easy to use, adopting a more familiar, television - like "look and feel". Moreover, these programs can provide coherent and comprehensive information about a knowledge domain, assist the learner in forming conceptual frameworks that provide a basis for other kinds of learning, and place what is learned in a rich, real-world, human context.

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Distance Learning: Success Barriers and Strategies for Students and Faculty

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Walden University is a graduate level degree granting institution. From 1970 until 1995 Walden granted strictly doctoral level degrees. In 1995 they began offering an on-line Master of Science degree. During the first year of programming, teacher evaluation data were gathered. Many barriers to adult, student success are related to characteristics of the students themselves. The relationship between students and faculty is a second area of influence on student success, and problems related to the technology of the on-line course a third.

The purpose of this paper is to explore these barriers for students and faculty, compare the current literature on barriers to success with the data gathered from this program, and develop strategies for students and faculty in an on-line, asynchronous delivery model.

Student Success Factors

Personal Characteristics Related to Barriers

Many students returning to graduate school as adult learners have personal characteristics and life situations affecting their performance. A study by Bernt & Bugbee (1994) listed several characteristics.

- Lower expectations for success (Hugh, 1984 in Bernt & Bugbee, 1994).
- Having been away from the discipline of learning (Feasley, 1983 in Bernt & Bugbee, 1994).
- The need for feedback (Feasley, 1983 in Bernt & Bugbee, 1994).
- Higher level of insecurity in their ability (Distance Education, U of Idaho, 1996).
- A tendency to believe their own experiences are illegitimate (Distance Education, U of Idaho, 1996).
- Having little in common with instructors (Distance Education, U of Idaho, 1966).
- A tendency toward isolation (Distance Education, U of Idaho, 1996).
- A potential to procrastinate (Beaudion, 1990).
- Increased anxiety (Beaudion, 1990).
- A lack of discipline (Burton & Yuen, 1983 in Beaudion, 1990).

Many of these characteristics closely match characteristics of Walden University students. The gender distribution of Walden MS students is 67% female and 33% male. The average age is currently 42 years. Six percent of student received a grade of "incomplete" for not finishing their work during the course of the quarter. We have also seen a high level of anxiety in the first quarter of the program, along with a tendency toward isolation from the class if they are uncertain of their ability.

Situational Characteristics Related to Barriers

Career expectations. Adult students have high expectations that their educational program will relate to their career aspirations (Council of Graduate Schools, 1994). As active participants in the learning process, adult students demand their education be relevant in both the medium and the message (Sherry, 1994).

Time available for school. Adult learners who often have multiple responsibilities (Boston, 1992). Because of work, school, family, and social obligations they often have less time to read, but more reading to accomplish (Bernt & Bugbee, 1994). Problems can include: lack of time to prepare for assignments (Boston, 1992), missing information and discussions creating gaps in meaning (Graham & Wedman, 1989).

Family Obligations. Students often struggle with obligations forcing choices between family commitments, school commitments and work commitments Problems can include a lack of an environmental support system (Wagner, 1993)This lack of support may lead to guilt over potential failure as both a parent/spouse and failure as a student.

Funding. Most master's level, adult learners are also self-funded and hold a very strong desire to see a return on their investment (Distance Education, U of Idaho, 1996).

University Strategies for Assuring Success Related to Student Characteristics

Walden University employs two checkpoints in which the institution can evaluate the potential for success and begin the learning process for appropriate strategies.

Application

During the application process it is critical to establish the maturity level of the potential student. The student who is more highly motivated and exhibits greater self-discipline is much more likely to succeed (Souder, 1993).

Orientation

The orientation should include frequent contact from all constituents related to the program. This includes administrators, advisors, staff, and faculty creating an opportunity for students to relax and ask questions. It also serves as an opportunity to teach strategies for success related to: realistic career expectations, timing issues, funding and family obligations (Boston, 1992).

Faculty Success Factors

Personal Characteristics

While some student success is dependent on personal characteristics, life situation and support systems, the relationship between the student and faculty also has the potential to affect student success. Students place responsibility for their learning squarely with the faculty. "Program faculty have the responsibility for the delivery of academic course work and seminars, and for the advising and guidance of graduate students through the completion of their master's degree programs. It is the faculty members who have the ultimate responsibility for ensuring that appropriate standards for academic performance are required of all who participate in the program" (Council of Graduate Schools, 1994, p. 23).

At Walden University we have established the following faculty criteria for the distance education M.S. program:

- Must hold a related Ph.D. or Ed.D. degree.
- Must have experience in the K-12 education arena.
- Must have experience teaching adult learners.
- Must have experience teaching at the graduate level.
- Must have knowledge of the content of the course.
- Must have a high comfort level with technology in education.
- Must have excellent and thoughtful verbal and written communication skills.
- Must have a high level of intuition.

These criteria are important in on-line delivery of course content when all communications are written. Written communication, due to its contextual nature can be easy to misunderstand or ignore. Miscommunication between students and teachers can easily have negative consequences (Sherry, 1994).

Faculty Situational Characteristics Relating to Barriers

Some faculty barriers to success may include the following:

- Most faculty have their primary experience in presentation style (Wagner, 1993).
- Faculty are sometimes unable to transition from a teacher led model to a student led model (Wolcott, 1993).
- Some faculty are unable to appropriately pace and respond to student queries (Wagner, 1993).
- The danger of allowing the course to lose its rigor (Klemm & Snell, 1996).
- The danger of allowing the technology limitations to support only superficial participation (Klemm & Snell, 1996).
- The danger of focusing only on technology (Sherry, 1994).

Walden University Faculty Evaluation

Within the context of course and instructor evaluations at Walden University students complete a quantitative ranking of 16 items at the close of each quarter. Five of the 16 questions asked on the final evaluation were isolated for this paper. The frequency of the responses was tracked for each instructor over the course of the first year of the program.

The questions included are:

#4) The instructor worked hard at helping the students understand the material.

#5) The instructor worked hard at helping the students understand the technology.

#7) The instructor communicated regularly with the students.

#8) The instructor responded to each assignment promptly.

#11) The instructor was genuinely concerned with student progress.

The range of responses was:

1—Strongly agree
2—Agree
3—Disagree
4—Strongly disagree
NA—Not applicable

Instructor A:

Instructor A received very high marks from the students related to her feelings of concern (#11) for their learning and her communication and feedback regularity (#7). She received lower marks in her efforts to help students understand the material and the technology. This instructor was highly successful with students, if somwhat less rigorous.

Table 1.
Instructor A

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	6	5	0	0	0
Tech-5	6	5	0	0	0
Comm-7	11	0	0	0	0
Feed-8	9	2	0	0	0
Caring-11	11	0	0	0	0

Instructor B

This instructor received exceptional marks in her efforts to help students understand the material (#4). Her highest criticism was in her ability to respond to the student's assignments (#8) promptly. This instructor was very well received and students tolerated her inability to provide prompt feedback because she was perceived as supportive and caring (#11).

Table 2.
Instructor B

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	6	0	0	0	0
Tech-5	2	3	0	0	1
Comm-7	5	1	0	0	0
Feed-8	1	3	2	0	0
Caring-11	5	1	0	0	0

Instructor H

This instructor had positive rankings and comments. He did well in the area of regular communication (#7) and genuinely caring (#11) for student progress, but less high in his ability to assist in the technology (#5) and responding to assignments (#8). This instructor was also considered successful by his students because of his obvious attitude of support and caring.

Table 3.
Instructor H

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	5	2	0	0	0
Tech-5	2	3	0	0	2
Comm-7	6	1	0	0	0
Feed-8	3	4	0	0	0
Caring-11	6	1	0	0	0

Instructor S

This instructor was clearly perceived as less successful. He received moderately high marks in his genuine concern for the students (#11), but there was more disagreement among students related to his efforts at helping students understand the content of the course (#4) and the technology (#5). There was strong belief that the instructor did not communicate regularly (#7) with students or communicate about assignments (#8), but overall the students felt he was a nice person due to his genuine concern for them (#11). This instructor needs to work on the rigor of the course and immediacy of his feedback.

Table 4.
Instructor S

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	4	3	3	0	0
Tech-5	3	1	3	0	3
Comm-7	3	3	3	1	0
Feed-8	2	5	2	1	0
Caring-11	4	5	1	0	0

Instructor W

This instructor had a moderate ranking from the students. They believed he was somewhat concerned with their progress (#11), and worked at helping them to understand the content (#4) and the technology (#5). They were less happy with his communications (#7) and response to assignments(#8). This instructor was accepted, while not liked by the students because he was teaching them content (#4). He needs to work on his feedback to students and sense of caring for their success.

Table 5.
Instructor W

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	0	5	1	0	0
Tech-5	0	3	1	0	2
Comm-7	2	3	1	0	0
Feed-8	2	3	1	0	0
Caring-11	3	3	0	0	0

Instructor O

This instructor was a clear failure in the on-line environment. He was seen as creating additional barriers for the students as opposed to assisting them in succeeding in their course. Only one student felt he was sincerely concerned with student progress, and felt he worked hard at assisting with understanding the material. All other students felt he was not communicating (#7) effectively or often enough, not assisting in their understanding of the material (#4), and not genuinely concerned (#11) with how the students were doing. In my supervision of the instructor it was clear that the instructor had expectations of the students that were not being met. He extended significant effort in attempting to assist, but exhibited a "tone" of superiority to which the students took offense. This instructor, in order to be successful in this environment, must adjust his communication style and pacing. He must increase his level of intuition with students and intervene more quickly and more frequently, with student achievement as his goal.

Table 6.
Instructor O

	Str. Agree	Agree	Disagree	Str. Dis	NA
Content-4	0	0	2	8	0
Tech-5	0	1	1	8	0
Comm-7	0	1	1	8	0
Feed-8	0	0	2	8	0
Caring-11	1	1	0	8	

Instructor J

This instructor met mixed success. The instructor received very high marks related to regular communication (#7) with students, and rated quite high for providing feedback (#8) on assignments. There was some disagreement that the instructor was genuinely concerned with student progress. Her lowest ranking was on helping students to understand the material (#4), both content and technology (#5). This instructor set very high standards. She had little tolerance for their problems in meeting her expectations. She assisted them greatly by answering direct questions but showed little concern for their anxieties. While few students liked this instructor, they were aware of the great amount of learning and growth they experienced. Students seemed to tolerate this instructor as she tolerated them. This instructor needs to improve her support of the program, intuition and tone of communication to succeed in student evaluations.

Table 7.
Instructor J

	Str. Agree	Agree	Disagree	Str. Di	NA
Content-4	5	5	4	2	0
Tech-5	1	5	3	3	4
Comm-7	10	6	0	0	0
Feed-8	9	3	3	0	1
Caring-11	6	5	3	1	0

Instructor E

This instructor consistently received lower marks than most of the other instructors. She established a moderate composite score, but in closer evaluation, there is a clear issue with feedback (#8) and regular communication (#7) to students. Eventually, it became clear that this instructor was very reactive with students rather than being proactive. Those students willing to ask the questions and demand service received assistance. Those who were less secure or quieter were generally ignored by the instructor (#11). This instructor needs to adjust much of her on-line style in order to be successful. She will need to develop a stronger skill set for presentations, feedback, pacing, rigor, encouragement of participation and intuition.

Table 8.
Instructor E

	Str. Agree	Agree	Disagree	Str. Did	NA
Content-4	2	7	7	7	0
Tech-5	4	3	4	5	7
Comm-7	2	7	7	7	0
Feed-8	3	6	9	5	0
Caring-11	4	8	5	4	0

Strategies for Assuring Success Related to Faculty

Preparation

As instructors prepare to teach a course on-line to adult graduate students there are several strategies that can assist them. They include the following:

- Understand the roles of all the participants (Carter, 1955).
- When establishing objectives for the course, accept adult student obligations and adjust for realistic expectations (Hays, 1990).
- Prepare all materials well in advance of the course (Boston, 1992).
- Understand and be comfortable with the hardware and software of the delivery model (Boston, 1992).
- Possess a high skill level and be comfortable with word processing (Boston, 1992).
- Develop social protocols and rules for the delivery of the course and behavior of participants and include these protocols in the syllabus. Paulson (1995) in Berge (1995) pointed out instructors need to serve three functions: organizational, social and intellectual. The first two must be met to achieve the third.
- Establish pre-class study questions allowing students to prepare for discussion. (Distance Education, U of Idaho, 1996).
- Over-prepare with multiple topics that can be kept active simultaneously (Klemm & Snell, 1996).

Delivery

Gagne's work (1985) describing the events of instruction in Graham & Wedman (1989) is an excellent starting place for a discussion on successful delivery methods for teachers.

Gain the learners attention. It is critical for instructors to know who the students are, and understand their diverse situations. Walden University begins the process of learning about the students and getting their attention through a required phone conversation between the student and the faculty. The call is placed by the faculty to discuss the course, probe for issues that might affect the student level of commitment. It can also reduce anxiety (Boone, 1996), assess learner needs for appropriate instructional strategies (Hays, 1990), bond (Boone, 1996), and if necessary assist with any problems the student might have encountered related to the technology (Carter, 1995).

State lesson objectives. Adult students, insist on having a clear understanding of the course objectives, and the necessary output for achieving their goals. Walden University provides this through a detailed syllabus that is filed on-line in the classroom. The syllabus includes a course description, course objectives, faculty contact information, text and required reading materials. It also has assignments related to the course objectives, the evaluation processes and a weekly topical outline.

Stimulate recall of prior learning. Many virtual classrooms make use of the threaded discussion. This ongoing, asynchronous conversation, by use of its automatic documentation and transcribing, captures easily prior conversations. The instructor is better served to facilitate the discussion to engage the learner actively (Darkenwald & Merriam, 1982 in Hays, 1990) challenging them to think critically.

Present information. Teaching on-line is new for many teachers who have a history of teaching in presentation format. For new on-line instructors there are several tactics to be learned. The adjustment of techniques to concise facilitation, instructional materials to distributed texts and on-line resources, and the adjustment of time to weekly, asynchronous postings are necessary for successful presentation of information. It is vital the instructor is able to communicate in a clear, concise, and appropriate a manner (Boston, 1992). The facilitator role allows constructivist theory related to learning styles to thrive. Students must be encouraged to be active learners, applying new knowledge to their own setting, increasing both applicability and retention (Berge, 1995).

Guide learning. The on-line delivery model is based on the process of learning, which is driven by learner initiated inquiry (Teles, 1993). There is a self discipline demanded of both the instructor and the students based on regularity, pacing and feedback around certain topic areas. Instructors are encouraged to facilitate multiple learning styles. Examples might be:

- A group collaboration projects.
- Applying cases independently to experiences.
- Supporting discussion threads with activities.
- Having the students act as facilitators leading a discussion thread (Teles, 1993).

The instructor that can facilitate several learning styles (Gunawardena, 1992), initiate inquiry, sequence instruction from one on one coaching to reflection (Teles, 1993), and design structured group process (Riel, 1993) is much more likely to be successful in the on-line classroom.

Elicit learner performance. Many of the activities discussed earlier lend themselves to papers, presentations and postings by students as individuals, and in the collaborative group format. The instructor must take the opportunity to reinforce for students the role they hold in responsibility for assignments (Distance Education, U of Idaho, 1996). Adult learners with a concrete syllabus, learning objectives, assignments and evaluation process are more likely to perform to the appropriate level of expectation held by the instructor.

Provide feedback. For the expert on-line instructor, providing feedback is the key to taking advantage of the synergy within the classroom. To keep students focused and foster critical inquiry, the instructor must provide great amounts of immediate feedback to students, both collectively and individually, publicly or privately. This feedback must also be timely for it to be effective. In addition feedback creates a system of answering questions from students while the answer is still relevant to them.

Assess learner performance. Ativities an instructor might use as a means for evaluation within discussion threads, both individually or within groups, might include: defending a position, creating or prioritizing a list, formulating a problem, solving a problem, or preparing a report (Klemm & Snell, 1996). Other alternative teaching methods leading to evaluation might include such assignments such as mastering a topic, detailed analysis, and formal presentation.

Facilitate retention and transfer. Adult learners, demand direct application and transfer of course content to their daily life. Instructors that promote and nurture opportunities for adults to transfer theory to applied cases will be perceived as successful, as well as having met a key goal of the students.

Technology Success Factors

Technology issues

A last barrier related to the situational aspect of adult learners in an on-line program is the technology itself. Students not having the time, experience, ability to learn the appropriate technological functions, or access to the necessary equipment often experience frustrations leading to anger and failure (Boston, 1992).

The orientation process can address some of these problems, by including training for the students, related to the technology of the distance delivery model. Understanding the technology will allow students access to their peers, facilitate group bonding, assure a positive self-identity, avoid some costly errors, and begin the creation of new support systems.

Conclusion

Teachers in the on-line environment must be aware of student characteristics and situations presenting barriers to the students effective learning and success. Instructors that are aware of the barriers can adjust for them by assisting the student in being "aware of and comfortable with new patterns of communication, learn to manage their time and take responsibility for their own learning" (Sherry, 1995, p. 8). In addition they must integrate new strategies into their traditional repertoire of skills as teachers.

Instructors that are successful in a traditional classroom environment are not guaranteed to be successful in the on-line, classroom environment. However, with an acceptance of the process orientation towards learning and an adjustment of teaching styles, feedback and assessment faculty will have a much greater chance of assisting students toward success, making their teaching experience more successful. It is critical for on-line programs to provide instructors with appropriate tools to make them successful. Having dedicated, skillful faculty with a desire to learn creates an opportunity to influence faculty success, and by extension student success in the virtual classroom.

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Some Issues Concerning The Creation and Use of Electronic Textbooks

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The aim of this paper is to provide an overview of current developments in the area of electronic books. Following a discussion of the key terminology used in this field, a number of issues will be investigated: computer programs as textbooks at schools.

Looking for a Definition

From K-12 schools to universities, textbooks in part dictate the curriculum's content, guide the teacher's instructional plans, and model the student's understanding. However, the term textbook is neither precise nor stable (Johnsen, 1993). If we confine the word *textbook* to books produced for use in instructional sequences only, we exclude books whose authors did not intend such use. For instance, when a copy of Shakespeare's plays is used for teaching, it becomes a "textbook". The manual accompanying software or hardware is also a textbook in a sense. In order to better explain textbooks, in "Paradigms Lost: Towards a Historical Sociology of the Textbook," Stray (1991) reserved the term *textbooks* for books written, designed and produced specifically for instructional use, and the term *schoolbooks* for books used in instruction but less closely tied to pedagogic sequences. In this strict sense, "schoolbook is first attested in the 1750s, and more commonly from the 1770s," (Stray, 1991). "Textbook does not appear until the 1830s. Its two word predecessor *text book* is much older, and denotes the text, usually Latin or Greek, used for instruction" (Stray, 1991). According to Johnsen (1993), the definition of a textbook can also be so general as to include other books made and published for educational purposes, or even any book used in the classroom. The textbook may also be a subset of an even broader and increasingly more commonly-used term — teaching media. In this paper the term textbook refers to material designed specifically for instruction in either K-12 or higher education.

Computer Programs as Textbooks

Jonassen predicts that K-12 textbooks will evolve over time. "The term textbook will be applied to a growing variety of functions in differentiated, individually-tailored teaching situations" (Johnsen, 1994). The shift away from the context of textbooks as ink-on-paper products redefines in many ways the work of publishers, and authors, and it is forcing textbook publishers into association, and competition, with businesses formerly thought to be alien, such as television, movie , and other non-print media creators.

Computers have been used in K-12 education for many years, principally for tutorial and drill and practice activities but also for innovative activities such as simulations. Computers are also widely used in education as tools. Many students, for example, regularly use word processors or drawing and painting programs. Until the 1990s, however, computer software was generally a supplement to instruction rather than a focus for primary instruction. When students completed tutorials at the computer, or played simulations, they were adding a computer-supported learning strategy to others that were based on a printed textbook.

In the 1990s, the almost total dominance of ink-on-paper textbooks has been challenged by a number of electronic texts. Texas was the first state to adopt Optical Data's *Windows on Science,* a videodisk-based product that replaced, rather than supplemented, the science textbook. In 1992, the state of California also adopted a number of non-print-based science programs as textbooks. Among these were the *Britannic Science System* and *Science 2000* by Decision Development (Hopkins & Itelson, 1994). Since then, several publishers have produced electronic textbooks for a wide range of K-12 subjects and levels, and state education agencies as well as local school boards have sometimes accepted them in place of a printed textbook. Traditional texts are still the primary resource in the great majority of classrooms, but the success of some first generation electronic textbooks may encourage wider adoption and use.

There have been a number of innovative projects that have created electronic texts. Voyager' *Expanded books* series represents a commercial effort to introduce electronic books into K-12 classrooms and to the general public. One example of a Voyager electronic text is *Macbeth*. The *Living Books* series of electronic books on CD-ROM by Broderbund are also used in many American schools and are in hundreds of thousands of homes. More recently, with the advent of the Internet, teachers and the student are able to access electronic databases from their personal computers at any time of the day or night as long as they have a valid account.

Many children's books are designed to be played on a typical home computer with multimedia features. Other types of books, such as corporate operations manuals, are often created to be distributed via a LAN (Local Area Network). Some multinational companies with proprietary Wide Area Networks even use this method to disseminate a wide range of books to locations around the world. Until recently, however, few of the individual buyers of electronic books had access to WANs. The distribution of electronic books to buyers through traditional book stores and software stores has been accomplished to date primarily by storing the books on disks or CD-ROMs. Several hundred e-books are now available on diskette or CD-ROM. At the end of 1996, CD-ROMs offered storage capacities up to about 700 MB in a small, sturdy package. The majority of electronic books purchased today are probably distributed on CD-ROM. Their characteristics of durability and compact size make them easy and cheap to ship.

CD-ROMs have many advantages but the unbelievable growth of the Internet has also made electronic distribution direct to the buyer's hard disk feasible. A few years ago, when Internet access was limited primarily to academics and the military, distribution via the Internet made little sense. Today, with millions of people using the Internet daily, it is becoming a cheap way to disseminate electronic books. Voyager, a pioneering publisher of electronic books, was one of the first to sell some of their electronic books through the Internet.

The Internet, especially the World Wide Web, may be poised to play a critical role in the easy dissemination of electronic books. It may also play another role as well - that of unofficial standards agent. As more books are created in electronic form and as more bridges are constructed to help numerous printed books pass over into the world of electronic books, there is a need for some standardization in the way text, graphic, and multimedia elements of electronic books are created, stored, and disseminated. The World Wide Web, through HTML and browsers such as Netscape that accept a variety of plug-ins, may become a standardizing influence in the electronic book publishing market. HTML, or the standard that emerges from HTML, may become the standard for most electronic books that will be disseminated via the Internet. HTML, with the help of plug-in software that supports display of many different types of media, offers developers a platform that is flexible and robust enough to support the creation of a wide range of electronic books.

There is no doubt that there is a need for some standardization, even in the face of rapid technological developments. One particularly important area in which some standards or approved alternatives is needed is in the area of search commands and indexing formats. Currently electronic books support an idiosyncratic range of indexes and data types that make it virtually impossible to use a single electronic search program to look for information or "hits" in electronic books produced by different publishers (Lu, 1993). The World Wide Web has, however, a number of search engines that were created to locate material written in HTML. The work on Web search engines could be used for electronic books as well if HTML becomes the standard format for them.

A Comparison of Print and Electronic Textbooks

Guidelines for choosing between the use of paper-based versus electronic textbooks are not well documented in the literature. Some common sense issues do, however, seem clear. If there are situations where electronic books are more useful, desirable, or effective than printed books, they are probably situations that need or require features unique to electronic books:

1. The ability to incorporate a wide range of media: text, pictures, and illustrations as well as animation, video, and sound.
2. The potential search and retrieval features of electronic books that include the ability to conduct sophisticated searches of the book (and linked resources).
3. The potential for non-linearity that allows students and teachers to create different "paths" through the material.
4. The ability to link material in the "book" to other material outside the book such as resources on the Internet. A reference at the end of a chapter, for example, could be "hot" so that the reader can jump directly to that reference if it is located at a site on the Internet.
5. The ability to move individual readers beyond the static, somewhat passive nature of book reading to an interactive, much more involved form of participation.
6. The potential for group interaction between readers of the same text as well as links to other groups and forums that deal with topics relevant to the book.
7. The ability to provide useful feedback to students and to provide interactions that involve students heavily in the exploration of the material presented. Electronic books can incorporate everything from drill and practice and tutorial exercises to cases, problem-based learning activities, collaborative projects, and simulations.

The "book" is no longer only a static, linear, and passive medium of instruction. Simply replacing what is done with paper and books with electronic versions of more of the same fails to capitalize on what the multimedia environments of modern personal computers are now capable of providing. Reading an electronic book can be very different from reading a traditional book. Different usage patterns call for different designs to facilitate new ways of reading. For example, if readers have the option of exploring the content of an electronic book in a non-fashion, designers must take care to provide appropriate navigation tools, built in a rich set of links, and make sure each segment of material can stand alone. Someone reading any single page or screen may not have seen the preceding one and may not move on the the following page. There is a sense of position readers miss when they read a non-linear electronic book. Readers thus need help to develop a sense of where they are in the material as well as how large the information landscape they are working with is (Boiling, 1994).

Where Do Electronic Books Seem Most Useful?

Electronic books using current technology seems most suited to applications that involve storage of large amounts of information that will not be read "from cover to cover" but will, instead, be searched by readers looking for specific bits of information. There are a number of uses that fit those general characteristics. "What are the characteristics of the information that scholars obtain from books to write their research monographs?" is the question raised by Kilgour in "Providing Scholars with Information from Electronic Books" (Kilgour, 1994). He conducted a series of analyses on scholarly books, journal articles, and proceedings, and found that two-thirds of the citations in scholarly books are to information on a single page of other books. Electronic publication, which allows the user to use sophisticated search strategies to locate relevant information, would be an advantage to many scholars as well as their students.

In K-12 schools, it is in the area of reference works and indexes that electronic access is often far superior to access via print (Aust, 1993). Some of the most satisfying electronic book genres sold for home use are those intended mainly for reference (*The Economist*, September, 1994). These electronic books are referred to as "hyper-reference" by some researchers (Aust, 1993). *The Economist* recognized the electronic edition of the *Oxford English Dictionary* as the masterpiece to date in electronic reference books to date. The article commented that what "sets it (the *Oxford English Dictionary*, Second Edition) apart and makes the choice of CD-ROM much more than just a means of storage, is the addition of an unusually flexible . . . search-programme that enables the user to isolate almost any variable — etymology, for example, or citations — and so conduct on a whim, with perfect accuracy, arcane analyses that might otherwise have taken months" (*The Economist*, September, 1994, p. 83). Electronic encyclopedias share similar advantages with the *Oxford English Dictionary*'s electronic version. Reference books thus seem to be one type of publication that is most suited to electronic publication.

The advantages of using electronic technology to deliver detailed, fact-based materials are well documented in other literature (Sutton, 1994). Encyclopedias, statistical reference works, bibliographies, technical manuals, and similar kinds of publications can be adapted to electronic environments in ways that not only improve on their traditional functions but also offer new ones, such as quicker access to information and sophisticated search options for locating material on specific topics. Hypertext also offers the designer the opportunity to create materials that include a wide variety of media, including text to images, animation, video, and sound. The links among nodes of material may be built into the document by the author/designer, or they may be constructed by the user as needed, or "just in time". Thus, a second area where electronic publication seems to have the advantage is large knowledge domains that are more often searched or browsed than read from beginning to end. These are, however, simply extensions of the basic model of an encyclopedia or dictionary.

The advantages of electronic books for texts where interpretation and the experience of reading itself are more important than quick access to facts are less recognized in literature. Richard Lanham suggests in a essay that the mass movement towards electronic texts in other fields will eventually affect arts and letters as well, altering texts of the past and our perceptions of them as well as the written word of the future (Lanham, 1989). Sutton also pointed out that a variety of efforts are now underway in the production and use of literary texts in electronic form (Sutton, 1994). In the arts and literature, computers are regularly used for certain types of research (Pickard, 1994), but the role electronic books will play in these fields is not well understood at present. There is even some debate about whether electronic books like *Grandma and Me,* one of the Living Books series of multimedia children's stories, is an appropriate expansion of the concept of a children's book, something quite different from a children's book, or a step in the wrong direction.

Electronic Textbooks As Elements of Change

Analyzing the place of electronic books on the basis of the type of content in the book is only one approach to answering the question, however. Another involves matching the book with the approach to instruction. Traditional teacher-centered approaches to instruction are well supported by printed textbooks. Traditional models assume the teacher has selected the content of the course, established the tasks students must complete, and developed a means of assessing student achievement. In this linear, top-down approach, a printed textbook can play an important role. An electronic textbook may offer students additional media such as sound and graphics, but much of the flexibility of hypermedia/multimedia materials is not used in a traditionally-taught course. Students begin with assignments from Chapter 1 and proceed through the course, reading chapters in order, and completing teacher assignments.

When a course is taught from a constructivist perspective, the flexibility afforded by hypermedia/multimedia materials becomes much more important. When students make many decisions about what they need to know, the search and analysis features of electronic books become much more important, especially if the textbook contains much more material (and links) than could be covered in the course if everyone were expected to learn all the material. Constructivist teaching/learning environments also emphasize the need to explore and understand multiple perspectives. A powerful feature of electronic books is the capability they afford a learner for extensive interaction with an idea, or even a word on the screen. In fact, if Jonassen's (1994) eight characteristics of constructivist learning environments are considered one by one, all are facilitated by the use of electronic textbooks over printed books. For example, his seventh principle, "enable context- and content-dependent knowledge construction" can be supported by providing tools students can use to build their own "textbook" on the topic and by providing links to rich information resources. The material to be developed is an electronic book to support a constructivist approach to teaching and learning.

Conclusion

The potential of electronic books has considerable appeal to teacher educators, both as options for the creation of instructional materials for teacher education courses and as a vehicle for supporting K-12 education. Teacher educators with the expertise and experience needed to create electronic textbooks may find them important elements in solutions to instructional problems in both higher education and K-12 schools.

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TELEMENTORING: PRE-SERVICE TEACHERS TO IN-SERVICE TEACHERS

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After surveying the literature on information technology and teacher education, Willis andMehlinger (1996, p.978), conclude that, on average, "pre-service teachers know very little about effective use of technology in education." Furthermore, teacher education is indicted for "not preparing educators to work in a technology enriched classroom." (Willis & Mehlinger (1996, p.978). According to the Office of Technology Assessment (1995), graduates of teacher education programs in the United States do not think of using technology as a "teaching tool." Even though students are taking computer literacy courses for teacher certification, they are not incorporating it into their lessons when they become certified as teachers.

Technology in Teacher Education Programs

It is not enough for students to take a computer literacy course. Integration of technology must be modeled by the faculty in the college of education (Office of Technology, 1995). That usually does not happen (Willis & Mehlinger, 1996; OTA, 1995). The problem lies in the fact that many present day teacher education faculty did not receive training in technology and taught in K-12 schools that had little, if any, technology. This gap in training is part of the reason technology is not modeled in teacher education programs (Office ofTechnology, 1995). Furthermore, effective integration of technology into teacher education involves more than adding a single required "computer course." Technology needs to be incorporated into content area methods courses (Office of Technology Assessment, 1995, Fullan, 1991, Novak, 1991). One step toward integration would be for students to communicate with content area professors and other students by e-mail or on a listserv created specifically for a particular class.

Telecommunication

Findings from the *1995 Survey of Advance Telecommunications in U.S. Public Schools, K-12,* revealed that fifty percent of U.S. public schools now have Internet capabilities somewhere in the school building as compared to thirty-five percent of the schools a year before (National Center for Education Statistics, 1996). Because there is an influx of telecommunications resources into our schools, pre-service teachers particularly need to know how to incorporate those resources into their teaching curriculum. Telecommunication is an easy first step that can facilitate collaboration between faculty and students (Bishop-Clark & Huston, 1993).

Telecommunication Projects

An example of an on-going telecommunications project involves biology students at the University of Illinois (Levin & Boehmer,1994). Freshman biology students are involved in a model called *teaching apprenticeship.* Students are apprenticed by a community of educators through e-mail. The Internet-based *Electronic Emissary Project* (Jones & Harris, 1995) is still another example of an on-going telecommunications project. The *Electronic Emissary Project* matches teachers with subject matter experts. One of the benefits of this program is the promotion of collaborative learning.

Telementoring: Preservice to Inservice Teachers

The telecommunications projects reviewed above, and other electronic projects that have been described in the literature, influenced me to venture out on her own. Preservice teachers from the author's *Reading in the Content Area* methods class were chosen for this research project. As mentioned before, the literature supports modeling of the integration of technology in methods' courses.

Mentor teachers from all over the USA and Australia volunteered by responding to a notice on an educational listserv. The mentors had a wide range of teaching experience. Many of the mentors held master's degrees and had their own web page. One mentor had recently published an article about her own on-line experience in the classroom.

The pre-service teachers, prior to being matched with a content area mentor, were administered the *Computer Attitude Measure* (Kay, 1989). The measure consists of Likert type questions about behavioral, affective, and cognitive aspects of their views about computers. The survey can easily be completed in fifteen minutes.

Next, the pre-service teachers observed a short e-mail demonstration by the instructor that modeled the way they could use the telecommunications resources available to them through the university. At that time, a computer technologist was not available to help them or provide additional demonstrations. For some students this demonstration was enough. For the students that had not obtained their university e-mail address and thus had no experience with the system, getting "up and running" was more difficult.

Originally the preservice teachers were asked to communicate with their mentors six times during the semester. Later in the semester I reduced the minimum contact to four times. The quality of the messages was more important than the quantity. I originally was looking at the effectiveness of implementing electronic mentoring via e-mail in a methods course. It soon became clear that other ways of using technology could also support the course and possibly influence pre-service teacher's perspectives on the implementation of technology in their classroom. Setting up a listserv for this class was another way to model technology. The listserv was aptly named, *scaffold*. The listserv was one mode of communication linking the classmates. Students also had the option of sharing teaching tips from their mentors with other students via the listserv. It was also a way for students to continue discussions from the class meetings. The instructor was also able to communicate with the students without having to wait until the following week.

In examining the end of the semester reflections, students that did not feel as comfortable with an electronic mentor were more comfortable communicating on the listserv. On the other hand, some of the students who had a working relationship with their mentor were not as impressed with the listserv. The instructor was able to see patterns emerge on the listserv. In the beginning, it was viewed as a place to socialize, even share jokes. As the semester progressed students shared information from their mentor regarding discipline, first year teacher anxieties, and lesson plans. Late in the semester the students were sharing web sites they found on the Internet and recommending technology articles they read!

The majority of the class was excited about having an electronic mentor. Because the author matched the preservice teachers with a mentor in their content area, it was a difficult task that required considerable time and effort. The biggest problem was the effort required to find mentors for an unusually large number of all level music majors who happened to take the course. None of my original volunteers were music teachers. I had to rely on local mentors for them.

Reflections

Within a week after receiving the mentor's name and e-mail address, students began to share their successes in terms of positive experiences with their mentors. I had a very good feeling, as their instructor, when students talked about their successes. The honeymoon was short lived, however. My e-mail soon became a complaint department! Fullan's (1991, p.27) comment that "conflict is essential to any successful change effort" became my solace. Some of the students had unrealistic expectations as far as how rapidly a mentor could answer their myriad of questions. They somehow forgot that these dedicated men and women were teachers with other responsibilities as well.

Logistics was another problem for some of the students. Not all students owned a home computer. They thus had to use computers available at the university and their class schedules determined when they were on campus and when they were able to check their e-mail messages. One of my students suggested that in future a few minutes might be taken out of class time to allow students to check and send e-mail messages. This might be a practical suggestion worth pursuing.

Many of the preservice teachers that felt a kinship with their mentors and one remarked "we have the same philosophy of teaching, we are so alike in our thinking, we are passionate about teaching." The pre-service teachers that developed a nurturing bond with their mentors were often open to suggestions from their mentor.

Even though some students were reticent in the beginning about having an e-mail mentor, most of the students felt it was a beneficial project by the end of the semester. Many of the students plan to continue communicating with their e-mail mentor, especially when they are involved with student teaching.

This research project was an initial attempt of a college of education methods instructor to model the integration of technology. The rationale was based on a review of the literature. It represents one of many ways technology can be incorporated into a methods course as a means of supporting the goals of the course (as opposed to being one of the topics in the course). It is a first start, but it hints at what is possible.

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Use of Mentorship in the Integration of Technology for Teacher Preparation

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According to Papert (1993), many hold the view that the only route to better performance is the improvement of instruction. But, as we are transitioning from the Industrial Age to the Information Age, we are finding that teaching methods used in the past are not the best methods to use for teaching the skills needed for this new era. If we want to help students learn how to problem solve and develop critical thinking skills, we need to integrate technology into our daily planning of lessons. Most educators agree that our students need to acquire the following "survival" skills: problem solving and critical thinking, information handling (organizing, accessing, manipulating, and evaluating), global awareness, technology skills, and ability to cooperate and collaborate with others (Simonson & Thompson, 1994). A critical aspect of the process of integration is helping educators become aware of the resources technology can offer them as professionals within the context of their jobs. According to Helen Harrington, "Preparing teachers to use technology or using technology to prepare teachers each serve a function but it is the second that addresses the most critical issues in teacher education" (Harrington, 1991, p. 55).

Our goal at Iowa State University in the College of Education is to integrate technology into teacher preparation. One of the ways we achieve this goal is through the use of mentorship. As a component of the course entitled "Technology in Teacher Education," doctoral students are assigned by the instructor to work one-on-one with a Curriculum and Instruction faculty member as a mentor. Our objective is to provide a supportive learning environment and become a resource in technology for these volunteer faculty members. We believe that in order to help in the process of integrating technology into the classroom, we need to model the process and how it works. Mentorship has provided opportunities for our faculty members to understand technology's role in education and to achieve the goal of being able to integrate technology within the learning environment.

The purpose of this paper is to describe the role of mentorship in the integration of technology in teacher preparation at Iowa State University in the Department of Curriculum and Instruction.

Background/Program Description

The following quotation describes the background of the mentorship program at Iowa State University and provides an overview of the program.

> During the spring semester in 1994, a graduate course entitled "Technology in Teacher Education" was offered for Ph.D. students in Curriculum and Instructional Technology. The basic purpose of the course was to review the literature on use of technology in teacher education and to provide professional practical experiences for the students. For the field component of the course, each of the eleven graduate students was assigned to help one or two faculty members to integrate technology into their courses (Thompson, Schmidt, & Hadjiyianni, 1995,pp.17-18).

During the fall semester of 1996, seven graduate students participated as mentors to the faculty members who volunteered. Represented were faculty from a variety of disciplines such as foundations, methods and ethnic studies, possessing a wide range of computer skills. The mentors met with their mentees for one hour each week during the semester assisting with their work with technology and teaching.

Process Description

The instructor matched the doctoral students enrolled in the class to faculty members who had volunteered to participate. Letters were sent to faculty members to identify their prospective mentor's names, reiterate the purpose of the mentorship, and to set guidelines for the working relationship. It was important to communicate to all participants, both the mentors and the mentees, that the mentors were not being provided to do the mentee's work, but to be available to aid in the development of the mentee's skills in the area of technology.

The mentees were contacted through personal visits and notes. Some of the objectives of the first meeting included geting to know each other, alleviating any immediate concerns, deciding on meeting dates and times, discussing expectations, assessing technical knowledge, and seting goals. The most vital part of the first meeting was to get to know each other and to define the expectations of both parties.

Mentee Descriptions

Mentee Dr. A was a seasoned classroom teacher with a background of over twenty years of teaching experience at the elementary level, and ten years at the college level working and teaching in various capacities. It should be noted, also, that Dr. A earned her Ph.D. in May of 1995 and was in her first year of teaching as an assistant professor teaching multicultural education. She describes the technology skill level at which she entered the mentoring program as "pre K," and stated that she used the computer as a "glorified typewriter" to type papers, materials needed for the classes she taught, and other communications. Dr. A explained that she was confident with most of the functions of the computer as it related to word processing and was ready to begin looking at expanding her use of the computer in order to communicate more efficiently with other faculty, colleagues and students.

Mentee Dr. B was a first-year faculty member at Iowa State University. She teacges social studies methods. Her previous teaching experiences included five years in K-12 public schools (ninth grade world history and twelfth grade economics and government) and nine semesters at the postsecondary level (elementary and secondary social studies methods). Her main use of technology prior to the mentorship was using the computer for word processing and e-mail communications.

Theoretical Framework

The theoretical framework used in the discussion of these mentorship experiences is based on the three levels of technology use in teacher education described in the Office of Technology Assessment report on technology and teacher education. The three levels are defined by the knowledge and/or the integration of technology into teacher education. Level One is identified as discussion/demonstration where the professor may discuss or even demonstrate how technology may be used within a classroom. Level Two is identified as technology practice where the teacher provides hands-on practice in technology. The last and most involved, Level Three, professional practice, involves the students seeing the integration of technology into the curriculum and practicing teaching with technology (Office of Technology Assessment, 1995).

We have used this model as a lens through which to view our mentorship experience as it relates to the progress of the mentees toward the integration of technology into teacher preparation.

Level One: Discussion/Demonstration

This stage began within the first meetings after the mentees identified their specific goals for the tutoring experience. Dr. A identified the following goals:

- learn more about the basics of computers and related technology to be able to integrate it into her curriculum.
- learn how to use e-mail and Quickmail, an interdepartmental mail system, to be able to communicate with faculty, colleagues, and students.

Mentor A's response to accomplish these goals:

- taught the basics of computers and networks.
- taught procedures for the efficient use and management of the e-mail system.
- demonstrated and help set up a spreadsheet to manage grades.
- discussed/suggested using Hyperstudio, an authoring program, for students to make curriculum projects.
- discussed/suggested using the WWW for obtaining current resources for her subject area.

Dr. B identified the following goals:

- use technology for professional purposes (i.e. use Scholar and the WWW for research).
- create a student/class mailing list utilizing the e-mail system.
- integrate technology into daily lesson plans.
- justify technology (i.e. find/utilize the best method for a given task e.g. PowerPoint vs. overheads).

Mentor B's response to accomplish these goals:

- taught how to access Scholar through telnet—performed an ERIC search.
- provided information regarding non-accessibility of Quick-Mail from a remote site, provided information regarding the necessary logistics to access e-mail from a remote site.
- demonstrated using WWW use for class/lecture.

Level Two: Hands-On Practice

With a designated time set aside for meeting with Dr. A, the opportunity for hands-on experience and practice was set in place. Dr. A faithfully completed her "assignments" whether it was going through her, seemingly endless, mail list to delete or file mail documents as needed or entering student information on her newly created spreadsheet template. Seeing immediate positive results provided Dr. A with some intrinsic rewards that served to motivate and encourage her as she went through months of old and outdated messages. This proved to be of benefit and a means for Dr. A to gain the hands-on practice necessary to strengthen her technology skills. As the relationship between the mentee and the mentor grew, Dr. A readily sought help when needed between meeting times. Messages were easily and quickly exchanged by e-mail as Dr. A became even more efficient with its use.

As the weeks progressed, a number of teachable moments occurred such as when Dr. A unintentionally changed her printer destination and printed some of her personal documents on a printer not usually accessed by Dr. A. With the use of a bit of levity to lighten the seriousness of what had happened, little or no damage was done to Dr. A's confidence as she continued to work on increasing her technology skills.

After constructing a template together using Microsoft Excel, a spreadsheet application, Dr. A was provided, again, with hands-on practice as she found it necessary to enter data from each of her class sections. Soon she was able to paste formulas and cut and paste entries to manipulate data to personalize the spreadsheets to meet her own particular needs. Changes and additions to the original entries were completed with increased ease, as Dr. A continued to use the spreadsheet application for managing her grades. When the end of the semester arrived, Dr. A was able to see, firsthand, even more of the benefits of using technology, as she was spared the time and effort usually needed for calculating final grades.

By the end of the semester Dr. B decided to experiment with a Technology Day for her two sections of social studies methods students. During class time the students completed three of eight possible prescribed stations set up in the Instructional Resource Center. The type of stations included: VCR, laser discs, WWW, scanner, CD-ROM software, social studies software, and a seek 'n find of other technology located within Instructional Resource Center.

The students worked cooperatively in eight groups of three to four each. At each station, criteria sheets were filled out. The sheets were used to aid the students to critically evaluate the usage of each type of technology. Also, the students trained each other how to use the equipment.

Mentor B and Dr. B observed from the process that the students crosstrained each other on the equipment, collaborated on the project, discussed the justification of the technology, and generated lists of how to integrate the technology. From the criteria sheets the students found the technology to be realistic, interactive, and student centered. They also noted that most of the technology lent itself to supporting multiple learning styles. Some of the issues the students saw as problematic were lack of funds, lack of user-friendly software, lack of teacher training, and lack of time.

Level Three: Professional Practice

When Dr. A completed her spreadsheet containing her grades, she was able to inform her students on a weekly basis of their up-to-date progress in the class. A large number of these students, who were education majors, could see how Dr. A used technology to provide current information regarding their grades and progress. After the Technology Day experiences, Mentor B and Dr. B looked toward modeling the use of technology within the classroom. The goal was to locate equipment, find suitable software, and develop criteria for software review.

As Dr. A and Dr. B increased their use of technology in the classroom arena, the ground work will be laid for preservice teachers to continue moving along the continuum of the three levels of technology as outlined by the Office of Technology Assessment. Hopefully, they will be able to model the same use of technology when they have classes of their own. If so, the ultimate goal of the three-year program at Iowa State to infuse technology throughout the teacher education program will have been realized. That goal is for preservice teachers to become creative classroom teachers who use technology to its fullest to facilitate the teaching and learning process.

Observations and Future Considerations

Ely (1995) lists the following as necessary elements for successful acquisition of technology skills:

- dissatisfaction with the status quo
- knowledge and skills
- resources
- rewards, incentives
- commitment
- leadership
- time
- participation

The Office of Technology Assessment 's (1995) list includes the following items:

- hands-on-learning
- resource person
- practice
- access to equipment
- administration support
- time
- learning to use as a pedagogical tool
- incentive to use and to integrate.

A number of things come to mind as we reflect on this experience. Dr. A and Dr. B exercised a great deal of initiative by volunteering to be part of the mentorship program. Dr.A was an instructor who could have easily decided to bypass the experience at this stage of her teaching career, having taught over twenty five years without using most of the technology available today. Yet, she was willing to take part. We believe this relates to one of the factors on Ely's list of factors needed for the technology integration process to work effectively. That factor is dissatisfaction with the status quo. Dr. A was no longer satisfied to use technology in the minimal ways she had in the past. She realized that she was behind many others who were reaping the benefits of technology in their teaching. She shared that a close department colleague had started using technology to correspond with other colleagues outside of the country. Also, Dr. A had recently returned from a sabbatical where she had traveled to other countries and formed friendships that could be maintained through the use of e-mail.

Dr. B, a first-year faculty member, saw a need to expand her knowledge of technology as she became a member of a technology-oriented department. Other factors, such as time, which appears on both lists as factors needed for successful technology integration, had an enormous impact on this experience. Participating faculty members, when asked why they thought the experience was a success, responded that having a designated time set aside each week when the mentor came to work with them in their own environment, allowed them the benefit of working in the least threatening environment. They also added immediately that the one-on-one situation provided an opportunity for them to ask "dumb questions" that they would not have been able to ask in a group setting. Finally, a key point mentioned was the fact the relationships that were built allowed the mentees to feel free to seek assistance between sessions. The literature has repeatedly made the point that availability of technical support is a key issue relating to successful use of technology. Additionally, as these pairs and groups bonded, emotional support was easily added to the list of benefits of the mentorship experience. Dr. A is now looking forward to all of the possibilities that are available to her as she is inspired to learn how she can integrate technology into her curriculum. " I didn't even know enough about technology to even realize the possibilities of what I could actually do with it. Also, I'm now using my computer every day, where I used to use it only twice a week because it was so tiresome. I avoided it because it was just another chore. I frankly didn't like it. Now, that's changed and I believe that the enthusiasm of my mentor helped to cause that change." Dr. B is looking forward to using technology to expand her professional development. This includes presentations at the state and national levels. This further supports that fact that the mentorship program offered numerous unanticipated benefits and it is with this in mind that we hope to see it continued at Iowa State and replicated in other settings.

Our experience was very positive and plans exist to continue with the mentorship relationship. Both of the mentees expressed feelings of increased confidence with technology. One of the positive results was the professional growth for both the mentors and the mentees. The goal is to continue to research, write proposals and papers, and to present our success as a model for others to follow.

Suggestions for others who try to replicate this model are to provide practice time for the mentees, get to know each other, set goals, be able to justify technology, create an unthreatening environment, develop a support system, provide one-on-one instruction, meet on the mentee's "turf," and inform appropriate administrators of the positive outcomes of the mentorship program.

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An Innovative Technology Education Program: Enrichment and Opportunities

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This paper will describe the effects of the Synergistic Curriculum on students and teachers in middle school settings. Why should we think carefully about interventions with technology education programs in middle-school settings? We make the argument that the evaluation process should impact technology design. We have no doubt that the promises for technology applications will ultimately come to pass, at least insofar as barriers on resources and implementation are reduced. We wish to encourage the design of educational technology that will help students learn, help teachers, and transform schools into a truly valued part of the community. What we specifically looked at in this paper was the effect of Synergistic Systems in middle-school settings in terms of design and educational benefits to students when learning about technology (Harnisch, Gierl, & Migotsky, 1995; Harnisch, Migotsky, & Gierl, 1995).

A recent report from the Congressional Office of Technology Assessment (1995) suggests that the teachers are the most important part of the education equation when considering the integration of technology in the classroom. In addition to examining the student outcomes, we examined the role that the teacher plays in the Synergistic lab. This was evaluated both through our observations in the classroom and also by visiting the teacher-training program offered by the Synergistic Systems, Inc.

Evaluation of technology education programs requires multiple levels of thinking. First, we must address whether the technology education program accomplishes its intended purpose. Synergistic Systems (1995) have the following features:

- new educational system that transfers responsibility for learning to the student
- four primary components in the Synergistic Systems necessary to ensure success for student & teacher
  - Learning environment
  - Learner organization
  - Module curriculum
  - Instructor enablement package
- Learning environment that features a lab configuration which conveys a sense of order and excitement. Ergonomic workstation design, storage capability, and aesthetics are fully incorporated in the furniture.
- Learner organization that is based on a two-by-seven principle where students are paired for seven days to complete a module of the Synergistic curriculum. Teachers respond to student questions when they see a call light at their workstation. Students use computers, videos, hands-on activities, and other educational materials to complete the educational activities of the module.
- Synergistic module curricula integrated with the learner organization resources to ensure a consistent delivery of information with a specific format which allows the teacher to monitor student progress and success.
- Instructor enablement package that allows the classroom teacher to realize their role as a facilitator of learning and allows the teacher to gain philosophical insights and hands-on experience with the Synergistic Systems. Instructors are given software resources to handle student scheduling in addition to professional technical assistance via phone, electronically, and newsprint. All of these support features are designed to help teachers succeed.

New technology education programs are likely to suffer from ills related to its novelty, its integration into existing systems, and its high initial costs. Technology education, provided in the Synergistic Systems, represents a new start and a program that helps to attain new goals which may have attitudinal effects and provide additional time for other important outcomes. Our evaluation examined outcomes beyond the instructional goals. Our approach used multiple techniques to determine the outcomes, both positive and negative, of the technology education program. In the next section of this paper we describe the methods used and discuss the evaluation questions and approaches along with their merits.

The Synergistic Systems were used to enhance and supplement technology education in middle schools. The system we observed contained 16 modules that allowed students to interact with different forms of technology. Modules included computer problem-solving, rocketry and space technology, and applied physics. Each module was self-contained providing instruction through videos, reference books, hands-on projects, progress log books, and tests. Students worked in pairs and typically spent eight days in each module, with the final day as a "Discovery Day." The teacher served as a facilitator of learning by organizing the modules, coordinating activities, and troubleshooting problems. The Synergistic Systems are purchased by a school, and includes software, teacher-training, technical support, lab furniture, and reference materials. The school provides computers and other hardware (for example, schools purchase the cassette recorder for the audio broadcasting module).

The effects of the Synergistic Systems on the students and teachers at Washington Middle School and Fremont Middle School in a Midwest community were evaluated. The focus of this evaluation was on cognitive and affective engagement in the participating students as they worked in the Synergistic lab. We also assessed the effects of the system on the culture of the school. Although the system has been endorsed by teachers and students, this evaluation was both timely and important because no systematic empirical studies have been conducted. Consequently, the results of our evaluation yields important information about the effects of a Synergistic lab experience.

Research Questions and Evaluation Overview

The evaluation was developed around seven focus questions.

I. Student Level

1. Do students understand the material presented in Synergistic modules?
2. Do students find lab tasks interesting and engaging?
3. Do lab activities instill self-confidence in learning and self-esteem in the learner?
4. Does cooperative learning occur in the lab and does this style of learning transfer to other classes?
5. How has the relationship between student and teacher changed as a result of the Synergistic lab experience?

II. School Level

6. How have other teachers responded to the Synergistic lab, and the style of learning that it promotes?
7. How has the Synergistic lab influenced the culture of the school?

In order to address these questions, our evaluation design contained six main components: shadowing pairs of eighth-grade students through a rotation of a module, interviewing the shadowed students along with their parents about the impact of the system, conducting focus groups with eighth-grade students about their impressions of the system, talking with teachers and administrators about the Synergistic Systems, surveying students, and critiquing Synergistic Systems modules. Eighth-grade students were the unit of analysis in this evaluation because the Midwest sites had well-equipped Synergistic labs where eighth graders completed a semester of lab work.

Methodology

The evaluation questions were addressed within a quantitative and qualitative research paradigm. A multi-method, multi-site approach provided the evaluators with a complex assortment of data from which to evaluate the system. This approach also ensured that our conclusions were triangulated across data sources. The quantitative modes of inquiry included the use of surveys and district standardized test scores. The qualitative modes of inquiry included observations, interviews, and document reviews.

This evaluation was conducted at two school sites, Washington and Fremont Middle Schools. Our primary focus was at Washington Middle School which was the site chosen by the sponsor, Dr. Harvey Dean. A second site, Fremont Middle School, was introduced to provide a comparative element to the evaluation. Five visits were made to WMS totaling ten days of on-site observation. Three visits were made to FMS totaling three days of on-site observation. The activities 1-5 outlined below were conducted at WMS but only activities 4 and 5 were conducted at FMS. We also saw Synergistic labs in Texas, Indiana, and Illinois.

(1) Shadowing of Dyads. Two pairs of eighth-grade students were followed through a rotation in the Synergistic lab at Washington Middle School. Shadowing simply refers to the unobtrusive nature of our observations. We followed students throughout the school day observing and interpreting behaviors. For example, we examined students' cooperation, effort, and attention toward activities in and out of the lab. The students were chosen by Mr. Lincoln, the technology education teacher, and represented a typical pair of eighth graders. Both students were observed in the lab setting and then followed throughout the school day.

Each of the two pairs observed came from different classes. The evaluation questions guided and structured our observations. Student, parent, and teacher consent were obtained before the beginning of our shadowing component.

(2) Interviewing the Shadowed Students and their Parents. The impact of the lab was assessed by interviewing the shadowed students and their parents. The students were asked to comment on the lab experience using a structured interview. The protocol contained questions about student attitudes, understandings, and impressions. The interviews were based, in part, on our observations of the shadowed students that developed during the week. Parents were also asked to comment on the impact of the lab for their child using a structured interview. The students were interviewed during the school day. The parents were interviewed during the parent-teacher conferences held at the school. These audiotaped interviews allowed for closure of the shadowing process and provided an outlet for discussion about the Synergistic lab and its perceived effects on both the students and the school.

(3) Focus Groups. Focus groups were conducted and videotaped. The purpose of these groups was to allow students to discuss the lab experience, compare the lab to other classes, and critique their technology education program. Both evaluators interviewed their shadowed pairs at the end of the module rotation. In addition, the pairs were interviewed along with other students in the class to get a broader view of potential outcomes and benefits associated with the technology education program.

(4) Supplemental Activities. In addition to the shadowing, interviews were conducted with the Synergistic lab teacher, principal, and five other teachers in the school. The interview questions covered both student and school-wide effects of the Synergistic lab. Both researchers also observed and informally interviewed students participating in the end of semester display activities. This end of semester activity was videotaped.

(5) Surveys. Three different surveys were developed for this evaluation. The first survey contained four questions intended to measure both positive and negative effects of the Synergistic Systems. This survey was administered to 85 eighth grade students at WMS in November, 1994. The second survey contained the same four questions as the first survey plus additional questions addressing specific concerns raised by the sponsor. This survey was administered to 90 eighth-grade students at WMS and 79 eighth-grade students at FMS in May, 1995. The third survey was developed to measure the effectiveness of the teacher training session. It was administered to the 24 participants at the Synergistic Revolution Seminar, Pittsburg, Kansas in June 1995.

(6) Critique of Synergistic Modules. The instructional materials (i.e., video tapes, workbooks, reading materials) used in Synergistic modules were critiqued at the University of Illinois at Urbana-Champaign. Six modules were selected: two-used during the shadowing of students (Engineering Bridges and Applied Physics), two selected by the WMS lab instructor (Transportation and Computer Applications), and two selected by the sponsor (Biotechnology and Career Explorations). These modules represented a diverse set of tasks used throughout the Synergistic Systems. The modules were evaluated on seven criteria: (a) logical sequencing of activities and materials, (b) clarity of instructions, (c) quality of instructional materials and equipment, (d) balance between content knowledge and experiential, hands-on learning, (e) complexity of tasks and activities, (f) application and relevance to real-world and future careers, and (g) appropriateness of research activities and test questions.

Results

In this evaluation, both quantitative and qualitative methods were used to document the engagement of students who worked in the Synergistic Systems. To conclude this paper we answer and discuss the findings for each of the evaluation questions listed as well as elaborate on themes that emerged during the study.

Do Students Understand the Materials Presented in the Synergistic Modules?

For the most part, students seemed to understand the materials in the Synergistic modules. Results from the module post-tests indicated high levels of mastery but these findings require qualification. First, assessments in the Synergistic Systems were weak. Our case studies, classroom observations, and module critiques revealed that module tests contained cognitively low-level items that required little effort or careful thought. Students were also given few opportunities to demonstrate their new understandings. In addition, the module tests were poorly connected to the module activities and to the real world. Thus, the module tests shed little light on this question. Second, our case study observations confirmed what Mr. Clark called "a mixed bag" as some students clearly understood the activities and concepts while others did not. Ryan and Teresa, for example, consistently excelled at their module activities. They were motivated middle school students who demonstrated an understanding of the concepts in the Engineering Bridges module by what they said, by what they did, and by what they wrote. Yet in the second case study, Christina and Matt rarely demonstrated a thorough conceptual understanding during the module activities. They often completed their activities in a mechanistic manner with limited understandings. Third, our interviews and observations supported the view that the level of understanding varied across students. The technology education teachers both believed that most students had a good understanding of the concepts presented in the modules even though the effects were not visible to the non-technology education teachers and parents. The principals at WMS and FMS were much more optimistic, as both believed that students did understand the content in the technology education curriculum.

Do Students find Tasks Interesting and Engaging?

Students clearly enjoyed module assignments and were frequently on-task. Case studies, surveys, and interviews all provided strong, consistent evidence for this conclusion. More specifically, survey data demonstrated that most students were more interested in the technology education class compared to their other classes and that most students preferred the multimedia approach to learning. Students in both schools reported that the best parts of the technology education lab were related to the hands-on constructivist nature of the module tasks and the frequent use of high-tech equipment. Student comments and module critiques also suggested that a balance between hands-on, experiential learning and content knowledge was important. Students were dismayed with modules that presented too much information while the evaluators were concerned with an overemphasis on experiential learning—both features are needed. Indeed, we found several modules that failed to balance and integrate content information with hands-on activities.

Do Lab Activities Instill Self-confidence in Learning and Self-esteem in the Learner?

The lab may instill self-confidence and self-esteem although we found little evidence to directly address this question. During our visits to WMS and FMS, technology education teachers and administrators frequently reported anecdotes about student successes in the Synergistic lab. For example, Mr. Clark identified two FMS students who could not successfully complete their coursework in most classes. Both students were "incompatible with the system," he said. In technology education, however, these two students found an outlet for success, and they consistency completed their work in Mr. Clark's class. Mrs. Winston had a similar story to tell. We did not observe such a case. Rather, we consistently encountered, through interviews with teachers and parents, indefinite and unsubstantiated claims. Most respondents simply stated that they could not tell if the lab influenced a students' self-esteem. However, some indirect evidence was available. For example, students reported that they were more comfortable working with high-tech equipment as a result of this technology education class experience. Case study and classroom observations also indicated that many students who successfully completed their activities were proud of their achievements. The impact of this pride, which may have been fleeting or enduring, was almost impossible to assess with our evaluation design.

Does Cooperative Learning Occur in the Lab and Does it Transfer to Other Classes?

Cooperative learning consistently occurred in the lab whereas transfer was rarely, if ever, observed. The case studies demonstrated that students consistently worked well together. Ryan and Teresa were a model example. They frequently helped one another through an effective exchange of ideas and information. They also critiqued one another. During the course of the evaluation we saw many examples of students who worked well together. The survey results suggested a slightly different picture as students reported that partners were both a help and a hindrance in the lab. Apparently, the quality of the relationship influenced the success of the partnership and the cooperative learning experience. In other words, partners must work well together in order to have a meaningful learning experience. Students were quick to point out that inadequate partners were detrimental to the learning process. Another factor that likely influenced cooperative learning was class time. Students and, surprisingly, parents reported that class time was often inadequate to complete module activities. Christina and Matt failed to finish their work more than once.

Transfer of learning was difficult to document although we found some evidence that transfer was occurring. In most cases, the parents and non-technology education teachers could not identify a transfer of learning to the home environment or respective classrooms, with one exception. Surveys also suggest that transfer was possible as students reported that they thought about module activities outside of class. Our observations on this point were more pointed: transfer of technology-related skills was slight, if not impossible, because the lab differed dramatically in instructional format and physical structure compared with most other middle school classes. The technology education lab was unlike other classrooms in these two respects, thus limiting the opportunities for transfer of knowledge and skills.

How has the Relationship Between Student and Teacher Changed as a Result of the Synergistic Lab Experience?

The relationship between student and teacher has changed in the Synergistic lab but not as much as many people would have us believe. We heard a great deal of rhetoric on this point in both the schools and in the teacher-training seminar. However, our case studies and observation at WMS and FMS clearly demonstrated that the teacher is the single most important factor related to the success of the system. The teacher's success depends on a core set of principles that likely transcends content areas and grade levels; namely, a carefully structured classroom with well-organized instructional materials, high expectations for students, strong content knowledge and interest in the content area, clearly defined boundaries for behavior and conduct, leadership, and mutual respect between students and between other teachers, parents, and administrators. Mr. Lincoln was an exceptional technology education teacher who possessed and continually demonstrated these skills. The role of the facilitator in a Synergistic lab has changed, but good facilitators are still good teachers.

How have Other Teachers Responded to the Synergistic Lab, and the Style of Learning that it Promotes?

Teachers in WMS strongly supported the Synergistic lab. Almost every teacher we interviewed was proud of the technology education program and almost every teacher had seen the lab. Again, we heard anecdotes related to the lab—that it was the "show piece" of the school, that many of the school faculty brought visitors to the Synergistic lab, that teachers and parents wanted to work through module activities. Despite this enthusiasm and support, the lab was isolated in WMS. The mathematics teacher saw opportunities to combine math principles with module principles but viewed Mr. Lincoln as an elective teacher who was not closely related to teams in the core subject areas. The science teacher was also open to collaborations but felt isolated and burdened by a lack of time. The language arts teacher was optimistic about establishing links to technology education but didn't really know what Mr. Lincoln covered in class. In addition, Ryan's father wanted the opportunity to enhance the teaching of technology education but didn't know what activities were occurring in the technology education lab. Mr. Clark reported that some teachers still sent students to his lab with broken glasses and torn shoes, even though his role as an industrial arts teacher had changed more than two years ago. Intentions were good but collaborations were limited despite the apparent opportunities that existed. We consistently noted these missed opportunities during our site visits at WMS.

How has the Synergistic Lab Influenced the Culture of the School?

The Synergistic lab has had a positive influence on the culture of WMS. Administrators, teachers, parents, and students spoke without hesitation of the lab's merits. We did not encounter one disgruntled respondent. All of our interviewees stated that the Synergistic lab made an important contribution to WMS, citing different reasons. Mrs. Winston viewed the lab as middle school philosophy in action, something good for education today that would likely serve students in the future. Teachers identified the importance of middle school philosophy and the use of hands-on, collaborative learning that Mr. Lincoln promoted in the lab. Parents consistently saw links between the lab and the real world of jobs and careers. Students liked the lab because it required hands-on work with interesting equipment in a multimedia environment that was self-directed and interesting. Everybody had their reasons for proclaiming the benefits of technology education thus it was clear that the Synergistic lab had a positive effect at WMS.

The University of Illinois evaluation team agreed that the Synergistic Systems were an educational success. Consistently we observed students working as responsible, independent learners across different modules and in different sites. Students were frequently engaged in solving real world problems. Students were guided by different forms of educational technology that they manipulated with ease and with comfort. We saw, in practice, middle-school philosophy in action.

We also agreed that many questions remain unanswered—we list but three. First, the Synergistic lab was effective at WMS, but how typical was WMS? And how much of the success at this site was attributable to Mr. Lincoln? Our visits to other schools, most notably FMS, suggested that the teacher's role was central to the success of the lab. But how flexible and how tolerant is the system to different styles of teaching? Second, how would a Synergistic lab operate with a diverse student population such as a large Hispanic population or in an inner city school? Does the teacher's role change in these circumstances? Again, our limited observations suggested that these factors would influence the success of the lab. Third, what types of assessments should be used in the Synergistic Systems? Our evaluation continually identified assessment as a weak link in the system. But how should an alternative assessment program be developed? What types of performance-based items are appropriate? How would a change in assessment influence the rest of the Synergistic Systems? Our evaluation provides a starting point as many of the concerns raised by our sponsor were addressed. Predictably, however, we raised more questions than we answered. Much work remains.

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Running Future Workshops to Improve and Enhance Education Practice

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This paper presents a theoretical and practical framework for Informatics research in the area of education. The context for this research is Sweden where schools often have an advanced infrastructure of computers and networks but the use, by teachers, of the technology, is very limited. The reason for this is two highly interrelated issues. First, teachers do not know what to do with the technology, and second, many of the teachers are sceptical about technology as well as conservative and reluctant to change their current practice. This paper presents an alternative where both these issues are addressed.

Motivation

A new society is emerging and there are many notions of what this society is: post-industrial society, information society, learning society, digital society, and so on. However, despite different notions, most agree that computing technology (CT) is an important part in this new society. The importance of CT is of course recognized in the education system. Community leaders, school boards, legislators, parents, etc., proclaim the value of this technology. Therefore, a large number of schools have an advanced infrastructure of computers and networks due to a 'push'. By this, schools ensure that students are exposed to computing technology as it will be a major part of their future lives. However, in this push, most teachers had no chance to assimilate and explore the technology on their own terms, and as a result of this, combined with a conservative attitude, their use of CT is very limited and this is a problem.

This paper discuss three issues related to this problem. First, adapting CT as a natural element in their work involves considerable change to most teachers. Second, the use of CT in schools, by teachers, must be more innovative and creative than currently. Third, institutions training teachers will benefit from an arena where educational aspects of CT is explored and discussed before they enter their profession.

In this paper, an Informatics perspective is put forward. The practical departure to the three specific issues are through future workshops (FW). This is a technique for approaching a problematic situation, generating visions about the future, and discussing how the visions can be implemented. FW is a means to utilize the power and competence that appear when people experience that they have common interests, needs and problems. Groups of teachers, or education students, are here guided by a facilitator who ensures active and equal participation, and makes the participants aware of current CT trends and development. Users possess the practical understanding necessary as the basis for the design, but to support their technical imagination they must gain insight into new technological possibilities as well (Ehn, 1988).

Education System in Change

From one perspective, we can see that the education system is opening up and the borders of the past are slowly dissolving. And in line with this, the main tendency on all levels of the education system is to question the disciplinary borders, e.g., thematic approaches, where real life situations and problems are taken as a point of departure is strongly emerging as an alternative to a subject focus. However, mature organizational cultures, such as the education system, experience change, or the challenge to change, most significantly as a disruption, an intrusion, or as a failure of organizational defense. We can see that the form of schools and education has remained fairly unchanged over hundreds of years, and so has the technology used in teaching, despite both pedagogical and technological influence. Summarizing the critique of the current education system is that the underlying mission of education can not remain the inculcation of knowledge and skills, values and behavior, not the transmission of information and authority.

From another perspective, enthusiasts in the education system bring forward new ideas about pedagogy and technology. However, it is obvious that teachers and other school staff, as individuals, are well adapted to a particular niche and it is understandable that their first response to attempts at innovation would be one of resistance. The norms of 'the teacher culture' are profoundly conservative and teachers' resistance to change plays an important role in shaping their response to both pedagogical and technological innovation. We can also see that the more innovative the suggestions for change, the grater the critique, and hence its threat to existing principles, that is, the underlying ideas and insights. For years educators have tried to come up with ways to reform the system, yet many people have reached a point where the enormity of the task result in abandonment of the ideas. Over time the idealism and enthusiasm of the novice teacher will fade away.

Today the culture of the educational system and its technology is challenged. CT is here the main vehicle for implementing change and may help bring about some important reforms (Barker & Dickson, 1996). The ability to change is embedded in the culture of the organization. Historically, technology that reinforces existing lines of power and information have been adopted but this assures at the same time that the traditional approaches to teaching will be cemented. The convergence of computing and communication technologies and the pervasiveness of computer networks—the Internet in particular—have strong potential for transforming education.

Struggling with Technology

Computing technology can be used to enhance existing traditional methods. This is what we do in most cases today. This means that no changes, at least no major changes, are made to the content and form of teaching. CT is used just as another technology for fact or information transfer. If we continue to re-implement conventional models borrowed from classroom based education focusing on passive transmission, we can expect only marginal improvement of the quality in our teachinG.

Just providing schools with an infrastructure, that is computers and networks, will not have the desired effect. This push action may actually result in a continuation of the technology rejection. Teachers will begin the process of 'pull' when they know for what and how to use the technology. Today most educators have no idea where to begin and what to do with this technology. One reason for this is that *"most technology instruction in Colleges of Education involves teaching about technology as a separate subject, not teaching with technology by integrating it into other course work to provide a model for instructional use"* (From the U.S. Office of Technological Assessment, in (Wetzel & Chisholm, 1996)).

'Outsiders' have tried to introduce computing technology into high schools. After proclaiming its potential in the classroom, the teachers use CT only slightly, if at all. Even if CT artifacts are used, classroom practice remains fundamentally unchanged. As a matter of fact the last technologies that made a substantial influence on the general organization and practice of teaching were the textbook and the blackboard.

Educators often work in isolation and could especially benefit from sharing with other professionals. If teachers do not have the commitment to apply CT in their work, it is not going to happen. Instead of educators isolating the learning process within the confines of their own classroom and the particular school, they should forge links to the outside community to find ways of refining and sharing their knowledge with others.

A large number of teachers are confronted with new pedagogical principles as well as new technology. It is not easy to switch to a different mode of teaching and learning for those with years of experience of a traditional teaching. For them the view of the authority or the professional who is the ultimate source of all knowledge is threatened.

Teacher education has been out for long standing critique as most education of teachers, in CT use, focus on using software products, not the technology itself. Far to many training sessions emphasize computer hands-on, instead of discussing computing technology in a wider context. The ignorance of the technology comes apparent in cites like, *"computers are a good thing, but there are not programs available."* The teachers do not know enough to utilize the possibilities with the technology. Most teachers graduate from teacher preparation institutions with limited knowledge of the ways of the ways technology can be used in their professional practice. However, there is work going on to integrate CT and its possibilities. These institutions has only recently discovered the pedagogical usefulness and advantage of the technology.

An Informatic Perspective

The major theoretical foundation as well as the practical guidelines in this paper originate from informatics. Informatics is the *"design oriented study of information technology use with the intention to contribute to the development of both the use and the technology itself"* (Dahlbom, 1996, p. 88). New use domains, in all fields, are constantly made possible by advances in computing and the central interest of informatics is to intervene and contribute to the process rather than just observe and describe it. Computing technology changes people's work and our interest is to augment their skills by the technology rather than replace them with the same (Ehn, 1988). Informatics' critique of traditional computing research is that it often is an *"anthropology of the past"* rather than an experimental *"archeology of the future"* which is our interest (Dahlbom, 1995).

Work Oriented Design

A central principle in informatics is that design of computing artifacts and design of its use should take place close to the users (Ehn, 1988). The approach is called participatory design (PD), where 'users' and computing experts share the responsibility for designing the technology and the new work place (Bjerknes, 1993). Note that PD is fundamentally different from 'user participation' where users serve as passive information suppliers. PD is a process of mutual learning where computing experts learn about the work and users learn about the technology. PD is therefore an approach which highly supports a software use perspective.

There are three different motivations for PD approaches in informatics (Greenbaum, 1993). First, from a pragmatic perspective, those who know the work should participate in improving the same work. Second, from a theoretical perspective, users and experts have limitations in communication skills and therefore need to work closely to gain understanding. Third, the political perspective, people have the right to influence their own work place.

Participatory design have many similarities with soft systems methodology (SSM). SSM is a problem understanding and problem solving methodology, introduced by Checkland (Checkland, 1981), which uses discussion, debate and the development of a series of models as a means to facilitate learning about a problem situation. The methodology evolved as a reaction to the evident shortcomings of traditional hard systems approaches which failed to address the complex softer issues. In the subsequent evolution of SSM, a strong user participation has been a major characteristic. SSM has evolved toward a collaborative approach where 'users' will involve other people in the process of problem handling.

Whereas as PD focus on the current work situation, future workshops is taking PD a step further by approaching the future. FW is a technique for approaching a problematic situation, generating visions about the future, and discussing how the visions can be implemented (Jungk & Müllert, 1987). The core of FW in this research is of course problems and visions concerning education practice as well as problems and visions with computing technology in education. The FW is divided in three phases: the *critique phase* were current work practise is in focus, the *visionary phase* were the participants discuss and propose alternatives without consideration of limitations, and the *implementation phase* were the participants discuss the realistic alternatives and how they can be implemented. A general prerequisite for constitution of FW groups is that all participants should share a problematic situation, desire to change it according to their visions, and have the means to do it. The FW is run by a facilitator who is guiding the participants and ensures active and equal participation, but also makes the group aware of current CT trends. A group of ten persons including the facilitator is an advisable size. Tools used are for instance wall charts and other tools allowing the participants to explicitly post and discuss each other's viewpoints and ideas, and very simple prototypes of CT.

Improve and Enhance Education Practice

There are several substantial outcomes of future workshops that will improve and enhance education.

First, future workshops are real eye-openers to conservative teachers in that they realize that computing technology is central to the entire shaping and direction of our education. They become aware of how they can use the technology and the awareness brings about the necessary motivation required to start changing the individual teacher's practice. For education students, the future workshop is a creative arena where they have the opportunity to shape their own and their students' future.

Second, the underlying principle of FW is to approach a problematic situation, generate visions for the future, and discuss how the visions are to be implemented; future workshops are likely to surface innovative and creative, but also realizable computing use domains in the classrooms.

Third, evolvement of 'teach cases,' which is an abstract description of an activity that can be supported by, or made possible through the use of a specific computing artifact. A 'class' or a 'course' consists of a number of activities with specific purposes, such as information searching, presentation, documentation, validation, etc. Each of these activities can be supported by one or many computing technology artifacts, such as: e-mail, presentation software, word processors, groupware, etc. It is important to emphasize that teach cases focus on processes, or activities, that take place in education, and on products, that is, computing technology. This means that the content of the activity is subordinate. In contrast to most research and suggestions, the focal point in this research is not the subject taught in the class, but the type of activity that is going on.

Below is a tentative suggestion of two teach cases. It should be emphasized that the two examples are not the result of future workshops, but from my own experience with teaching and reflection over the application of CT to improve and enhance the learning process.

Example I - 'Opening Discussion'

The first example is opening discussion where we have an activity, discussion seminar, and we have a technology, Group Support Systems (GSS). GSS are general-purpose collaborative problem solving tools and usually based on a network of personal computers. All participants in a GSS session can 'talk at once' and the session can be followed on each computer and often also on a large public screen. All contributions become part of an electronic script. As all participants have an equal opportunity to contribute, strong personalities will not be dominating the meeting, and the more quiet participant is able to be more active.

For the purpose of discussion, one feature of particular interest is the option of being anonymous. Using this option, the class can discuss more controversial or unpopular issues without the fear of being exposed. Applying GSS in an opening discussion encourage students to participate if they desire to remain anonymous. This is an example of a teach case where computing technology facilitates the necessary conditions. From my own experience, I see many courses where this teach case could have been a very viable point to start a discussion. I do not believe full time anonymous students is a good idea, however, I do believe being anonymous in the opening discussion is feasible to surface the important issues no matter the content discussed.

Example II - 'Decision Making'

In the second teach case emphasize is on the decision process. Whereas the first case utilized existing software this case involves the design and implementation of a multimedia tool where a group of students interact with the tool in a decision making task. A scenario is presented to the students and they follow the scenario as it evolves and make decisions related to the scenario. The context for the scenario can be any context where decisions made now will have consequences in the future. For the students, some decisions are possible to regret, but most of them are not, all in line with reality. This type of tool provide the teacher with an opportunity to introduce decision making problems related to the specific subject discussed. Examples are environmental issues, the long term effects of pollution and social programs, such as housing and education.

Concluding Remarks

The motivation for this research is the fact that a large number of schools in Sweden have an advanced infrastructure of computers and networks. However, this infrastructure is poorly utilized by teachers. To change this, it is stated that a traditional solely expert driven approach is likely to fail. A more teacher centered approach, future workshops, is therefore suggested. User participation is a means of reducing resistance to the change process. It is postulated, that close expert and teacher interaction, i.e., future workshops, will result in innovative and creative ideas and design of computing technology use in an education context. These ideas and design will be communicated as good examples of CT use and serve as catalyst for other teachers.

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Adult Education and Communications Technology: Synthesis for the Future

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Curien (1995) states that we are entitled to ask whether the gathering, processing, and dissemination of enormous amounts of information is essential to our well-being. The answer is obvious: we must not only embrace the information age but be able to control its direction and future. Curien's question is underscored by several irreversible processes. First, technology is here to stay. There is no turning back to simpler days of blackboards and flip charts. Second, technology will continue to develop at an increasing rate of change. Third, there will be more applications of technology in all areas of life, including, work, home, and recreation. One result of these processes is that educators must begin to incorporate the use of technology into their practice so that they will not become increasingly marginalized in society. Examples of these processes include the increased uses of personal computing, both at home and in the workplace, the increasing popularity of the Internet, and the increasing uses of technology in entertainment.

Instead of embracing the use of technology many educators and educational institutions appear to resist it. The lecture mode is still dominant in colleges and universities. Public schools continue to be dominated by traditional classroom settings. Adult education often revolves one-on-one instruction and the use of technology is seen as intrusive.

The purpose of this paper is to describe the origins and development of a graduate program in which adult education and communications technology are synthesized. First, the development of adult education and the incorporation of technology into that development is described. Second, recent developments in the use of educational technology is addressed. Third, the conceptual basis for the curriculum is outlined. Fourth, the basis for the new graduate program as defined by a needs assessment is presented. Finally, the curriculum itself is described.

Adult Education and the Use of Technology

Recent years has seen an increasing amount of activity in the field of adult education. Not only has the field grown in terms of its research and literature base but also as a field of practice (Houle, 1991). Adult education is practiced in a wide variety of settings. Apps (1989) provides a framework for describing the many settings. He notes the existence of adult education in several different types of funding situations. First are tax supported institutions such as public schools, colleges and universities, the cooperative extension service, and libraries and museums. Second are nonprofit self supporting agencies and institutions such as religious institutions, health care agencies, community-based agencies, service clubs, voluntary associations, and professional associations. Third are for-profit organizations such as correspondence and proprietary schools, consultants, training in business and industry, and conference centers. The fourth category is described as nonorganized and consists of family and leisure learning that is usually self-directed.

With adult education occurring in so many different arenas, it is not surprising that the use of technology is becoming increasingly important in the field. Technology is being used in several different ways. First, it is being used to enhance instruction in traditional classroom settings; second, it is used as a substitute for traditional classroom instruction and third, it is used to provide distance education opportunities. In the first scenario technology is used to enhance traditional classroom instruction. In this case the use of media such as video, presentation aids (such as overhead projectors), and computer aided presentations are used to supplement the face-to-face instruction. In the second scenario some technologies have been found to be effective in lieu of face-to-face instruction. Examples include the use of computer assisted instruction and guidance (such as programs for career exploration and some training programs) and the more recent applications of interactive multimedia. The third scenario includes the applications of technology to provide for learning opportunities where face-to-face instruction is not possible. Garrison (1989) describes distance education as consisting of three criteria: communication among teachers and students occurring noncontiguously, two way communications, and technology used to mediate the communications process. Garrison's last point is significant as it shows the increasing importance of technology in distance education for adults.

Recent Developments in Communications Technology

There are several recent developments in communications technology which have applications to adult education. First is the development of the personal computer with enough memory to use multimedia allowing for interaction with the computer. No longer is the learner passive— he/she can direct the learning process. The computer can be used with authoring languages, windows, HTML, and other software packages which easy programming. This was not available a few years ago.. One application of the personal computer is the use of interactive multimedia which is defined as the computer-controlled integration of text, graphics, still and moving images, animation, sounds, and any other medium where every type of information can be represented, stored, transmitted, and processed digitally (Fluckiger, 1995, p. 5).

According to Clark (1996, p. 4) the Internet is the most comprehensive medium ever developed She points out that people can communicate easily and inexpensively with others anywhere in the world. In addition, with the new developments of Internet video conferencing, real-time digital audio, and real-time Internet-wide document sharing, the list of potential uses is growing every day (Clark, 1996, p.4).

The development of computer technology has not outdated the use of more traditional media such as audio, graphics, photography, and video. These media can still be effective educational tools and have their role in classroom and other more nontraditional instructional settings

Conceptual Basis for the Graduate Program

The graduate program is an attempt to meet the educational needs outlined in the two sections above. Combing instruction in the use of communications technology with a foundation for practice in adult education can help prepare educators and trainers to be fully participatory in the new educational environment. Educators and trainers of adults must be conversant in a number of fields to be fully effective. Traditional graduate programs in adult education have taken the approach of providing process knowledge which is added to a student's existing store of content knowledge. In this approach, graduate students in adult education learn how to teach what they already know. The missing link for most of these graduate programs in adult education is the emphasis on the incorporation of communications technology into the curriculum. This program accepts the process knowledge emphasis, but with a twist. It is acknowledged that the field of training and development is becoming increasingly responsive to two trends: first, there is an increasing use of technology in training, and second, there is an increasing use of generalists as opposed to content experts as trainers.

A second basis for the new program comes from the disciplines of adult education and communications technology themselves. Both are applied fields which have as an emphasis the application of learning principles to educational settings. The commonality between the fields include instructional design, the application of adult learning theory, the integration of the use of technology into classroom instruction, and distance education.

Needs Assessment for the Program

In order to substantiate the need for the new program a two part needs assessment was conducted. The first part addressed the needs of students and the second part addressed the needs of potential employers.

The student needs assessment demonstrated that undergraduate Communications Media students at Indiana University of Pennsylvania had a strong interest in graduate study. One-hundred-seventy-four (84.9%) of those surveyed indicated a moderate to strong interest in pursuing graduate study. This is indicative of the fact that as undergraduate students they learned how to create and develop various technologies, but were not exposed to the educational milieu in which the media are applied. Many of the students perceived that graduate school is an opportunity to expand their career options by obtaining such an education.

A second survey, also of undergraduate Communications Media majors, indicated that 86.4% (n = 32) of the students had a moderate to high interest in the new program that was being proposed. In addition, 81.8% of the same sample indicated a moderate to strong likelihood that they would enroll in the program. Furthermore, 94.5% of the sample stated that they felt the new program presented good career opportunities.

A survey was also sent to employers in western Pennsylvania to determine the extent of employer interest in graduates of the proposed program. Surveys were sent to 200 employers obtained from lists used for internship sites for undergraduate Communications Media students. A 96% (n = 192) response rate was obtained. The following results were obtained: 58.8% (n = 113) stated that they would consider hiring a graduate of the program if they had an opening, 14% (n = 19) indicated a high probability of having an opening in the next year, and 60.9% (n = 117) indicated that they would be willing to host an intern from the program. It should be noted that the number of employers indicating the possibility of an opening is high for the economically depressed area of western Pennsylvania.

These needs assessments demonstrated that there would be a sufficient supply of students for the program as well as employment opportunities for graduates of the program. This laid the foundation for developing the curriculum of the program which is outlined in the next section.

Adult Education and Communications Technology Curriculum

Based on all of the information reviewed in preparation of the program proposal including the review of the relevant literature in both adult education and communications technology, the needs assessment, and the expertise of the faculty proposal developers, the following purpose statement for the program was developed:

The purpose of the program is to help students acquire knowledge and skills in theory and research in adult education and in the applications of current and emerging production technologies. Upon completion of the program, students will be able to: Understand and apply the dynamics of adult development and learning theory to the design and implementation of educational programs and media selection and use. Develop needs assessment procedures to make decisions regarding educational programs and media use. Develop goals and objectives for the design of educational material and the selection and use of media. Develop plans of action for educational programs and the use of technology. Select, design, produce, and evaluate target media. Develop formative and summative evaluation procedures for educational programs and media selection and use. Design educational experiences using instructional design and other systematic approaches. Conduct meaningful educational experiences using appropriate adult education methods. Manage and administer educational and media programs and events.

The program consists of a thesis and nonthesis option. The thesis option consists of 36 semester hours and the nontheiss option is 33 semester hours. Following is a description of the core courses in the program:

The Adult Learner: A survey course of adult development and learning theory with applications for the design of adult education programs.

Program and Process Development: This course addresses the development of educational programs for adults including conducting needs assessments, administering program activities, and program evaluation.

Organization and Administration: The following topics are addressed in this course: organization theory, leadership and management issues, and resource acquisition and management.

Facilitating Adult Learning: Students learn and practice instructional techniques such as making presentations, group techniques, and conducting classroom instruction.

Instructional Design and Development: This course emphasizes the use of instructional design processes to plan and evaluate educational programs.

Media Production: Students learn to design and create instructional video programs and slide-tape presentations using computer presentation programs such as Powerpoint.

Instructional Computing: This course examines creating of WEB pages, learning to use and apply authoring languages, and exploring the educational applications of the Internet and the World Wide WEB.

Multimedia Techniques: Students learn how to integrate and apply text, graphics, images, and sound into educational programs.

Seminar in Technology and Adult Learning: This is a capstone course for the program in which the application of technology in adult learning situations is explored. Distance education is an emphasis for this course.

In addition to the courses listed above, students have the opportunity to take up to six credits of electives. An internship option is also available so that students can acquire actual job experience prior to graduation. This program required substantial capital investment prior to implementation. Substantial investments must be made in video technology (e.g., studio equipment, editing equipment, and remote equipment), computer software and technology, and audio recording equipment.

The program is currently in its first year of operation. There are a mixture of students in the program. Some are just out of undergraduate programs and possess limited work experience. Others are returning students who bring substantial professional experience. This mix has been an advantage to the program since students learn from each other. The general impression at this point is that students are excited by the new program and the potential career options open to them.

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Applied Sociology in Virtual Worlds

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Computers are allowing teachers from all disciplines to develop project based curriculum that encourages higher order thinking and cultivates classroom community. One no longer needs to be a programmer, scientist, or technician to feel comfortable using computers. Graphical user interfaces, simulation software, the World Wide Web, and intelligent agents have brought the power of computing to a wide range of people working in a myriad of disciplines. Today, the "lessons of computing… have little to do with calculation and rules; instead they concern simulation, navigation, and interaction" (Turkle, 1995, p. 19). Sociologist Sherry Turkel asserts that we are in the midst of a shift from a culture of calculation to a culture of simulation (Turkel, 1995, pp.19-26). For computer-using educators, the shift to a culture of simulation has promoted a hands-on, project-based, or "constructionist" approach to teaching (Papert 1993, pp. 137-156). Instead of being the object of study, computers are used as a powerful tool for enhancing, developing, interpreting and creating content.

This project-based approach facilitates the integration of technology across the disciplines. The Isidore Newman School in New Orleans is currently implementing an ambitious technology plan that includes integrating technology across the K-12 curriculum. In addition to these efforts, Newman has an academic computer department of six computer teachers who teach programming and applications courses in the four school computer labs. This paper focuses on a lesson developed within Newman's computer department and explores the way the lesson has been adapted to meet the needs of other departments and disciplines.

Background — Technology Implementation in the Newman Curriculum

Newman's computer department is committed to adding a focus on applications and the Internet to the traditional programming and keyboarding computer curriculum. Focusing on applications and the Internet has created new opportunities and challenges. As the focus of instruction moves away from computers per se, and towards what computers can do, computer teachers have had to develop curriculum that extends beyond the field of computers. Computer applications courses at Newman use technology to address the political, sociological, musical, artistic and literary imaginations of Newman students. Computer teachers are able to explore topics that do not fit neatly within the general curriculum, thereby filling gaps in instruction and exploring nontraditional topics.

Although many topics are covered, department head Dale Smith has placed a strong emphasis on using the applications courses to encourage students to think critically about the social and cultural implications of technological change. In addition to learning to use applications, students grapple with issues specific to individuals entering a culture of simulation at the end of the second millennium. The following lesson was developed as part of my tenth grade applications course. The lesson focuses on Sociology, a discipline that is not traditionally part of the High School curriculum and addresses issues of identity that are specific to the information age. In this case study, the computer department served as a testing ground for a lesson that would later find its way into the history curriculum. Thus, the lesson typifies the Newman Computer Department's efforts to address nontraditional topics, integrate technology across all the curriculum, and prepare students to live and work in an emerging culture of computer simulation.

Virtual Worlds in Tenth Grade Applications

Multi-user, real-time, interactivity in three-dimensional virtual worlds is now available on the Internet. Access to these worlds is becoming available to a broad range of educators and has the potential to radically change pedagogy. Yesterday's science fiction is beginning to find a place in today's classrooms. It is imperative that the next generation of educators be acquainted with the three dimensional frontiers of cyberspace. Before addressing how this technology could be used across the disciplines, I will focus on the opportunities this technology has created for exploring personal identity and social justice as part of the tenth grade applications course.

Participants in virtual worlds invent complex and nuanced fictional identities and interact with other people without revealing their real life identities. Working in pairs, the students created a sociological profile for their character that included the social categories they felt to be most important. This exercise provoked discussion about race, class, gender, geography, sexual orientation, and age. Students struggled to imagine themselves living a life and inhabiting a body very different than their own. They were challenged to explore unfamiliar perspectives and question their own cultural and moral presuppositions.

Two 15-year old girls decided to become a 9-year-old boy named Mohammed. Mohammed was a precocious little boy who communicated on the Internet from his home in Alaska. Two prep-school boys decided to become a self-professed "redneck" car mechanic. The mechanic often initiated conversations about hunting, fishing, and camping. The cast of characters included a dentist from Boston (unsure about his sexual orientation), a French quarter waitress with a penchant for Voodoo, a Japanese-American film animator working in San Francisco, and an African-American premed student at Stanford University.

Using a Virtual Reality Modeling Language (VRML) browser, my tenth grade students were able to enter 3-D, multi-user worlds and interact with other people under their assumed identities. First, they picked out a 3-D virtual body, called an avatar, that became the visual representation of their character. Then, they created a "public card" that contained information about their character that everyone in the virtual world could access. The body and card express the identity that was elaborated in the sociological profiles. Once the character has a body and a public card, she/he is ready to venture out into social space to interact with others. The students searched the virtual world for other avatars and engaged in lengthy real-time conversations with people from around the world. Students used these interactions to develop, explore, and further elaborate their virtual identities.

Students often had conflicted feelings about their experience in cyberspace. One student described a feeling of freedom "being able to put my identity and problems aside and go inside someone else's body." Yet, many students who cast a positive light on the experience could not help but feel "a little guilty" deceiving an "innocent participant." This feeling was particularly acute when a meaningful relationship developed between two virtual people. One girl eloquently commented on a distinctively modern predicament: "Virtual Worlds create a shadow over real life because there is no way to tell the difference between what is real and what is not through only a computer screen."

The problem of determining what is "real" was further emphasized when students were exposed to artificially intelligent machines. In a corollary lesson, students were invited to engage in dialogue with computers programmed to simulate natural language conversations.[1] By talking with artificially intelligent (AI) systems, students began to make distinctions between computer mediated communication, on the one hand, and human-computer interaction, on the other. Students agreed that using avatars to interact in virtual worlds constituted computer mediated communication because they were interacting with real people somewhere in the world. Conversing with AI machines, however, is just human-computer interaction because only one person is involved in the conversation.

One student's reaction to natural language AI dramatizes this distinction. She loved using computers to "chat" with other people over the Internet. Nevertheless, she was emphatically opposed to having a conversation with an Artificially Intelligent machine. She used computers to connect with other people but thought that talking directly to a computer was "stupid" because a machine could not "really understand what I am thinking." Other students, however, enjoyed talking to machines because they could "speak freely" and "vent" without being judged. As a whole, the class was worried that as AI improves it will become increasingly difficult to tell the difference between computer-mediated communication and human-computer interaction. Historian of science Donna Haraway tells us that "Our machines are disturbingly lively, and we ourselves frighteningly inert" (Haraway, 1990, p. 194). This predicament animates one student's worried exclamation: "What if I discovered my best on-line friend was a computer?"

Virtual worlds and AI confuse and complicate the process of social interaction and identity formation. Nevertheless, many students reported that they learned important information about the real-world from their journeys in Cyberspace. A female student whose character was a gay male was upset when an interlocutor abruptly ended a conversation and stated, "By the way, I'm not gay!" "I was angry," she reported. "What if Jason [her character] was real? He would be so offended." Another student found that male characters would aggressively seek out conversations with female characters. She noticed that when a "guy knew he was talking to a girl he would definitely treat me differently." This experience helped her realize "just how prejudiced people can be." Although each student drew different conclusions from their experiences, they shared one commonality. As fifteen-year old humans, they were all in the process of developing their real life adult identities. Exploring virtual worlds gave them the ability to play with different identities and contemplate the larger social ramifications that identity choices entail.

Virtual Worlds Across the Curriculum

History

It can be difficult for teenagers to understand sociology and psychology because of their limited life experience and the theoretical nature of the disciplines. VRML environments allow students to put abstract disciplines into concrete practice. The practice of inviting students to participate directly in educational worlds can be used effectively across the curriculum. I am currently working with the chair of the History department to use Virtual Worlds as a tool for exploring American History. His class has engaged in an in-depth study of President Andrew Jackson. In addition to using textbooks and discussions, Dr. Cowett's students conducted research on the Internet and worked with one of Newman's Technology Coordinators to create interactive multimedia presentations about Andrew Jackson.

Using Virtual Worlds allows Dr. Cowett's students to stop studying Andrew Jackson and actually become him. This creates the opportunity for students to shift perspectives and become the object of their study. Students from several sections of American History will take turns using the classroom computers to role play President Jackson as he engages in critical debates with on-line companions. This means that there will be an on-line historical interpreter available on the Internet several hours each day which will serve as a resource for history students and teachers around the world. It will be possible to discuss politics with a virtual Andrew Jackson being role played by the knowledgeable American History students at the Isidore Newman School. Dr. Cowett will receive transcripts of the dialogues in which his students engage, allowing him to evaluate his students learning processes and fine tune his Andrew Jackson curriculum.

Sciences

History is certainly not the only discipline that 3-D Virtual Worlds could impact. On the not-so-far-off horizon, Biology teachers will be able to use this technology to navigate 3-D simulations of cells, organisms, or ecosystems. Computer-based alternatives to dissection have already become widespread. Unfortunately, these current simulations replace a 3-D organism with 2-D diagrams. VRML Worlds can solve this problem by modeling organisms in 3-D space. Students will be able to journey into a frogs stomach or travel through a cell's membrane to get a closer look at a mitochondria. Best of all, students will be able to explore that same frog or cell simultaneously. That means that they can "meet" at the frog's pancreas to discuss enzymes or at the cell's membrane to discuss osmosis. Indeed, Biology teachers will be able to give guided tours through biological entities that were previously represented by flat diagrams in textbooks. In this instance, computer simulation provides more than a humane alternative to dissection. VRML simulations have the potential to allow students to see the invisible, travel through microscopic worlds, and participate in unparalleled distance learning over the Internet.

Literature, Foreign Language and Beyond

I can imagine English classes writing and performing collaborative plays in elaborate and globally accessible virtual theaters. Foreign language students could speak French at a sidewalk café in a Virtual Champs Elysee or take a tour of a Spanish Church led by Catalonian High School students. Inviting students to participate directly in simulations can be an effective tool in almost any discipline. Indeed, we may soon participate in academic conferences that take place entirely within 3-D cyberspace.

Conclusion

Virtual Worlds have allowed students in computer applications courses to explore nontraditional topics (sociology, social justice) and address perplexing issues that face citizens living in a culture of simulation. The technology that facilitated their exploration was first used in the computer department but is spreading to the History department and has the potential to enrich other disciplines as well. This provides one model for how a computer department can be used as a testing lab for ideas that can enrich other disciplines. More importantly, I have attempted to illustrate methods for using computers to help students actively participate in constructing their own knowledge and exploring their personal and moral selves.

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DUCATIONAL TECHNOLOGIES PREPARATION IN NORTH AMERICAN UNIVERSITIES: AN AERIAL VIEW

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Questions: 1. What is the state of educational technologies (by whatever name!) programs in American and Canadian universities? 2. What kinds of undergraduate offerings and requirements are there? 3. What do the graduate programs look like? 4. What markets are being served? 5. What does it take to offer a credible graduate program? 6. What does the future look like?

In the Summer of 1996 we had answers to none of those questions, but, fortunately, one of us was due a sabbatical leave and the other took early retirement, so we were in a position to visit universities and to develop some at least tentative answers. The choice of universities certainly had no scientific basis, and there are important programs that we know of that we missed. Since we traveled in our Cessna T210, weather was, of course, a factor. Some we didn't visit because we had been there before. Others we just couldn't schedule. Nonetheless, we were able to visit 12 universities with active educational technology (or instructional technology, or some other name) programs. They were, in order of our visits, Utah State, Western Washington, Alberta, Michigan State, Indiana, Penn State, Virginia, Georgia, Florida State, Vanderbilt, Houston, and Texas (Austin). The cooperation and courtesy we received from the faculty, staff, and students at each of these universities was extraordinary and refreshing.

We prepared in advance a questionnaire so that we could collect comparable information from each university. In addition, we asked other questions that occurred to us as a result of things we had learned. We report here some of our findings and some observations.

Summary of Findings

Departmental Organizations and Major

University	Department	Major
Alberta	Ed. Psychology (Ed. Tech.)	ET*
Florida	Educational Research	IS*
Georgia	Instructional Technology	I T*
Houston	Curriculum & Instruction	C & I*, emphasis in I T
Indiana	IST*	IST*
Michigan State	EPsy*	EPsy., emphasis in ET
Penn State	Adult Ed & Work Force	IS*
Texas	C&I*	C&I*, specialization in IT
Utah State	IT*	IT*
Vanderbilt	Technology & Learning	Ed&HD*
Virginia	Leadership, Found & Policy	IT*
W. Washington	College of Ed (no depts)	ID*

**ET=Educational Technology, IS=Instructional Systems, IT=Instructional Technology, C&I=Curriculum and Instruction, IST=Instructional Systems Technology, EPsy=Educational Psychology, ED&HD=Education and Human, ID=Instructional Design*

Core Graduate Faculty Size and Number of Students

Faculty ranged in size from three full-time core faculty to 10 full-time plus two adjuncts or 9 full-time plus four adjuncts. Master's candidates ranged from 12 to 200+. Ed.S. candidates ranged from none to 28. Doctoral candidates (excluding Western Washington, which does not offer a doctorate) from 3 to 166.

Technologies Requirements for Undergraduates

Most universities require three semester hours in educational technologies for undergraduates, but the requirement ranges from none to 15 hours. It is common to find that graduate teaching assistants are responsible, under faculty direction, for the teaching of undergraduate courses.

Markets Served

Some universities serve only the traditional education market. Some serve predominantly the industry/military market. Several serve both markets approximately equally.

Observations

We aren't prepared to call anything in this section "conclusions", for our data collection was not scientific enough for that, but we feel reasonably confident that these "observations" add to the knowledge of educational technologies programs. Some of the observations are derived from findings summarized above, but others are taken from informal data.

1. What is the state of educational technologies programs in the American and Canadian universities? Programs vary greatly in size, theoretical orientation, markets served, and emphases. Nonetheless, we were greatly impressed with the knowledge, enthusiasm, and effectiveness of the faculties and with the quality and enthusiasm of students wherever we went. We frankly observed no weak programs. Of course, there were some practices that we questioned, but we believe that the profession can be very pleased with the present state of graduate programs in educational technologies.

2. What kinds of undergraduate offerings and requirements are there? Almost all of the universities had a least one required course in educational technologies for undergraduates. Two universities had tried having the responsibilities for technologies preparation split among various methods courses on the assumption that the applications would be more immediate. However, faculty from both the universities indicated that the effort was not effective. It seems that faculty in those methods courses had very different competencies from each other in educational technologies and different commitments to technology inclusion in their courses. Further, it was difficult to assure that all areas were included and that there was not inappropriate redundancy. It seems that the most effective approach at present is to have at least one required course in educational technologies for undergraduates, with further application included in other methods courses. Ideally, of course, effective use would be modeled in all courses.

3. What do the graduate programs look like? All of the programs visited except Western Washington offered a doctorate. The educational specialist degree, offered in some universities, was not widely used except at Georgia, where the State requirement for a technologies coordinator in each public school makes the Ed.S. an attractive degree.

The number of credit hours required for the master's and doctoral degrees does not vary greatly, but the amount and kinds of technology courses varies substantially. Some derive theoretical support in such areas as learning/ development and measurement/research methodology from other courses and faculty, while some attempt to include that support in technology courses. It is clear that there is no consensus concerning the amount and mix of technical, theoretical, and research preparation.

4. What markets are being served? Although some graduate programs make no attempt to serve any market other than the traditional k-12/higher education market, others serve predominantly the industry/military market. It is common to serve both markets, and the mix is fairly even. In general, and predictably, the industry/military market outbids the education market.

5. What does it take to offer a credible graduate program? We visited some large programs with very substantial resources, but we were particularly interested in what minimums were necessary in order to offer a credible, quality program. Certainly, a program need not be large to be effective, but a certain critical mass seems necessary.

It seems obvious that a program must have administrative support, but a further necessity is *consistent* administrative support. It takes time to build a program, but it takes almost no time to destroy one. With the rapid turnover in administrators, we have become aware of very strong educational technology programs which have been severely damaged or destroyed by a change in administration. It seems that the only protection a program has from that possibility is to become so strong in terms of community and university support that it is, at least to some degree, immune from the vagaries of administrative change.

The faculty needed to offer a credible program depends upon the market(s) to be served. We believe that either the education or the industry market can be served in a relatively small program, with a core educational technologies faculty of three. Both markets can be served by a faculty of four. In either case, at least one subspecialty should be in instructional design and one should be in networking applications. The education market should have a least one faculty member who concentrates on k-12 applications, while the industry market should have at least one who specializes in business applications. One faculty member should have a technical (programming/analysis/engineering) strength. All of this assumes that the "core" faculty is well supported by strong faculty support in learning/development, measurement/research methodology, and other areas.

Laboratory support, both hardware and software, must be designed specifically for instructional purposes. Open access labs are designed differently for different purposes and do not serve at all well as instructional labs. A separate high-end lab for production purposes is highly desirable.

The program should also have adequate technical support. Faculty, no matter how well qualified, cannot reasonably be expected to use their time that way.

There must be support for graduate students. The ideal support is involvement in instruction/ research in the educational technologies program or as development assistants.

6. What does the future look like? It seems clear that there is a substantial and growing industry/ military market. The education market, however, is quite mixed. While Georgia, for example, is supporting k-12 educational technologies quite effectively with lottery and other moneys, other places are continuing to cut both k-12 and higher education budgets. For business, funding is called investment; for education, it's "throwing money at the problem."

The quality of students in the programs we visited seems very high, and students seem quite enthusiastic, so it is reasonable to expect the professional area to do well in the sense that we will have good people in charge. The only internal danger that we perceived was an apparent lack of respect in some places for those having differing theoretical orientations. Both of us have most of our professional preparation and experience in the field of reading, and both of us have watched reading damage itself seriously, and damage hundreds of thousands of children in the process, while whole language advocates and direct instruction advocates lobbed bombs at each other from their adopted extreme positions. There is some danger that educational technologies will do the same, as constructivists and systematic instructional designers choose up sides, neither willing to respect the contributions of the other, and both requiring 100% agreement in order to accept others into the chosen camp. Use of aspects from the opposing camp is viewed as heresy, i.e., compromising with evil. It's a bit disturbing to find that some doctoral students know that they are opposed to a camp, but they don't know anything about it. Knowing that there's an enemy, but not even knowing anything about the enemy is what happened to reading. Unless educational technologists can recognize that there are valuable contributions from those with whom we may have disagreements, we could go the way of reading. There are those who seemingly wish to align everyone with one camp or another. Fortunately, there are many who are willing to search for solutions to problems without the constraints of ideological bias. May they prevail.

In general, we are quite impressed with what we have seen. We therefore are pleased to observe that the future of educational technologies is quite bright.

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Distributed Virtual Reality: Its Application to Education & Training

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This paper discusses the potential uses of distributed Virtual Reality (VR) in education and training. Although a new technology VR has many applications in the near future given the rapid increase in computing technology. In this paper the authors develop a classification system for VR and use it to explore the potential applications of VR and distributed VR. Some state of the art technology in the VR field and related fields is also explored. The potential applications to student and teacher training are examined along with the development problems that must be solved. Two examples, the use of VR in engineering and earth science training are explored in detail.

Virtual reality (VR) is a rapidly developing technology that has many potential applications from entertainment to warfare (see for example Aukstakalnis and Banner, 1992; Rheingold, 1991, and Sims, 1991). One of the most important applications is in training and hence it has direct relevance to both student and teacher training, or will have in the near future, given the current rate of advances in computer technology.

The key ability inherent in VR is the ability of the user to fully visualize a product and integrate, primarily through visual means, a large number of inputs. Until recently a human, a three dimensional being, had to use two dimensional instrumentation to assess and control a three dimensional world. With VR this is no longer the case.

Virtual Reality: Its Principles and Classification

VR is mostly thought of as a pure visual technique. This is not necessarily the case, under it's widest definition Virtual Reality is a method for providing visual, and/or aural and/or tactile inputs which provide an artificial reality for the subject/operator in which relevant information can be displayed and/or manipulated. VR can be used both for display of data and control of the environment or equipment. Control and manipulation of the VR environment can be via manual, visual, tactile or physiological means. In order to understand the types of VR the authors have developed a classification scheme which can be used to understand the type of system required for a given application. Table 1 details this scheme, which will be used later in the paper. As with all schemes there are exceptions to the classification with many potential subclasses, however the classification does at least show the potential complexity of VR systems.

Table 1.
A Virtual Reality Classification System

Type	Output Method to Subject/ operator	Control/Input Method by Subject/Operator
0	Visual	Keyboard/Mouse
I	Visual (3D)	Head Tracking and/or Body Tracking
		Keyboard/Mouse
II	Visual	Head Tracking
	Aural	Voice
		Keyboard/Mouse
III	Visual	Head Tracking
		Body Tracking
	Aural	Voice
		Keyboard/Mouse
IV	Visual	Head Tracking
		Body Tracking
	Tactile	Tactile
		Keyboard/Mouse
V	Visual	Head Tracking
		Body Tracking
	Aural	Voice
	Tactile	Tactile
		Keyboard/Mouse
VI	Visual	Head tracking
		Body Tracking
	Aural	Voice
	Tactile	Tactile
	Physiological	Physiological
		Keyboard/Mouse

936

The prime input used by the brain is visual information. Because humans have binocular vision a three-dimensional picture can be created by providing the brain with two overlapping artificial visual images, allowing for depth effects. If correctly presented the brain will process this visual data to produce a Gestalt or artificial or virtual reality. If touch and aural sensations are combined with the visual output then the Gestalt can be further enhanced. If eye and body motion is tracked, then the output of the VR system can be varied to produce a continuous consistent virtual reality. Visual output is mostly commonly provided by helmet mounted CRT's or LCD displays relayed to the subject/operator's visual field via infinity focused optics (as shown in Sims, 1991). Any image output must be stabilized in a variety of ways:

(i) Head stabilized for general observation and selection of parts of the Gestalt
(ii) Surrounding stabilized for presentation of real or virtual control systems
(iii) Space stabilized for superposition of VR images on the real world if required.

Aural output can be used to provide a stereo, i.e. position sensitive, sound input to the subject, and in fact one can think of an aural and tactile based system for training of and use by the visually impaired. Further output can be provided via tactile systems, e.g. piezo-electric vibration or even direct electrical simulation of the skin.

All three methods can also be used to control the system, visual by eye motion tracking, aural input by voice control system, and tactile input via body coverings with appropriate sensors. The detailed requirements and methods associated with VR are covered in many publications (for example Aukstakalnis, and Banner, 1992; Rheingold, 1991, and Sims 1991) and will not be dealt with here. Physiological parameters of the subject/operator can also be monitored and affected if required by VR systems.

The classification scheme developed by the authors therefore covers the range of possibilities inherent in VR technology. A class 0 system is included in which visual non-three dimensional output is provided to the subject/operator. This is included to highlight the current common technology used for display of three dimensional data and virtual tours of facilities etc.

Uses of Virtual Reality and State of the Art Technology

To paraphrase a saying, the uses for VR are limited by the imagination. Table 2 lists some of the potential and actual uses for VR technology. The table gives the uses, development status (under development or under advanced development to the best of the authors' knowledge) and whether a distributed (or linked) VR system is a necessity or just desirable. Finally the type of system that may be required for this application is given using the scheme developed above.

Table 2.
Applications for Virtual Reality Technology

Application	Development Status	Distributed VR N or D	VR Type
Military			
Weapon Control	Advanced		I-VI
Submarine Warfare	Developing?	D	II
Training	Advanced	N, D	0-V
Command/Control	Developing?	N	0-V
Architectural Design	Advanced		I
CAD/CAM	Advanced	D	I
Air Traffic Control	Developing	N	I
Medical			
NMR	?	D	I
Surgery	Developing		IV
Training	Developing	D	0-V
Biochemistry	Developing		0-IV
Spacecraft Technology			
Design	Developing	D	I
Control	Developing	N,D	II
Training	Developing	N,D	0-II
Shopping			
Commercial:Home	Developing	N	0-I
Commercial: Travel	?	D	0-II?
Entertainment	Advanced	N,D	0-II
Education	Developing	N,D	0-II?

Note: D=Desirable, N=Necessity

The technology in VR and related areas is continuously advancing and it is impossible to highlight all current developments or even keep abreast of all developments. Four developments which are at the "cutting edge" will be described. The first two "edge" technologies involve display technology, the third storage technology, and the fourth networks. A current or near term technology with respect to data storage and playback will also be described.

One of the problems of VR has been the need for essentially bulky helmets holding the displays. Much work has gone into reducing the size and weight of such systems. Micro Vision, (Aviation Weekly, 1996) has demonstrated prototype monochrome and full-colour displays that shine images directly onto the retina of the eye. The system consists on a low power light source or sources (red, green, blue lasers are used for the colour system) linked by fibre optic to a helmet mounted mirror scanning system which positions the light at a given pixel position. The prototype system can refresh a 640 by 480 pixel image at 60Hz. This rate is high enough for the eye not to see flicker, the human eye being only sensitive to frequencies up to about 30Hz. In addition a 128 element grey scale has been demonstrated along with 40 degree horizontal and 30 vertical field of view.

Recent work (Downing, et al, 1996; Stocksted, 1996) has shown that it may be possible to create real three dimensional images which can walked round and examined, hence eliminating the need for helmet mounted displays. In this work a block of heavy metal fluoride glass is used. The glass contains traces of rare earth elements which emit visible light when exposed to lasers. Three elements are used to produce red, blue and green light.

The image is created by scanning the block with infrared beams at two different wavelengths. Where the beams intersect the combined energy is sufficient to excite the rare earth elements and produce light. The object can therefore be recreated by tracing the outline and contents using a scanning system. Although the light decay time per picture point, or voxel, is fast (a few milliseconds) the lasers can rewrite the image at 30-60Hz and produce to the eye a "continuous" image. There is however much development required before this becomes an available technology.

New storage technologies are starting to emerge which have the potential to store terabits of data in a small space. Nearly all of these rely on organic-based crystals where the optical properties change following exposure to light of given wavelengths. In most cases two lasers are used to change the properties/state of a few molecules and one laser is used to read the state. Such crystals provide the potential to store multiple images, holograms, or massive amounts of data. Packing densities of ~ 1 Terabit cm^{-3} are in principle possible. Readout times can also be extremely fast (Kreuzer & Tschudi, 1993).

One of the potential problems in VR is data transmission rates over networks. Optical fibre technology has developed such that within the near future transmission rates of 10 Gigabits sec^{-1} will be possible over optical networks, (Chan, 1995).

A current or near term technology is the so-called "DVD" CD-ROM (Bell, 1996) where data is written to a multiple layer CD. This technology gives the CD-ROM the capacity to store up to 17 Gigabytes on a single disc with a data rate capacity of 11 Mbits sec^{-1}. Such technologies, given development, are of direct relevance to VR and it's application.

Distributed Virtual Reality

A VR system can essentially be stand-alone with a single subject/operator or can be linked via a common database and/or other systems into a distributed VR system. The common database can either by held centrally and modified if required by each system, or local copies can be used with changes highlighted to the other components of the system. A column in Table 2 indicates whether a distributed VR environment/system is required for a particular application. In some applications it is desirable or mandatory. For example in flight training a distributed VR is desirable, but pilots can be trained individually, whilst for other training it is mandatory where, for example, teams of operators interact in command and control of forces. An example where a distributed VR system would be mandatory is in Air Traffic Control where a three-dimensional visualization of air space needs to be accessed and controlled by many operators.

Virtual Reality in Teaching and Training

Given the inherent ability of VR to display three or multi-dimensional properties of objects to an operator, the uses in teaching and training are virtually endless. It must, however, be remembered that it is essentially only a display tool and therefore cannot fully substitute for other forms of learning. It is also obvious given the growing importance and development of VR technology that the VR itself should be taught as a subject.

Being a multi-disciplinary subject it can only be taught at a relatively high level. It should however become a mandatory subject in all information technology courses even if minimum time is devoted to it.

VR systems can be used in a variety of ways in teaching and training. For most purposes only a type 0 or I system is required. A class 0 or I system can be used to demonstrate concepts to a class by using a fixed sequence in which no changes to the VR database occur. For example, the three-dimensional structure of organic molecules in biochemistry can be explored. This type of system can be PC-based with a CD-ROM. Subjects where interaction maybe required will require better technology. An examples of such subjects include CAD/CAM in engineering. One can envision an instructor leading a class through an exercise and then students working on an individual basis on other exercises. With the exception of single class 0 systems used as demonstrators, a distributed VR system is probably essential for use in teaching.

Table 3 below lists a few potential applications for VR in teaching.

Table 3.
Some Uses of VR in Education

Subject	Use
Physics	Motion, Orbital Mechanics etc.
	Gas Physics, Multi-dimensional analysis and interactions
Chemistry	Structure of compounds, molecules etc.
Biology	Structure of Organisms
	Behavior, Ecological Relationships
Geography	Earth Observation, Landscape
Geology	3-D structure
Paleontology	Structure of Fossils
Engineering	CAD/CAM
General	Display & analysis of multi-dimensional data

Technology Requirements and Developments Required

For basic tutorial type work the basic technology already exists with PCs and CD-ROMs. For more extensive use, lightweight, cheap helmet-type displays need to be available along with the appropriate computer technology.

One of the key problems in the field may be the development of appropriate software. All manufacturers seem to have adopted their own standard in VR, both for software and hardware. Unlike digital image data the authors are not aware of an international standard such as JPEG, MPEG, or TIFF in the field of VR, although basic VR systems can use simple graphics in JPEG and other standards. The following developments are critical in the opinion of the authors to the application of VR in many fields, not just education:

(i) Cheap Displays (<<£/$1000 a set)
(ii) Fast Networks (> MBytes sec-1)
(iii) Standard Protocols
(iv) Large Data Storage Capacity >>10 Gigabits

Use in Engineering and Earth Sciences

One of the main uses of VR Technology currently is in CAD/CAM in engineering. One of the hardest aspects of CAD/CAM is to appreciate the three-dimensional nature of design, manufacture and use. Hence the recent emphasis on solid modeling and concurrent engineering. It is not difficult to think of many situations where a manipulable three dimensional image of a product or process is of great value to professionals working on the design, manufacture or use of a product.

A VR system of type 0 or I enables the student or user to view a design/model as if in reality, hence reducing the need for changes later on. A VR type I or higher system would allow the student to manipulate a solid model learning easily the three-dimensional interactions between any part of the design. Similarly such a system could be used in principle to view measured inspection and other test data alongside the original design. As mentioned earlier, a distributed VR system would enable a group of students to work together for joint instruction or individually for exercise. A key element of CAD/CAM use has to be the ability to alter the VR database to input changes, new designs, and so on. The VR system would therefore have to have a direct interaction with appropriate design tools to be an effective system.

Many areas in the earth sciences require knowledge on the three or multi-dimensional aspects of a subject. For example, in geology folded rock structures although understandable in two dimensions are best viewed as in "reality". Similarly in geography, land use and detailed geography are best understood by use of stereo imaging. VR offers the operator/subject the ability to view in three-dimensions and the ability to manipulate such images to view from any viewpoint.

In both engineering and earth sciences much data is multi-parameter dependent. A suitable VR system would enable multi-dimensional analysis to be performed and viewed in an understandable fashion.

Conclusions

Virtual Reality is a rapidly developing field with many potential applications. It has direct application to teaching and training at many levels. Educators should be made aware of the capabilities and limitations of the technology. Distributed systems are required for its effective use in many areas. Virtual Reality should be taught as part of any information technology course.

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S C I E N C E

Section Editor:
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Educators in the field of science are actively pursuing avenues for building scientific literacy and reasoning into the classroom through the use of technology. Several authors describe exciting projects involving students from all grade levels, preservice and inservice teachers, and scientists. Schaverien, Sawers, and Sen begin this section with a discussion of an elementary school teacher education program that uses a virtual elementary school classroom to help preservice teachers develop a generative view of science learning rather than the typical transmissive one. Through the experiences of this program, preservice elementary education teachers experience generative learning themselves and build confidence in their ability to facilitate generative science learning by their future students.

A state-wide project for enhancing preservice and inservice teacher training through the use of technology at the elementary and middle school levels is described by O'Haver, Knight, and O'Haver. A wide variety of technology is infused through out this project. However, the authors stress the need to avoid rushing "too quickly into the technological dream," recommending instead to "move thoughtfully and deliberately, listening to our colleagues and especially to our students, as they join us in the thrill of discovery and learning."

Snyder expands this theme of preservice professional development to the secondary level of education. She examines the development of science literacy in preservice secondary science and math teachers through active, generative learning activities that utilize the internet and computational aspects of a computer.

Generative learning through science and mathematics activities in the elementary school is explored in the next article. The professional development model described by Buss, Zambo, and Wetzel integrates technology into the science and mathematics instruction of an elementary school district. The success of its implementation is particularly promising for the use of technology as a means to reform science and mathematics instruction away from transmissive to generative, authentic instruction and learning.

Coverdale continues this investigation of generative learning experiences by examining a specific case of integrating instructional technology into the science curriculum. The study's elementary teacher used instructional technology to develop students' scientific literacy through an electronic field trip, facilitating scientific inquiry through collaboration with students across the world. The development of this type of "global classroom" that utilizes authentic, technology-rich experiences is in its infancy. Coverdale's qualitative study adds depth and rich contextual understandings of this cutting-edge movement.

Another professional development program that integrates science, math, and technology is described by Bowman and Davis, but at the secondary level. Teachers explore both technology and new forms of teaching that make use of technology. This program has the added element of teacher input and formative evaluation impacting the direction of the workshops and on-going regional inservice agenda.

The theme of technology-enhanced science teacher education programs is brought into close inspection by Kumar and Altschuld. The contextual variables that impact such programs are the focus of their discussion. Using a context-specific model of program evaluation, the authors evaluated an interactive media elementary teacher preparation project of Vanderbilt University. The findings are quite promising in regard to facilitating appropriate understanding of discovery science and reflective teaching through the use of interactive media-based science methods courses.

Another teacher preparation program that emphasizes the use of computers is described by Orlik. This is a program designed to develop future chemistry teacher's understanding of computers, computer applications, internet applications, and their use in the teaching of chemistry. A specific course, "Educational Informatics for Chemists", is described and discussed in the context of countries such as Colombia, where access to software such as Windows is limited.

The final two articles address the area of scientific reasoning. Leddo describes the development of Internet-based intelligent tutoring games that help develop subject-matter understandings through the use of scientific reasoning. A specific game is featured that develops scientific reasoning in the context of solving detective problems in outer space.

A theoretical discussion of modeling student reasoning completes this section. Leman uses a computer application to represent student reasoning as a subset of expert reasoning to solve a problem. As the learner's reasoning grows closer to expert reasoning, new factors are introduced to the model. The purpose of this line of research is to inform the design of tutoring strategies. As this research continues, Leman's findings will be of great interest to those who, like Leddo, are developing computer-based tutoring games and programs.

As can be seen in this brief overview of the articles included in the science section this year, the inclusion of technology in science teacher education is becoming more sophisticated. We are moving from the perspective of using technology as a means to enrich science teacher education programs to one in which technology is an integral, driving force. Our challenge is to continue this growth towards a new perspective and share our findings as effectively as possible so that all science teacher education programs can benefit.

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A Virtual Classroom for Elementary School Teacher Education in Science

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By identifying the diverse meanings learners have for a range of scientific phenomena, science education researchers have contributed significantly to our understanding of learning as active, idiosyncratic and often unpredictable (for example, Osborne & Freyberg, 1985). Such research findings pose critical questions for educators (designing science teaching strategies which will take account of learners' individuality), and for teacher educators (designing teacher education strategies which will assist individual teachers to take account of their students' personal knowledge).

However, in Australia, as elsewhere, many elementary school student-teachers and teachers not only exhibit a low level of confidence in their ability to learn and teach science but they underrate the value of science in classroom curricula (Cobbin, 1989; Speedy, Annice & Fensham, 1989; Whitehead, Symington, Mackay & Vincent, 1993). So, in educating prospective elementary school teachers to teach science, we confront a daunting challenge: to assist student-teachers to develop a repertoire of sophisticated teaching strategies in a discipline in which they lack knowledge and confidence not only with respect to their ability to learn, but also with respect to their ability to teach.

Thus far, science education researchers have responded to this challenge by investigating the development of styles of teaching which take account of the variation in learners' knowledge and which attempt to deal sensitively with student-teachers' and teachers' prior views (for example, Bell, 1993; Schaverien & Cosgrove, 1995; Segal & Cosgrove, 1992). However, these investigations report limited success with respect to these teachers' increasing confidence or their developing ability to teach science in their classrooms. There is continuing concern (for example, Hurd, 1991; White & Klapper, 1994) that although science education research has done much to illuminate learners' knowledge of the world, it has as yet been largely unsuccessful in developing effective ways by which teachers might be helped to exploit that understanding in classrooms.

In our research group, we think we are making progress both in understanding and addressing this apparent lack of articulation between research and practice. We recognise the need to provide workshops for student-teachers and teachers where they can learn science from carefully constructed curricula and where sophisticated teaching strategies can be modelled for them by presenters. However, we also recognise that student-teachers' participation in such workshops, in the absence of children, appears not to be sufficient to enable them to teach science to children in their classrooms in what are often new ways.

In a recent, sustained professional development and research project (Schaverien & Cosgrove, in press), we successfully complemented such workshops with classroom-based mentoring, as teachers attempted to develop innovative styles of science teaching with their own students. The findings of that project suggest that if teachers are to succeed in adopting innovative science teaching approaches in their classrooms, they may well need assistance to resolve deep conflicts between the values underlying their existing practice and those implicit in the innovation they are attempting. In particular, in order to adopt innovative science teaching approaches in that project, teachers needed to be helped to relinquish their view of learning as occurring only by being instructed. Only then could they perceive learning as generative (after Wittrock, 1974; Minsky, 1985; Edelman, 1992 and Plotkin, 1994), as occurring when learners generated ideas and tested them on their value. The support of a mentor appeared to be critical in assisting such relinquishment. Furthermore, that mentor support, with its sustained and frequent conversations between teachers and the mentor, appeared to contribute, by its very nature, to teachers' developing understanding of generative styles of teaching: it allowed them yet another authentic experience (in addition to the science workshops themselves) of learning and teaching generatively.

Such mentored teacher development, though successful, is slow and labour-intensive. It has prompted us to consider how we might scale up the mentoring process. This paper will begin by describing the Generative Virtual Classroom, our first attempt to scale up that mentoring process by computer mediation, before turning to a brief consideration of further directions for research and development.

The Generative Virtual Classroom: An Attempt to Scale Up the Mentoring Process by Electronic Means

The Generative Virtual Classroom is intended for use by teacher education students, in diverse locations, individually or in small groups. In it, teacher education students can develop their ideas about science learning and teaching from authentic, pre-recorded classroom learning and teaching events. Once logged in, teacher education students are prompted to choose from a set of available digitised videos of pre-recorded classroom learning events. Having selected those they wish to see, they are able to choose one with which to begin. Of course, they may choose to watch it from beginning to end, following the transcripted text track, or to capitalise on the versatility of this medium to replay particular segments. At any point, if the text becomes distracting, it can be hidden from view. Student-teachers are encouraged to stop to record their views about this learning event, first for themselves, as jottings in no particular order on their notepad, and then to organise their ideas, entering them into a community database for themselves and for others to access. In order to enter them into that database, student-teachers are asked to notice and record particular aspects of the learning events they are watching, including:

1. key ideas these children generate;
2. how these children test their ideas - that is, on what basis they keep or discard their ideas;
3. any progression they think they can detect in these children's ideas during the video excerpt;
4. any distinctive features of these children's conversations; and
5. any special insights they themselves might have into these learning events, insights which do not fit neatly into any of the four previous categories they have been asked to note.

Our choice of these particular aspects of these learning and teaching events as focuses for student-teachers' attention is deliberate. Perceiving and attributing salience to children's generating and testing of their ideas is the basis of a generative view of learning (Schaverien & Cosgrove, 1996); and attending to the development of children's ideas and the flavour of their conversations over the course of each event ought to help student-teachers to appreciate the subtlety required of teachers if they are to support such learning effectively (Cosgrove, 1995; Cosgrove & Schaverien, 1994, 1996).

As well as generating and recording their views about these children's learning, student-teachers working in the Generative Virtual Classroom are able to access this community database to search it for their own and for other student-teachers' views of learning events. They are also able to access pre-recorded narratives and conversations in which these events are interpreted according to a generative view of learning. They can listen to these narratives and conversations in their entirety, following transcripts, or replay segments as they wish.

So, in the Generative Virtual Classroom, student-teachers can observe authentic science learning and teaching events and use them as a basis for theorising about learning and teaching science. They are provoked to make their own ideas about these events explicit and challenged to think deeply about the value of their own and others' ideas in explaining the learning they see. Such consideration ought to help them to generate a rich variety of ideas about learning and teaching science from which to select ideas of value, from which to develop educationally powerful theories. Such experience ought also to help them to make explicit and to appreciate the progression, over time, in their own views of learning and teaching, of science and of science learning and teaching.

Further Directions for Research and Development

If this process occurs as we anticipate, we expect to be able to discern research evidence that student-teachers are learning generatively in the Generative Virtual Classroom, through electronically mediated conversations. In particular, we expect to be able to confirm empirically that student-teachers are:

1. gradually relinquishing their typically strongly-held theories of learning as occurring only by being instructed, to develop an appreciation of learning as a generative act;
2. developing, over time, a sense of science itself as the progression of ideas by successive, continuing cycles of generation and distinctive (scientific) testing; and
3. recognising such cycles in children's science learning and appreciating ways in which they might support them by subtle teaching.

The prototype of the Generative Virtual Classroom which is being demonstrated here is in its earliest stage of development. Its form is the result of our decision to use existing, relatively sophisticated applications, rather than to develop a customised package in a lower level authoring language.

At least four factors were influential in this decision. First, whilst the design of the Generative Virtual Classroom has evolved from well-theorised classroom research, we are yet to evaluate the effectiveness of such computer mediation as this in prospective teachers' learning. By developing our prototype in this form, we believe we have been able to retain a certain flexibility: we have deferred committing ourselves too early to particular, critical design features, a commitment which would inevitably have closed off options (some of which we cannot yet foresee) which we might wish to take later. Secondly, we valued the capacity to use the Classroom in a distributed way, such that individual student-teachers could own their notepads but contribute to a community database. Thirdly, we were severely limited in the funding of this prototype, and had to opt for a design which would minimise our need to buy in programming expertise. Fourthly, given the technical difficulties (at the time of development) of handling large video files over the Web and of simultaneously, smoothly and transparently using different kinds of text and video files, we opted for a design which would allow us to achieve satisficing (Simon, 1969) if not ideal solutions. In the meantime, we await software developments which might provide neater technical solutions than those we have been able to achieve in this prototype. Consequently, though we recognise that our prototype may well be a little less polished than it might have been had we taken another decision pathway, we believe that we are now well-placed to evaluate and refine it.

In the coming year, we intend to evaluate and refine this prototype of the Generative Virtual Classroom through trials of it with small groups of teacher education students. We will study the records these student-teachers make in the Generative Virtual Classroom and record conversations with them about science learning and teaching and about the Generative Virtual Classroom itself. As well, we will observe and converse with them in schools during their teaching practicum, in order to document their developing views of learning and teaching in general and of science learning and teaching in particular. Here, we will be looking for any explicit and implicit relationships between these views and these student-teachers' experiences in the Generative Virtual Classroom. In these diverse ways, we hope to be able to evaluate the salience and the effectiveness for these student-teachers of learning about science learning and teaching in the Generative Virtual Classroom. In essence, we will be hoping to answer the following research questions:

1. whether it is possible, by means of the Generative Virtual Classroom, to mediate and support those conversations between teachers and mentors which we know, from our classroom research, to be critical to successful, innovative science teaching;
2. if it is possible by these means, how we might do so better; and
3. if it does not appear to be possible by these means, what the barriers might be and how we might now try to overcome them.

Thus, we will be looking to this investigation to indicate ways of refining the Generative Virtual Classroom itself. Its development so far has been a generative process for us, too; already, even in advance of its evaluation, we can see ways in which we might enrich it further in the short, medium and long term. For example, as well as adding to the set of digitised excerpts from our extensive archive of research videotapes, we would now like to include a range of commentaries on these learning events from children, parents, teachers and researchers, and an expanded set of links to related materials on the Web. We would like to explore the possibilities of capturing student-teachers' views as audio rather than text files and of supporting email and/or chat between student-teachers using the Generative Virtual Classroom in different locations.

As we have attempted to make clear in this paper, we believe that, through the development of such alternative learning and teaching environments as this virtual classroom for teacher education in science, a new and critically important educational research and development agenda is evolving.

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A Technology-Enhanced Distributed Learning Community for Teacher Preparation

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This report describes a state-wide project to reform the preparation and support of teachers of mathematics and science for the upper-elementary and middle-school grades in the state of Maryland. The *Maryland Collaborative for Teacher Preparation* (MCTP) consists of approximately 125 mathematics, science and education faculty from twelve Maryland public four-year and community colleges, 165 undergraduate elementary education majors, and 90 elementary and middle school mathematics and science teachers from the cooperating Maryland county public school systems. The project is supported by a five-year grant from the National Science Foundation's "Collaboratives for Teacher Preparation" program, beginning in 1993. We are one of 13 such programs nationwide.

Maryland is a state that does not have separate middle-school certification at the present time; most campuses of the state college system offer an undergraduate elementary education degree; and most middle school teachers working in the state have elementary rather than secondary certification. The MCTP is focused on creating a new teacher preparation program, targeted on upper elementary and middle school grades, reflecting our belief that the challenge of reform in science and mathematics education is especially critical at that level and that there is growing support for use of content specialist teachers with interdisciplinary expertise.

Technology for State-wide Communication and Collaboration

Much of the work of the MCTP is the development or reformed science and mathematics content and methods courses and college faculty development. One of our aims is to build, for the first time in Maryland, productive collaborations that would reach across traditional institutional and disciplinary boundaries of the state educational institutions. Because our participants are scattered over the state, we have made considerable use of electronic networking tools to supplement our face-to-face meetings and to reduce the time and expense involved in phone calls, postal mailings, and traveling across the State.

Interactive Video Network

The Interactive Video Network (IVN) is a state-wide compressed-video teleconferencing system that allows project participants all over the state to engage in real-time multi-way video conferencing from specially-equipped rooms located at each state college and research campus. We used this system extensively for meetings in the early phases of our project, but the high demand for IVN time by regularly-scheduled courses and by other organizations has made scheduling very difficult. We now make less use of the IVN facility and more use of email.

Electronic Mail

Email has been very successful in facilitating day-to-day communication throughout the project that would not have been practical in any other way. It is a constant means of communications between the Executive Director, the Principal Investigators, and the Institutional Representatives on each campus site. All of the participating campuses have access to e-mail, and the Academic Information Technology Services at the College Park campus gives free email (UNIX shell) accounts to any teacher or administrator in the state of Maryland, in public or private schools, who request one.

The MCTP Listserv Discussion Groups

In the summer of 1993 we created a listserv discussion group (MDCETP@UMDD.UMD.EDU) that we hoped would facilitate state-wide communication across our campuses. It has proved to be very successful for those who participate. As of Fall, 1996, there were 111 subscribers to the MCTP listserv, including at least one representative from every four- and two-year college in the project. Listserv traffic averages 30 to 40 messages per month (about 2500 lines per month). In addition to the usual administrative announcements of MCTP activities, the list also shares interesting math and science news, resources, opportunities, and cross-postings from other lists followed by our members.

Based on an analysis of message subjects lines during 1995 and 1996, the most popular subjects of listserv discussion have been: daily class journals from introductory science classes; conceptual assessment questions; faculty development; the development of a "capstone" course; alternatives to lecture; and student attitudes towards new pedagogy; and discussion of specific content issues. Several faculty have posted regular updates on their ongoing MCTP courses - observations, student journals, experiments, student handouts. We continue our efforts to find exciting discussion topics that will stimulate a wider and more substantive participation from the MCTP participants.

A significant aspect of the listserv discussion is that everything is archived automatically by the listserv host computer (this is a standard feature of listservs) and can be accessed after the fact. The MCTP research group uses the listserv archives for research purposes.

The MCTP listserv list is viewed primarily as a faculty participant discussion group, even though students are invited to join. In addition to that list, we have also set up a student listserv list (MCTPINT@UMDD.UMD.EDU) that is intended primarily for student discussion (although faculty are free to join also). So far, the student list has had fewer participants than the faculty list. It is busiest in the summer, when many of our students are at their summer internship sites scattered all over the state and use their list to "check in" regularly. Both of our listserv lists are operated on a autonomous subscription basis.

In addition to the MCTP listservs, an increasing number of MCTP participants subscribe to other listserv lists in their areas of specialization (e.g. National Council of Teachers of Mathematics, Chemical Education, Physics Education, etc.) and actively participate in those forums. MCTP people contribute or answer an average of 12 messages/month on the MDK-12 listserv list (MDK-12@UMDD.UMD.EDU), to which 1000 Maryland K-12 teachers and administrators across the state are subscribed.

MCTP Web Site

The start of our project in 1993 coincided with the development of the World Wide Web and the introduction of Mosaic, the first graphical Web browser. The Academic Information Technology Services at College Park set up a Web server and began to offer training in Web site construction. By January of 1995, we were able to set up a World Wide Web site for the MCTP project (the URL is http://www.inform.umd.edu/UMS+State/UMD-Projects/MCTP/WWW/MCTPHomePage.html), to be used both internally to facilitate information sharing within the project and externally as a means of dissemination of project information to the wider community.

In addition to the usual "boilerplate" information on the project goals and structure and lists of participating people, institutions, and courses, we have made an attempt to provide collection of useful "resource" material, including:

- A sampling of course materials from some of our reformed courses
- A collection of selected essays on constructivism and education
- Tutorials on various aspect of instructional technology use
- A pictorial presentation of projects from the Summer Internship program
- A description of and an application form for the Mentor Teacher Workshop
- A database of books, reports, papers, software and other material in our collection
- A large collection of hypertext pointers to "Internet Resources for Science and Mathematics Education", which is used as a starting point for Internet exploration.
- Links to the NSF and to the Web sites of Collaboratives in other states.

The MCTP Web site has been growing steadily and now incorporates over 125 individual "pages" (the equivalent of perhaps 300 or so printed pages). Access data during 1996 show that the use of the MCTP Web site has been increasing steadily over time. In Fall, 1996, the MCTP top menu (home) page was accessed nearly 500 times per month. Other highly popular pages on our Web site include the *Science and Math Internet Resource Collection* (over 700 hits/month) and the *Chem 121/122* page (over 600 hits/month), and the *Chemistry Internet Resources* page (over 1000 hits/month). The majority of these hits are from *outside* the university system, suggesting that the Web site is contributing to our external dissemination efforts.

Direct evidence of the impact of the MCTP's "electronic" visibility outside our own organization are the instances in which external organizations cite MCTP and MCTP-sponsored activities on their own sites. These include the Eisenhower National Clearinghouse, the Virtual Schoolhouse, the BBN Copernicus Project, the Benton Foundation, Oklahoma Partners for Biological Sciences, Columbia University, SUNY Potsdam, Marshall University, and the University of Kentucky, among others. A list of hyperlinks to these organizations is kept on our Web site. There have been at least three documented instances in which MCTP course materials on our Web site have been adapted and used by schools in other states.

Technology Training of Pre-service Student Teachers and their Mentor Teachers

The Mentor Teacher Workshops

Each summer we conduct an intensive two-week residential workshop for 24 practicing teachers in Maryland school districts to prepare them to be the cooperating teachers for our student teachers. The mentor teachers are chosen by application. A substantial component of the Mentor Teacher Workshops is technology training, including using email, locating and evaluating information on the Internet, using graphing calculators, spreadsheets, taking a field trip to a local elementary school that is making exemplary application of technology in their curriculum, and gaining hands-on experience with some of the latest multimedia and CD-ROM software that is suitable for use in elementary and middle school classrooms.

The Summer Internship Program

Each summer we organize internship opportunities for our pre-service elementary education students that are carefully structured to give them genuine experience the ways that science and mathematics learning can occur in a variety of research laboratories and informal educational settings. Many of the internship projects have a substantial technology component; for example, some students are involved with educational multimedia CD-ROM development and in developing Web sites for the projects. All interns participate in a two-day workshop at the beginning of the summer that includes training in journaling and electronic communication.

Communication Software Distribution

In an effort to increase the number of MCTP college faculty, project teachers, and mentor teachers who have access to email and to the World Wide Web at home and in their classrooms, we have prepared and distributed floppy diskettes for both Macintosh and Windows that contain the freeware and shareware communication software and detailed step-by-step instructions. The free UNIX shell accounts provided to teachers by the Academic Information Technology Services at College Park allow IP network access via the PPP emulator program called "SLIRP"; our software distribution includes the software needed to utilize this method of access. Recently, commercial Internet Services Providers in the area have begun to offer superior PPP access at modest prices.

Electronic Distribution of Workshop Handouts

To facilitate the dissemination of our technology training efforts, we have converted most of our workshop handout materials to HyperText Markup Language (HTML) format and have placed them on the Web (http://www.wam.umd.edu/~toh/Handouts.html). These include tutorials on e-mail, Internet exploration, Web site construction, HTML, image processing, classroom multimedia production, finding and evaluating information on the Internet, delivering educational materials on the WWW, and downloading Web sites for local viewing.

Software Lending Library

We maintain a collection of computer software of use in science and mathematics instruction that can be borrowed. Many of the programs are public domain or low-cost shareware packages that can be freely copied and distributed; these have been featured in order to demonstrate what can be done even if extensive funding is not available. Many of these titles can be downloaded from our "downloadble software" page (http://www.inform.umd.edu/UMS+State/UMD-Projects/MCTP/Technology/software.html). We have made an effort to locate software that supports a student-centered, "constructivist" view of learning; thus simulations, student tools, and "construction kit" software is favored over simple tutorials and drill-and-practice.

Technology Events

MCTP participants are active in making technology-related presentations at annual state and national educational technology meetings (e.g. the National Educational Computing Conference; the Maryland Instructional Computer Coordinator Conference, and the Governor's Technology Showcase) and in giving workshops that are attended by teachers, students in our preservice teacher-preparation programs, and college faculty. Topics of these presentations and workshops have included: microcomputer-based laboratory (MBL) experiments; science and mathematics software and CD-ROMs; graphing calculators; World Wide Web; field trip to a local elementary school that is a leader in technology integration; live computer demonstrations of interactive mathematics programs; classroom multimedia production; Web authoring; integrating modern instructional technology into the classroom.

The Fairland Connection

Fairland Elementary School is a suburban public school in Maryland that has been making exemplary application of technology in their curriculum. One of their major accomplishments has been the development of a Web site for the publication of student projects (http://www.wam.umd.edu/~toh/Fairland.html) that has won multiple awards on the national level (O'Haver & O'Haver, 1997). The MCTP hosts the Fairland site on its Web server, provides technological expertise, and uses the school as a field trip site for our pre-service teachers and as a site for in-service training of mentor teachers.

Integration of Technology into Pre-service Coursework

Electronic Mail and Use of Internet

All MCTP students are expected to obtain email accounts from their respective campuses. Some students are making extensive use of e-mail and Internet in their courses: keeping electronic journals and emailing them to the instructors each week, finding and using course-related Web sites and other Internet resources, and analyzing data they have collected in laboratory experiments. Most campuses have developed training for students in email and WWW access. One of the campuses has set up a listserv for their own students.

Instructional Software in MCTP Courses

In general, instruction in the use of software as instructional tools is integrated into our content courses, rather than being separated out into a "Computers for Teachers" course.

Microcomputer-Based Laboratories (MBL). The most extensive use of microcomputer-based laboratories has been in introductory physical science courses. Motion detector and temperature probes have been the most widely used. The project has purchased several sets of probes and interfaces to loan to faculty in the project for their courses.

Graphing Calculators. The project has purchased classroom sets of graphing calculators, which have been used in several courses across the Collaborative. We have also purchased two Calculator-Based Laboratory (CBL) systems, which are being used primarily in physical science courses.

Spreadsheets. Several courses are using spreadsheets with students in their MCTP classes, particularly in mathematics and physical science classes, for such purposes as analyzing data from the science laboratory experiments; setting up and solving multi-step word problems dealing with atmospheric pollution (http://www.inform.umd.edu:8080/UMS+State/UMD-Projects/MCTP/Courses/PhysicalScience/ClarisWorks.html), and relating the linear dimensions, surface area, and volume of cylinders constructed from paper.

Discipline-specific Software Packages. In various classes, some of our student use mathematics-oriented software, physics-orientated software (a Newtonian mechanics simulation), statistics-oriented software, chemistry-oriented software, a 3D molecular visualization and animation software package, a computer language well suited for novices and some of the modules from a biology simulations CD-ROM. Some of our faculty have even developed custom instructional software for their classes.

MCTP as a Catalyst for the Promotion of Technology in the Participating Institutions and Schools

Integration of technology requires more that the available of technology and training to use it; it also requires that technology successfully compete for "mind share" with many other concerns of daily school life. Through a persistent utilization of technology in many of our project activities, combined with workshops and site visits to help with installation and application problems, and occasional direct purchase of critical software and hardware, we have encouraged our participating institutions and schools to pay more attention to the technological needs of faculty and students. This effort has payed off in improved access to and utilization of email accounts for faculty, students and mentor teachers, increased access to graphical WWW browsers, and more favorable attitudes of our participants towards technology.

Barriers of Effective Technology Application

As useful as it is in our project, email communications is neither universal nor 100% reliable. A few participants in the MCTP project do not use email regularly. In particular, some of our teacher colleagues do not yet have email accounts and most do not have computers at home, thus making access to email inconvenient. Buying computers for them is beyond what we can expect from the grant at the present time. We continue to work on ways to make email more universal in this project. It takes time to develop the email "habit" of regularly checking and using email routinely. One purely technical problem is that the email systems at the various campuses vary considerably, so that it is difficult to provide instruction that applies universally. The details of printing and saving email, and of attaching files and including pre-written text, is particularly troublesome. Participants must rely on local sources of help for such problems.

Participation on our listserv discussion groups is uneven; most of our college faculty participants are subscribed to the main project list, but relatively few teachers have signed up (subscription is voluntary; the project does not unilaterally subscribe people). As is often observed in such settings, a relatively few active subscribers contribute most of the messages and responses; many other subscribers read but seldom respond or originate messages. However, when asked, even these subscribers say that reading the messages of others is valuable and rewarding; they claim that they are "not ready" to participate actively.

A commonly-voiced objection to participation in listserv discussion groups generally is the fear of getting "too much e-mail". We usually recommend that people who subscribe to several active listserv lists switch to "digest" mode, a feature of most listserv hosts that concatenates all the messages for one day into one single message, greatly reducing the clutter a nd the intertwining of messages from different groups.

It has proven difficult to get the instructors of our various pre-service courses to contribute course materials for posting on our Web site. The problem is not technological but rather personal; many instructors do not feel comfortable contributing their personal materials to such a "public" forum. A more private project-limited forum would probably be more acceptable but would not serve the external dissemination function now served by our Web site.

The objective of all of this is not to use technology for its own sake but rather as a tool to help us achieve our more fundamental goals. In the classroom the important thing is student learning; to the extent that technology can enhance learning, then it is a good thing. The most fundamental problem is defining what really constitutes good learning. If technology can expand what it means to learn, then there is the ever-present danger that our own conceptions of learning, limited by our having been educated ourselves largely in the older less technological paradigm, will find it difficult to stretch to encompass a new kind of learning. For this reason we should not rush to quickly into the technological dream, but rather move thoughtfully and deliberately, listening to our colleagues and especially to our students, as they join us in the thrill of discovery and learning.

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An Emphasis on Science Literacy in Preservice Teacher Education

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Science literacy - which encompasses science, mathematics. and technology - has emerged as a central goal of education as identified by Project 2061, the long-term reform initiative of the American Association for the Advancement of Science. The National Research Council (1995) defines science literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (p. 22). According to the National Research Council (NRC), a person that is science literate is expected to be able to form questions and find explanations for everyday occurrences; read, understand, discuss, and evaluate articles of a scientific nature; describe, explain, and predict natural phenomena; be scientifically and technically informed about national and local decisions; and evaluate scientific information, arguments and conclusions based on evidence and the methods used to gather that evidence.

Why is a goal of science literacy for all students, for all Americans, important? The reasons may sound somewhat lofty but their importance cannot be disputed. In *Science for All Americans* the National Research Council contributed the following argument:

> Science, energetically pursued, can provide humanity with the knowledge of the biophysical environment and of social behavior needed to develop effective solutions to its global and local problems; without that knowledge, progress toward a safe world will be unnecessarily handicapped.
>
> By emphasizing and explaining the dependency of living things on each other and on the physical environment, science fosters the kind of intelligent respect for nature that should inform decisions on the uses of technology; without that respect, we are in danger of recklessly destroying our life-support system.
>
> Scientific habits of mind can help people in every walk of life to deal sensibly with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty; without the ability to think critically and independently, citizens are easy prey to dogmatists, flimflam artists, and purveyors of simple solutions to complex problems. (cited in Rutherford & Ahlgren, 1989, p. xiv)
>
> The council concluded that "the life-enhancing potential of science and technology cannot be realized unless the public in general comes to understand science, mathematics and technology and to acquire scientific habits of mind" (Rutherford & Ahlgren, 1990, p. xiv-xv).

Guiding Principals of the Science and Math Standards

The *National Science Education Standards* (NRC, 1995) and the *Curriculum and Evaluation Standards for School Mathematics* [National Council of Teachers of Mathematics (NCTM), 1989) were both written by national committees, made up of teachers, administrators, parents, and the business community for the same purpose: to describe what a quality science and mathematics education, respectively, should look like.

The following principles are the cornerstone of *the National Science Education Standards*: "science is for all students; learning science is an active process; school science reflects the intellectual and cultural traditions that characterize the practice of contemporary science; improving science education is part of systemic education reform" (NRC, 1995, p. 2).

The National Council of Teachers of Mathematics (1989) set societal goals of mathematically literate workers, lifelong learning, opportunity for all, and an informed electorate. Emphasizing that "educational goals for students must reflect the importance of mathematical literacy" (pp. 3-4), the NCTM also set these goals for all students: learning to value mathematics; becoming confident in one's own ability; becoming a mathematical problem solver; learning to communicate mathematically and learning to reason mathematically.

Both math and science standards make the assumption that all students can learn. Learning may take place in different ways, at different rates, and at varying depths, but all students should be encouraged and have the opportunity over a continuous and extended period of time to achieve understanding and confidence backed by experience and knowledge. In addition, all students should participate in challenging and interesting learning environments.

Both standards state that the learning of math and science should be an active, not passive, process with students engaged in problem solving, inquiry, decision making, and communication. Some of the verbs used to describe students doing math and science include investigate, question, explore, communicate, describe, read, write, and test. The *National Science Education Standards* (NRC, 1995) put a strong emphasis on the inquiry process that involves:

> making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze and interpret data; proposing answers, explanations, and predictions; and communicating the results. (p. 23)

Davis and Hersch (1981) claimed that the development of science and technology is a source of new mathematical questions. The NCTM *Standards* (NCTM, 1989) makes the claim that not only has technology provided tools that make many mathematical activities easier, they have also changed the nature of mathematical questions that can be investigated and answered. The *National Science Education Standards* (NRC, 1995) expound on the relationship between technology and science, stating that "the need to answer questions in the natural world drives the development of technological products; moreover, technological needs can drive scientific research" (p. 24).

Implications for Math and Science Education

The national committees that wrote the two standards documents recognized that central to the goals of science literacy and mathematical power for all students was the creation of a curriculum and learning environment that nurtured and supported the standards and was significantly different from the current educational environment. Science Teaching Standards (Chapter 3) of the *National Science Education Standards* and the *Professional Standards for Teaching Mathematics* were written to provide guidance for those people considered vital to the process of mathematics and science education reform - teachers.

The guidelines set forth in *Professional Standards for Teaching Mathematics* center around two assumptions: "teachers are key figures in changing the ways in which mathematics is taught and learned in schools" and "such changes require that teachers have long-term support and adequate resources" (NCTM, 1991, p. 2).

The following five assumptions are at the core of the science teaching standards (NRC, 1995):

- The vision of science education described by the *Standards* requires changes throughout the entire system.
- What students learn is greatly influenced by how they are taught.
- The actions of teachers are deeply influenced by their perceptions of science as an enterprise and as a subject to be taught and learned.
- Student understanding is actively constructed through individual and social processes.
- Actions of teachers are deeply influenced by their understanding of and relationships with students. (p. 28)

Both standards give recognition to Piaget's theory of constructivism, the theory that "human beings acquire knowledge by building it from the inside instead of internalizing it directly from the environment" (Kamii, 1990, p. 22). This theory supports the idea that children are not given knowledge, but, instead, they form mathematical and scientific concepts, science literacy, as they engage in instructional activities that support a problem solving environment (Yackel, Cobb, Wood, Wheatley, & Merkel, 1990). Both standards stress that teachers need to become more knowledgeable of effective learning and teaching theories and practices, recognizing that these practices may be significantly different from those experienced when teachers were students themselves. This fact underscores the importance of ongoing professional development. And, both standards emphatically state that teachers must be provided with support, encouragement, time, resources, and opportunities to make the changes recommended by the standards.

These changes in the teaching and learning environment represent major shifts in current practices including a shift from:

- supporting competition among individual students to supporting a classroom community characterized by cooperation, respect, and shared responsibility;
- presenting or giving knowledge through lecture and the textbook to guiding students in active inquiry and problem solving;

- memorizing and reciting facts and isolated concepts to providing the opportunity and motivation for discourse, debate, conjecture, and reasoning; and,
- acquiring and memorizing answers/facts to understanding, applying, and making connections among concepts.

Implications for Preservice and Continuing Teacher Education

For successful implementation of the math and science standards in the K-12 community, preservice and inservice teacher education must be well thought out and coordinated. Preservice teachers gain knowledge in their teaching discipline through courses they take in college, many of which are taught in a traditional lecture/demonstration style. They also bring with them the teaching models and learning environments that they participated in while they were K-12 students; again, these experiences are usually more traditional than reflective of the changes recommended in both standards.

One of the most influential experience that preservice teachers have is their clinical experience, which may consist of a one or two semester internship with a K-12 supervising teacher. This experience should be a time when the teaching and learning theories that students have been exposed to in the university environment meet up with trial and application within the K-12 classroom. It should be a time in which preservice teachers are encouraged and supported in their efforts to try out new ideas, learning theories, and teaching practices. The reality of the situation is that, in many cases, supervising classroom teachers are not selected because their teaching practices reflect the recommendations made by the standards; rather, they are selected because they are willing, for a diverse number of reasons, to participate. Therefore, traditional and, often, non-exemplary teaching practices are reinforced and passed from the supervising teacher to the preservice teacher. This underscores the idea that professional development, knowledge about content, students, and effective teaching practices, should be an ongoing activity for all teachers.

The *National Education Science Standards* (NRC, 1995) and *Professional Standards for Teaching Mathematics* (NCTM, 1991) recommend professional development standards for science and math teachers, respectively. Common threads run through both sets of recommendations made by the National Research Council and the National Council of Teachers of Mathematics; a few of these are summarized below:

Professional development for teachers of science requires learning essential science content through the inquiry method. Science learning experiences for teachers must involve teachers in actively investigating phenomena, interpreting results and making sense of findings. Experiences must also introduce teachers to scientific literature, media, and technological resources that build on their science knowledge and their ability to access further knowledge.

Mathematics and mathematics education instructors in preservice and continuing education programs should model good mathematics teaching by creating learning environments that support and encourage mathematical reasoning and discourse, using a variety of tools, such as calculators, computers, and physical and pictorial models.

Professional development for teachers of science requires integrating and applying knowledge of science, learning, teaching pedagogy, and students. Experiences should include inquiry, reflection, interpretation of research, modeling, and guided practice to build understanding and skill in science teaching.

Preservice and continuing education of teachers of mathematics should develop teachers' knowledge of: ways to represent mathematics concepts; instructional resources, including technology; ways to promote discourse and a sense of community; and various means for assessing students' understanding.

Professional development activities for teachers of science must provide opportunities for self and peer reflection on classroom teaching and for feedback about their teaching so that teachers may analyze and apply that feedback to improve their practice. Opportunities for collaboration and the sharing of teaching expertise should also be provided.

Preservice and continuing education of teachers of mathematics should provide opportunities for teachers to examine their assumptions about the nature of mathematics, how it should be taught, and how students learn. They should also have the opportunity to analyze and evaluate the appropriateness and effectiveness of their teaching.

Both standards make recommendations concerning quality preservice and continuing education programs and the teacher's role in professional development. The majority of these recommendations call for teachers to become life-long learners themselves, actively participating in experimentation with alternative approaches and strategies, participating in workshops and content related courses, reading and discussing ideas presented in professional journals, discoursing with colleagues about math/science teaching and learning, designing and evaluating professional development activities, and continually assessing the effectiveness and improvement of the learning environment.

A Preservice Education Course With an Emphasis on Science Literacy

In the Fall of 1996 at the University of New Mexico, a learning environment meant to support and enhance the science literacy of math and science preservice teachers was provided through a course titled Teaching Reading in the Content Area, a course that was once (but no longer) required for New Mexico state certification. Because the enrollment of science preservice teachers was low for the fall semester, the course was offered to a combined group of math and science teachers.

The instructor, an educational doctoral student and administrator of a technology program, NM Adventures in Supercomputing, saw an opportunity to provide preservice teachers with an experience whose main goal was to develop a conceptual and instructional framework for science literacy that could be transferred to the secondary classroom. The objectives of the course were to: define the meaning and goals of science literacy; create lessons, activities, and projects that meet the goals of science literacy; and become science literate individuals.

The two main activities chosen to enable preservice teachers to meet these objectives were participation in a science/math related Internet project and in a computational science project. The activities involved preservice teachers in actively investigating phenomena, interpreting results and making sense of findings. The activities were also designed to introduce teachers to scientific literature, media, and technological resources that added to their science knowledge and their ability to access further knowledge.

The Internet Project

After searching the Internet, discussing strengths and weaknesses of possible Internet projects, and evaluating their appropriateness for the math/science classroom, preservice teachers chose three group Internet projects from the Global SchoolNet Internet Project Registry (http://199.106.67.200/gsn/proj/index.html).

The objective of group one's project was to design and construct, using specified materials, the smallest parachute possible which had the longest hang time. Participating as students, the preservice teachers had to build and test their parachute and submit their results to a central site on the Internet to be compared with other students' results. The goal of group two's project, titled "A World Community of Old Trees", was to gather and submit information on trees that are important to people. One of this group's participants described this as a very open-ended project whose purpose was to analyze the types of information received from such a broad request over the Internet. In group three's project, "Men and Women of Math and Science", twenty-four classrooms were chosen to participate. Each participating group was responsible for contributing a set of clues to the identity of a man or woman of math or science to the project host school and for identifying the man or woman whose clues were submitted by another participating school. At the host school, this project was being shared by social studies classes who were creating a timeline for the mathematicians and scientists submitted and English classes who were keeping a log of the project.

At the conclusion of the Internet projects, each preservice teacher described their participation in their project, evaluation of the organization and effectiveness of the project, and possible implementation of the project in a 6-12 grade math or science classroom.

The Computational Science Project

Computational science involves the use of computers to investigate and analyze scientificproblems. A key step in the process is to represent the scientific problem by a mathematical model. A computational science project should: involve a scientific application; include a mathematical model; and, make use of a computer to investigate, analyze, and interpret the problem.

The preservice teachers, in teams of three or four, were tasked with: selecting a project question, conducting research on the project topic, choosing a mathematical model to represent the phenomena, designing a computational model which implemented the mathematical model, interpreting their results, and giving a written and oral presentation of their findings. Project topics include: the effect of weather on the expected birth rate for a given geographical area; prediction of future solar eclipses; projected number of AIDs cases in a particular state; and, the effect of various limiting factors on a population that has reached its maximum carrying capacity.

This course provided an environment in which preservice math and science teachers collaborated, integrating mathematics, science and technology - an environment meant to build science literacy.

Recommendations for Professional Development of Math and Science Teachers

"Becoming an effective science teacher is a continuous process that stretches from preservice experiences in undergraduate years to the end of a professional career" (NRC, 1995, p. 55). If current reforms in math and science education are going to filter down into the classroom, substantial changes must be made in professional development. Practicing teachers need to be encouraged, through stipends, advancement in professional career ladders, and/or time support to engage in professional development activities and courses side by side with preservice teachers. As technology enables students to consider new questions and investigate interesting problems, teachers need to learn not only how to use technology tools, but how to effectively integrate them into the curriculum. Preservice and experienced teachers need to have opportunities participate in optimal collaborative environments in which they engage in the same kind of activities the standards recommend for students, teaming, working on real world problems, investigating, interpreting results, learning concepts within an applicable context, and communicating learning in written or verbal form. If learning and intellectual development is to become a lifelong activity of our students, it must first become a lifelong priority of our teachers.

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Integrating Technology into Science and Mathematics Instruction: A Professional Development Model

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Technology has the potential to change radically science and mathematics instruction in K-8 classrooms. By using computers, multi-media, and telecommunications technology, teachers will be able to present and students will be able to engage in authentic, open-ended problem solving situations in science and mathematics.

Although this potential is substantial, considerable professional development will be required to meet this opportunity. The need for professional development is particularly essential when one considers the issue of incorporating technology into current instructional endeavors. In the present paper, we report on the development and validation of a professional development model for integrating technology into science and mathematics instruction. The professional development model was designed to be aligned with the most recent recommendations for effective professional development and it was funded by a national Eisenhower Grant.

New Science, Mathematics, and Professional Development Standards

Recent advances in mathematics and science teaching expectations as outlined in the National Council of Teachers of Mathematics (NCTM, 1989; 1991); American Association for the Advancement of Science's *Project 2061* (AAAS, 1990) and *Benchmarks* (AAAS, 1993); and the National Research Council's (NRC, 1996) *National Science Education Standards* attest to the reform efforts in science and mathematics that emphasize new instructional approaches. A recurring theme throughout all of these recommendations is the importance of technology in science and mathematics instruction. In particular, technology provides opportunities for students to formulate, investigate, and solve open-ended, authentic problems.

Although these recommendations, especially those related to technology and professional development, are important and will prove to be beneficial to students, inservice teachers are not currently prepared to meet the mandates. For example, recent research summarized in the US Office of Technological Assessment (USOTA, 1995) report indicates that teachers have not been provided with professional development to integrate technology into their instruction. Thus, the focus of the project is on fostering change in teaching science and mathematics as a result of using technology and examining how this change is exhibited in teachers' beliefs and classroom actions.

Successful Professional Development

Recent research shows that successful professional development takes place over an extended period of time to provide distributed learning and implementation as well as fostering systemic change (Fullan, 1991). Further, Fullan notes successful programs provide training and support for the entire faculty of a school. Male (1994) cogently argues that successful classroom implementation requires: theory, demonstrations of appropriate uses, opportunities for immediate practice and feedback, time to adapt curricula to technology, coaching, and periodic review. Finally, Strudler (1994) suggests that opportunities to be observed and coached are critical in implementing technology in the instructional/learning process.

The Professional Development Model

In the project, Arizona State University West worked collaboratively with Glendale Elementary School District to design and test a comprehensive, professional development model focused on changing the way that science and mathematics are taught in elementary schools by integrating technology into science and mathematics instruction. The comprehensive model has three distinguishing characteristics.

First, the professional development was conducted over an 11-month period, to date, to provide teachers with opportunities distributed over time. The professional development model provided for extended training, demonstrations of use, substantial practice time, immediate classroom implementation, adaptation of activities to their classrooms, observation, coaching, and review.

Second, instructional pedagogy issues were addressed in each workshop session, as well as issues related to the use of technology in science and mathematics instruction. Workshop instruction was conducted by technology leaders, master teachers with strong technology backgrounds, who developed and provided instruction and demonstration lessons, observed and provided feedback to teachers, and offered technical assistance throughout the project. Other experts in science and mathematics instruction and integration of instruction provided assistance to the technology leaders to ensure that the full array of technology and pedagogy issues were presented.

Third, teacher participants worked in two-member teams, sharing a computer and multi-media set-up, that allowed for mutual support and encouragement. These teams also provided for optimal use of the technology resources.

Method—Implementation of the Model

Forty-two teachers from two elementary schools with high minority enrollments participated in the professional development program that consisted of eighteen 3-hour sessions conducted on a weekly basis after school during the spring of 1995, a 10-day intensive summer session, and 8, 3-hour sessions in Fall of 1995. These workshops were carefully distributed over an extended period of time to allow for assimilation of the information, frequent practice opportunities, and extensive opportunities to implement the techniques and methods in their own classrooms. Consistent with the professional development standards, between each school-year session teachers were asked to reflect on their practice. Additionally, they were provided with opportunities to share successes and challenges at each session.

In addition to learning to use technology, teacher participants were provided with demonstrations and practice in using pedagogical skills necessary to effectively implement instruction that includes technology. For example, managing student use of the computers, cooperative learning techniques to optimize use of resources, and so on were presented and practiced as part of this pedagogical component.

The instructional component of the professional development program focused on providing teachers with information, materials, and skills that could be applied immediately to their classrooms. Topics of the individual sessions included: setting up the hardware including a Apple Macintosh AV computer with display, a laser disc player, and a 27" monitor/receiver; loading software and trouble shooting problems; using word processing, spread sheets, and data bases; using production software such as *HyperStudio*; using CD-ROMs; using laserdiscs; and so on. Other sessions allowed teachers to investigate using computers: as a means to present problem situations with science and mathematics content, as a resource for student research, as a student tool for science and mathematics presentations, as a tool for performing mathematics explorations, and so on. See Zambo, Wetzel, and Buss (1996) for additional details regarding the training.

During the school-year sessions, instruction in a topic and opportunity for individual practice with feedback was provided. Then teachers were expected to use the newest information/techniques in their classrooms and report at the next session on the successes and challenges they had encountered with the use of the information/material. As the project progressed, in addition to some instruction, participants worked in teams of two or three and designed instructional materials and lessons using the computer set-ups. The summer session provided teams with the opportunity to work on materials that could be integrated into thematic instructional units.

Results—Validation of the Model

Data were collected by several methods. Using a questionnaire, data were collected from the 42 participants at the initial professional development session and after one year of participation in the project. Items included both open-ended questions and Likert-type items. Likert items were rated on a 6-point scale from 1—strongly disagree, 2—disagree, 3—somewhat disagree, 4—somewhat agree, 5—agree, to 6-strongly agree. Items were organized into eight subscales, including: attitudes toward using computers; setting up computers and multimedia (C/MM); trouble shooting C/MM problems; computers in the curriculum; selecting C/MM materials; teaching using C/MM; developing lessons using C/MM; attitudes towards C/MM; and teaching specific topics like spreadsheets, databases, etc. In Table 1, we present several of the subscales and example items that illustrate the nature of the subscales and items.

Additionally, follow-up data were collected through interviews and through a review of the participants' reflections recorded in professional development journals, and logs for computer use. Both quantitative (for Likert-type items) and qualitative methods (for open-ended response items) were used to analyze the data.

Teachers expressed initially low levels of implementation and confidence in their use and ability to teach using C/MM materials. These quantitative data were also supported by qualitative data from teacher journals and use logs. As teachers became more familiar and confident with C/MM technology through instruction and implementation, their classroom use and confidence levels increased.

Importantly, across the one-year time period of the project, six of eight dependent measures—setting up C/MM, trouble shooting C/MM, etc., increased significantly, all Fs with 1 and 41 degrees of freedom. See Table 2. These increases in confidence and use of C/MM materials were also noted in their journals and in their computer use logs.

Table 1
Subscale and example items from the teacher survey of computer use.

Subscale	Items
Setting Up C/MM	I can connect cables from a VCR to a TV monitor. I can use a bar code reader for a laserdisc player.
Troubleshooting C/MM	I can install software on a computer. I can troubleshoot connections between a computer and a printer.
Computers in the Curriculum	Computers are an integral part of classroom instruction. The best use of computers in classrooms is as a reward for students who finish required work early. (negative item)
Attitude Towards Computers	I enjoy working with computers. I feel hostile toward computers.

Table 2
Pre- to post-test differences in means after one year of the project.

Dependent Variable	F	p	Pre-test Mean	Post-test Mean
Setting Up C/MM	54.64	.01	3.89	4.99
Trouble Shooting C/MM Problems	57.63	.01	3.15	4.25
Computers in the Curriculum	0.25	.62	4.90	4.85
Selecting C/MM Instruct. Materials	11.46	.01	3.96	4.36
Teaching Using C/MM	66.28	.01	3.71	4.75
Developing Lessons Using C/MM	76.77	.01	2.98	4.37
Attitude Towards Computers	1.99	.17	4.90	5.06
Teaching Specific Topics	16.39	.01	3.35	4.36

For the majority of these measures, teacher participants gained about one point on the Likert scale over the one-year period. Typically, for those means that revealed significant change over time, the means showed that they moved from a somewhat disagree (3) to a somewhat agree (4) rating or from a somewhat agree (4) to an agree (5) rating. See also the Conclusions section.

Several classroom scenarios illustrate how teachers used C/MM in their classrooms. These classroom scenarios are fairly representative of the types of C/MM classroom applications carried out by teacher participants. For example, in his sixth-grade science class, Mr. A's students explored the circulatory system and its function using laserdiscs. Students worked in groups of 4-5 to complete the self-guided instructional materials that required them to engage in extensive discourse. Following the small-group work, a whole-class discussion was used to verify and clarify student findings.

Mrs. I., a multi-age, third-fourth-grade teacher, previewed and practiced software for use in her unit on the desert. She then demonstrated to students how to use programs to prepare reports and to present information on deserts to the class. Students used the technology to gather information, create reports and presentations, and to conduct experiments.

Ms. L's third-grade students prepared reports on animals. After previewing the programs and demonstrating their use to her students, students worked at five stations that week for three days. Ms. L. asked her students to make a *HyperStudio* stack or slide show to present their reports to the class. The students worked in groups of two, took notes, and captured pictures or video for their reports.

Finally, some of the qualitative data suggests the integration of technology into instruction precipitated change in instructional approaches. Teachers more frequently utilized small group work, independent research, and student-directed problem solving as the project progressed. Moreover, data indicated that teachers may be undergoing paradigmatic shifts in their perceptions of science, mathematics, and instruction in those areas.

Conclusions

Although the participating teachers initially demonstrated minimal computer competency, they were able, within a period of five months, to fully engage their students in fairly sophisticated levels of learning by means of technology. For example, teachers required students to engage in problem identification, research, report generation, and presentations using computers and multi-media which is supported by data from Table 2—Teaching Using C/MM. Moreover, over the course of the one-year period of training provided to date, teachers made substantial gains in their abilities to use technology as an integral part of science and mathematics instruction as confirmed in Table 2—Developing Lessons Using C/MM. As the data in Table 2 illustrate, teacher participants indicated that they as least somewhat agreed or agreed that they could manipulate and/or use technology in their own classrooms to aid science and mathematics instruction. As teachers became more familiar with technology and its implementation, teacher logs demonstrated their own and students' classroom use increased.

Moreover, the classroom scenarios indicate the nature of use and level of sophistication of computer and multimedia use was substantial, given that this was the first year of a three-year project. In certain classrooms, students used computers and multi-media to gather, organize, synthesize, and present information relevant to the solution of authentic science and mathematics problems. As demonstrated in the scenarios, teachers' requirements of student use varied by grade level, with teachers of older students requiring more sophisticated applications such as *HyperStudio*. Nevertheless, teachers readily adapted computer and multimedia materials for appropriate grade-level use in their classrooms. Moreover, these adaptations became increasingly evident as teacher participants became more knowledgeable and garnered more expertise in the use of computers and multi-media.

Significantly, the increased utilization of small group work, independent research, and student-directed problem solving provided evidence for changes in classroom instructional culture. Although these changes were modest and only beginning to emerge, they suggest that technology can serve as a means to produce systemic reform of instruction that is more consistent with the new professional standards in science and mathematics.

Given the recent professional organizations' recommendations regarding standards for instruction and professional development, effective models for professional development are clearly warranted. This paper describes both a model and provides evidence of validation of its effectiveness. Based on the results, the present model appears to be useful and has potential for use in other school settings.

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ELECTRONIC FIELDTRIPS: STUDENT EXPLORATIONS OF THE GREAT RIFT VALLEY

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While current science policy documents suggest teaching and learning strategies that might lead to students becoming scientifically and technologically literate, little is known about how classroom teachers interpret the documents and how they actually incorporate the use of instructional technology in their teaching for scientific literacy. This paper evolved from a study designed to develop a richer understanding of how one elementary teacher, Ms. Brook (pseudonym), utilized instructional technology to teach for scientific literacy. Using qualitative methodology, I examined the integration of instructional technology into the science curriculum, focusing on how the teacher used instructional technology to advance students' scientific literacy. In this paper, I first provide a theoretical background for scientific and technological literacy. Next, I describe the Flamingowatch electronic fieldtrip and its focus on scientific literacy.

Theoretical Background

Americans live in a society that has become increasingly technological in nature. Apparently straightforward questions such as "Paper or plastic?" force Americans to interact with scientific and technological issues that affect the well-being of their personal lives as well as the health and well-being of the nation as a whole. From the classroom to the workplace, various forms of technology have become more and more integral in peoples' lives. Increasingly, jobs require more advanced skills, including knowledge of how to use technology in the workplace. Workers need to be able to think critically and creatively, make decisions, and solve problems [National Research Council (NRC), 1996]. Thus, it is becoming vital that teachers, students, and the American populace in general achieve a higher level of scientific literacy. The *National Science Education Standards* define scientific literacy as follows:

> Scientific literacy is the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity. It also includes specific types of abilities. In the *National Science Education Standards*, the content standards define scientific literacy. (NRC, 1996, p. 22)

This definition of scientific literacy argues that specific knowledge and abilities are needed in order to be scientifically literate. Thus, teaching for scientific literacy is central to science education reform and should be a goal of all schools in America.

Why is scientific literacy important? *Science for All Americans* [American Association for the Advancement of Science (AAAS), 1990] argues that the world's economic and environmental destiny is dependent on how wisely humans utilize science and technology. Through science, citizens not only can learn how to make decisions about the use of technology, but also assess the applicability and effects of new technologies as they emerge. While many global problems exist as a result of the misuse of technology, the use of technology to generate solutions to problems is vital to the survival of the human species.

The literature on instructional technology is abundant, despite the relatively recent emergence of instructional technology in K-12 schools. Fulton (1993), Viau (1994), Itzkan (1994-95), Max (1994), David (1990), Cuban (1993), Grejda and Smith (1994) and others offer definitions and rationales for technological literacy, and its role in K-12 education. Because of the recent emergence of and rapid expansion of the forms of instructional technology, many in academe link the implementation of instructional technology across the disciplines to the process of school reform. In other words, widespread use of instructional technology in K-12 schools is not the traditional paradigm. Thus, it is useful for researchers to identify and study situations in which instructional technology has moved from the fringe to the center of curricular efforts. In the next section, I describe an example of a technology-rich curriculum project that integrates science and instructional technology.

Electronic Fieldtrip: Flamingowatch

The potential of electronic communication is related to its potential audience: it is worldwide. Where students are given access, they can ignore the walls of the classroom and make direct contact with others across the world for collaborative work and in doing so appreciate the differences in culture and yet the similarity of people (Davis, 1994, p. 643).

This passage is uncanny in the accuracy with which it simultaneously describes the educational power of instructional technology and the ways in which Ms. Brook and her students utilized it in their scientific inquiries. Instructional technologies currently available to teachers and students offer significant potential for supporting active learning and adventurous teaching (Sheingold, 1990).

Flamingowatch was an "electronic fieldtrip" in which students from schools worldwide traveled to the Kenyan savanna in East Africa. For three consecutive days, students viewed an interactive telecast which was broadcast *live* from Kenya. Following is a description of the technology and science subject matter focus of the project provided in a faxed memo to schools throughout the viewing region:

> Delivered to the classroom via TCI Cablevision, and produced by Turner Adventure Learning, this new electronic fieldtrip, FLAMINGOWATCH: NATURAL HISTORY IN THE RIFT VALLEY OF EAST AFRICA, transports students to a region where geologic and climatic forces combine to create an environment singularly hostile to life, yet breathtaking in its biodiversity.
>
> Using two-way interactive cable, fax, and computer modems, students will be able to communicate from their classrooms with historians, scientists, and other students locally and around the country to ask questions and share opinions about Kenya and the annual convergence of three million flamingos in Kenya's Great Rift Valley. In this way, the teachers and Turner Adventure Learning combine a live event with interactive publishing, voice and video interconnects, and a variety of teaching tools that take learning behind the four walls of a classroom.
>
> TCI Cablevision
> January 30, 1995

During these three days, students learned about the people of Kenya, the geology, and the flora and fauna of Kenya, paying specific attention to the Great Rift Valley. The fieldtrip broadcasts were hosted by Peggy Knapp of Turner Adventure Learning, and included presentations by and interactions with CNN correspondents and local Kenya experts. Two features separate the electronic fieldtrips from typical use of video programs by schools:

1. the broadcasts were live, in real-time;
2. the broadcasts were interactive--students from schools across the world interacted with the program's experts in the field in Kenya, as well as with each other.

These unique features situated the learning experience for thousands of school children in a *real-world* context. To support teachers and students on the electronic fieldtrips, Turner Adventure Learning (TAL) provided an extensive curriculum guide which was organized thematically, integrating science curricula with mathematics, geography, literacy, and art.

The Flamingowatch Curriculum Guide

The curriculum guide was supplemented with a series of CNN video clips and an on-line text and graphics library. The interactive portion of the fieldtrip occurred in two forms:

1. students had the opportunity to interact with fieldtrip moderator Peggy Knapp and experts in Kenya in real-time by phoning the TAL number in Kenya;
2. students throughout the world interacted with each other after each broadcast through an electronic forum on America On-line (AOL).

Implementation of the Flamingowatch electronic fieldtrip was complex, requiring much organization of different resources. The resources that supported teachers' planning and organization, as well as provided background information on the subject matter in the curriculum, were the CNN video clips, which focused on the fieldtrip's major curricular themes; a monthly newsletter, which contained updates to all on-line resource material; and a teacher training tape, which oriented teachers to the teaching strategies and resource materials created for Flamingowatch.

One way to represent science curriculum is to integrate the different sciences together [Michigan Department of Education (MDE), 1991]. Another way to represent science curriculum is to integrate science with other subjects (NRC, 1996; Roberts and Kellough, 1996). The Flamingowatch curriculum was interdisciplinary, and organized around the following themes: constancy and change, observation and inquiry, and the independence and interdependence of communities. Each day of the three-day fieldtrip consisted of a one-hour live broadcast from Kenya. The broadcasts served a dual purpose: presenting information related to the curricular themes, and real-time question and answer sessions in which students used school telephones to call in questions to the host, Peggy Knapp. Ms. Knapp answered some of the students' questions and referred some questions to Kenya residents and experts. Other questions were directed to CNN correspondents in the field. Following is a brief analysis of the curricular content and subject matter of each fieldtrip.

Day 1

On day one, students explored the geology of the Great Rift Valley, the rich biodiversity found in varying habitats, and how species respond and adapt to a very hostile physical environment.

The theme *constancy and change* was emphasized. Major topics explored in this theme included:

- volcanism in the Rift Valley;
- the geology of soda lakes;
- geologic processes;
- biodiversity; and
- flora and fauna.

The topics in this theme correlated to three major curriculum connections: earth shaping processes, matter and energy cycles, and systems. In focusing on the physical setting and the living environment, students learned that:

> The inhabitants of the soda lakes often live quite literally on the edge. Through drought and flood, tectonic upheaval, and animal and human migrations, the historic ebb and flow of communities within the area presents a fascinating picture of the balancing act that accounts for the survival of a wide variety of species as they respond to this ever-changing environment. (Turner Educational Services, 1995, p. 3)

Day 2

On day two, students focused on the geography of Kenya and the Great Rift Valley. The flamingos of Lake Nakuru were used as a case study of species' adaptations to harsh physical environments. Students also learned about the soda lakes of the Great Rift Valley, examined the culture of the Masai people, pastoral nomads of East Africa, and explored the impact of "ecotourism" on the environment. The theme of *observation and inquiry* allowed students to ponder the many mysteries that surround the flamingo population of the Great Rift Valley.

Through inquiry activities, students addressed the following questions: Why do these colonies of birds migrate from lake to lake and even sometimes from Africa to Europe? What governs the 'decision' to nest and produce young? Why are they pink and how does this adaptation influence their survival? The topics in this theme correlated to six major curriculum connections: the nature of science, scientific habits of mind, the living environment, adaptations, habitat, and diversity.

Day 3

On day three, students focused on the theme *independence and interdependence of species,* specifically examining the communities of greater and lesser flamingos inhabiting the shores of the soda lakes. Students learned that: The food chain created around each lake is often fragile and tightly linked so that if one link is broken or weakened, the effects are quickly felt by the entire community. (Turner Educational Services, 1995, p. 5)

Major topics explored in this theme included:

- communities of flamingos;
- food chain/web;
- species adaptations; and
- human influences on the environment.

The topics in this theme correlated to five major curriculum connections: energy transformations, earth shaping processes, interdependence of life, social behavior of organisms, and systems. This overview of the curricular connections in the fieldtrips is consistent with the view of *Science for All Americans* (AAAS, 1990) and *Benchmarks for Science Literacy* (AAAS, 1993) that science curricula should be thematic and focus on larger concepts that are interconnected.

Flamingowatch and Scientific Literacy

Scientifically literate students should be able to use, construct, and reflect on scientific knowledge (MDE, 1991). The technology-based Flamingowatch curriculum guide contains many activities, tools, and resources that correspond to the dimensions of scientific literacy described in reform documents such as the *Michigan Essential Goals and Objectives for Science Education K-12* (MDE, 1991), and the *Benchmarks for Science Literacy* (AAAS, 1993). The passage below describes the interdisciplinary nature of Flamingowatch and its design which was framed by the *Benchmarks for Science Literacy* (AAAS, 1993):

> Social studies, science, language arts, problem solving, and study skills objectives are integrated into suggested activities. The underlying structure on which Flamingowatch is based is the *Benchmarks for Science Literacy of the American Association for the Advancement of Science,* published by Oxford University Press (1993). The content themes, overarching goals of the fieldtrip and all activities focus on competencies outlined in this excellent reference. (Turner Educational Services, 1995, p. 6)

Given that the authors of the Flamingowatch curriculum based their work on the *Benchmarks for Science Literacy* (AAAS, 1993), one would expect the guide's activities to promote scientific literacy. Document analysis of the Flamingowatch curriculum guide indicates that the *using, constructing,* and *reflecting on* dimensions of scientific literacy (MDE, 1991) are well-represented in the Flamingowatch curriculum guide.

The activities in the Flamingowatch curriculum guide contain several of the dimensions of scientific literacy. These activities are organized on Student Worksheets which the teacher may or may not distribute to students. Many of these worksheets also provide science subject matter in some way. For example, student worksheet T1a - The Big Picture: Constancy and Change provides students a summary paragraph on the science subject matter related to this particular theme. It also provides a list of resources to assist students in learning about the theme, and it provides a Questions for Discussion section. Following are specific questions from this worksheet that correlate to the dimensions of scientific literacy:

1. *Describe* the forces within the earth that have shaped the Great Rift Valley.
2. Read one or both of the famous stories by Dr. Seuss, *Horton Hears a Who,* or *The Lorax*. What do these modern fables have to say? How does it apply to the Great Rift Valley? *Explain*.

Worksheet T1b - The Big Picture: Observation and Inquiry is similar to worksheet T1a but asks students to compare and contrast, predict, and design in addition to describe and explain. Following are specific questions for discussion illustrating these dimensions of scientific literacy:

1. *Compare and contrast* the viewpoints of science and magic or ancient religious tradition. What does each viewpoint have to offer human beings? Is each a valid way to observe and seek understanding? (Explain)
2. After reading about the flamingos, visualize or imagine the actual bird, not the plastic figures people use to decorate their lawns. What do you think a flock might look like from an airplane? From under the water? (both questions ask for predictions) Draw quick sketches, preferably appropriately colored, to show each idea. (design)

In addressing the questions in number one above, students would also implicitly be engaging in the *habits of mind* (AAAS, 1993) dimension of scientific literacy because they would be: evaluating claims and arguments, thinking critically, organizing and expressing ideas.

Conclusion

We do not know how future technologies will effect science curriculum. In this paper, I described how Ms. Brook utilized current instructional technology to effect a technology-rich curriculum. Davis (1994) described the power of telecommunications in allowing students to "ignore the walls of the classroom and make direct contact with others across the world." (p. 643) Flamingowatch epitomized the curricular expansion that Davis (1994) alluded to, and allowed Ms. Brook and her students to pursue scientific inquiry by collaborating with students worldwide.

Flamingowatch is unique among current technology-rich curricula due to its worldwide audience, its three-day real-time fieldtrips, and its interactivity. Students were able to ask questions of the experts in the Kenyan field in real time, communicate with colleagues through America On-line immediately after each fieldtrip, and follow the progress of Kenyan school children as they traveled through Kenya's game parks and reserves. With its strong correlation to dimensions of scientific literacy, Flamingowatch's interactivity, interdisciplinary curriculum, and emphasis on research and problem solving could be the type of curriculum that is on the vanguard of the development of global classrooms.

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Reshaping Mathematics and Science Instruction Using Real Data

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During the last decade, mathematics and science instruction has become a problem of national concern. American businesses and government have made quality mathematics and science education a national priority because they perceive the lack of quality education in these areas as eroding the United States' position as a leader in fields that require a strong background in mathematics and science. In particular they are demanding that schools produce students who can solve contextual problems and think critically. In response to recognized deficiencies in student preparation, the mathematics and science communities have drafted education standards that present new visions for the classroom. The National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* (1988) and the National Research Council (NCR) *The National Science Education Standards* (1996) make recommendations requiring both curricular and pedagogical shifts.

Both mathematics and science *Standards* advocate instructional methods that encourage students to be active participants in the learning process and that provide students with opportunities to learn mathematics and science by doing them, using the tools and methodology employed by professional mathematicians and scientists. For example, with the aid of a computer or calculator mathematicians/scientists can collect and organize large sets of data, view graphs of complex relationships, and simplify "messy" algebraic expressions. With the use of technology, students can emulate the work of these professionals.

At present, active technology-based visions for mathematics and science classrooms are far from reality in Connecticut and in many other parts of the nation. Several obstacles stand in the way of implementing the new standards in mathematics and science. First, in order to implement the standards properly, teacher must learn to become effective facilitators of active student learning. For teachers brought up in the "lecture followed by paper-and-pencil drill or cookbook lab exercise," this can be a difficult shift. Furthermore, this skills-oriented style of teaching is not sufficient to prepare Connecticut students for the new types of assessment being implemented by the state or to meet the demands of Connecticut's modern work force. Similar stories can be told in other states across the nation.

A second obstacle to implementation of the NCTM and Science *Standards* is teachers' lack of familiarity with new technologies and with effective technology-based teaching approaches. Many teachers have only recently become aware of the exciting possibilities that technology offers but have not had sufficient professional development opportunities or the availability of equipment to implement new technology-reliant approaches. And still, there are many other teachers who choose not to notice the possibilities offered by technology because they are bound to a teaching style and content that matches their own educational background.

And last but certainly not least, teachers must contend with new content areas, most notably probability and statistics, which have been recommended for increased coverage by both *The National Science Education Standards* (NCR, 1996) and the NCTM *Standards* (NCTM, 1988) In particular, *The National Science Education Standards* states that "all students should develop the abilities necessary to do scientific inquiry" (p. 173), and that "The science program should be coordinated with the mathematics program to enhance the understanding of mathematics in the study of science and to improve student understanding of mathematics" (p. 214). The locally, draft state guidelines in Connecticut have also supported this change. Content Standard 7 of the draft version of the Connecticut Mathematics Framework states: "All students will understand and use basic concepts of probability and statistics to collect, organize, display and analyze data, simulate events, and test hypotheses." (Connecticut Department of Education, 1995, p. 2) Many mathematics and science teachers have little or no formal education in statistics. In fact, even those teachers with formal training in statistics have rarely had the opportunity to conduct a personal research project from start to finish. There is clearly a need to provide teachers of both mathematics and science with more background in statistics.

Our Professional Development Program

In response to the national needs mirrored at the local level in Connecticut, Eastern Connecticut State University was awarded an Eisenhower Grant, entitled Reshaping Mathematics and Science Instruction: A Statistical and Technological Focus. Key features of the program included:

1. Teaching content in the area of probability and statistics using models of instruction (for example, cooperative learning, laboratory projects, use of writing in the mathematics and science classrooms in accordance with the NCTM and National Science Standards).
2. Using technology as a tool in mathematics and science instruction to support the introduction of real-world problems and exploration projects into the classroom.
3. Fostering collaboration between mathematics and science teachers at the 7-12 grade and college level.
4. Designing an inservice program so that it can, over time, evolve (through teacher input and formative evaluation) to better meet the needs of classroom teachers.
5. Establishing an on-going regional inservice program in mathematics and science.

Components of the program included a summer workshop, fall follow-up sessions, and classroom support. Technology used in the program ranged from low-tech (sticky pads) to high tech (graphic calculators, Computer-Based Laboratory Units [CBLs], and computers).

This paper will document the needs of Connecticut teachers, detail how we are responding to their needs through professional development activities, and describe the challenges and successes our teachers have faced and continue to face as they work to implement change in their classrooms. We hope that our inservice model might inspire others to adopt similar programs that support change in mathematics and science education.

Needs of the Teachers

When we began this program we were determined to help teachers change the way they teach. We felt that using a traditional workshop approach would probably not elicit permanent change. Instead we chose to follow a model that would allow us not only to identify the needs of the teachers before the program, but also to respond to their changing needs (Esterle, Richer, Sleven, Myers, & Oppenheimer, 1994). We began developing the program by meeting with interested teachers in April 1995. At this meeting the teachers identified the types of professional development that they felt were needed to help them grow as teachers. As a result of this meeting it was determined that one of the major focuses of our program would be using technology outdoors. A one-week workshop was planned for the summer with four follow-up sessions in the fall. We also decided that the teachers would be provided with direct classroom support from either the project investigators or consultants during the fall and spring of 1995-1996. The teachers seemed most concerned with how to increase their use of technology and statistics techniques by making them an integral part of their curriculum not an add-on. They were also concerned with learning how to use new forms of technology.

Responding to Teacher Needs

In developing the week-long summer workshop, attended by 19 area teachers, we carefully considered the concerns and needs of teachers. The primary forms of technology that were used were graphing calculators and Computer-Based Laboratory units (CBL's). When connected to data collection units, such as ultrasound detectors, CBL's are capable of inputting data directly into the graphing calculators.

The first two days of the workshop were devoted to learning how to use the graphing calculator and to seeing how it could be used outdoors. We determined tree heights and collected data about water quality and temperature from a nearby lake. Graphing the data helped teachers develop an understanding of how graphing calculators could be included, rather than added into the curriculum. Several teachers remarked on how the short time between collecting and graphing the data would enhance student understanding of graphing. We made sure to include ample time for teacher experimentation throughout these two days.

The second two days of the workshop were devoted to leaning to use the data collection devices and to exploring various computer programs. Except for a few planned presentations on the CBL's and some "low-tech" statistics, teachers decided which avenues they wished to explore as they sought ways to include graphing and statistics in their classes. At the end of the four-day workshop we asked teachers to decide how they wanted to use their four follow-up sessions and their two days of in-house help from the developers of the workshop.

The teachers decided to combine two of the follow-up sessions into one all-day session on environmental education and to have one follow-up session concentrating on more uses of the CBL's and student misconceptions and one on alternative assessment. All three of the follow-up sessions were extremely productive. The majority of the teachers decided to begin using their classroom support by having one of the workshop presenters come in and present a lesson to their students. All such presentations were individualized to suit the curriculum of that particular teacher. Following the initial presentation, some teachers had us come in and assist them in presenting a lesson or had us do presentations on using graphing calculators to other faculty members. Almost all requests for classroom support were centered on using the graphing calculator.

The collaborative means by which we designed the workshop allowed us to adapt the program rapidly so that teacher needs could be effectively addressed. The success of this method can be seen in the extremely positive responses we got from all our teacher questionnaires. One of our teachers went so far as to say that this was the best workshop she had ever attended.

Challenges

The challenges found in delivering a highly collaborative workshop include developing a working rapport with the teacher and the increased amount of planning time needed during the delivery of the program. Additional challenges involved the use of "high tech." Despite the amount of time we spent practicing with the equipment, the technology did not always work. We were honest with the teachers about the glitches that did occur and tried to model how to work around such glitches. When the teachers tried used the advanced technology at their schools, they reported that their students were much more patient about technology that didn't work than they were, but they were still concerned about the loss of valuable instruction time and felt that they needed to develop alternative lesson plans, just in case. They also frequently asked us for technical support and for help in finding trouble-free programs to use with the graphing calculators.

Successes

Many of the successes we had with our program are due to the delivery format we chose. By allowing teachers to share their needs and expectations with us, we found that many of the teachers chose to use much of what we had to offer in their classrooms. Two of the school systems that we worked with chose to purchase graphing calculators. Another system had graphing calculators and CBL's, but the teachers had no idea how to work with them in the classroom. One school system is actively pursuing funding in order to purchase the calculators and CBL's. . All of the teachers involved reported improving their confidence in working with advanced technology. We continue to consult with some of these teachers as they strive to incorporate technology and statistics into their classrooms.

Conclusions

To change the delivery of education so that students are allowed to "do" mathematics and science, requires the use of advanced technology and a change in the delivery of instruction. In order for teachers to feel comfortable with these changes, it will take more than the standard "talking head" one- or two-week workshop. Workshops must be changed so that teachers have time to explore both technology and new forms of teaching. They must be allowed time to become familiar with new equipment so that they know the possible pitfalls they face as they try using a graphing calculator. Follow-up sessions are of vital importance so that teachers can expand upon their understanding of how both the new technology and the new teaching techniques. Without trusting teachers with this precious form of time, professional development will often fail to create important and necessary changes in education.

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Contextual Variables in a Technology-Based Teacher Education Project

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This paper discusses a contextual approach to evaluation of educational technology in teacher education. The study applied a context-specific model of program evaluation (Altschuld & Kumar, 1995) to evaluate Vanderbilt University's National Science Foundation (NSF) funded interactive media teacher education project, "Improving Science Education: A Collaborative Approach to the Preparation of Elementary School Teachers." Technology has gained considerable access to education, and often educators are expected to accept technology on face value with less or no sufficient supportive evidence of its quality, impact and physical and procedural requirements for successful implementation. According to Edmunds "we have a long way to go" (cited in Branscum, 1992, p. 84) before educational technology is integrated into instruction. While technology makes inroads to education, science education is undergoing rapid growth due to proliferation of scientific information and developments in theories of learning and problem solving. These changes have collectively increased the complexity of classroom science instruction.

One of the ways of reforming science instruction would be to revise science teacher education programs with special emphasis being given to the use of technology for classroom instruction. A case in point, interactive videodisk (IVD) technology, has been a center of attention in science education. The use of interactive videodisk technology for teaching methods by Goldman and Barron (1990), and for teaching content by Vitale and Romance (1992) are examples of successful utilization of educational technology in preservice science education. Even though in isolated instances it seems that technology and science education are allied to reform education, there is no guarantee that this alliance will improve preservice teacher learning, leading to improvements in elementary and secondary science classroom instructional practices. A lack of suitable frameworks for evaluating the effectiveness of technology programs in science education is a matter of concern. Most of the existing evaluation models in science education tend to focus on end products, and do not seem to provide a sound basis for comprehensive evaluation efforts with emphasis on contextual and supportive factors (Altschuld & Kumar, 1995).

Description of a Context-Based Evaluation Model

Evaluation, primarily of a formative nature, regarding the systematic development of curricula, products, and processes is evident in the writings of Pines (1980) and, to a lesser degree, Small (1988). While the evaluation of developmental steps is prominent in Pines and Small, it was not solely confined to those authors. Welch (1974), Virginia's Standards of Learning-Science (SOL-Science) by Exline (1985), and the Evaluation of a Child-Structured Curriculum by Espejo, Good and Westmeyer (1975) have developmental components. Also it should be noted that the works of Exline (1985), Exline and Tonelson (1987), Welch (1974), and Shell, Horn, and Savers (1986) in one form or another stress contextual evaluation. At the contextual level, Exline (1985) portrays the Standards of Learning (SOL)-Science, as a comprehensive approach to evaluation. One of the noticeable aspects of SOL-Science is the recognition of the need for a "buy in" period for administrators, parents, teachers and other stakeholders. Consequently, six critical support components - administrative support, learning environment, teacher preparation, community involvement, fixed facilities and instructional materials - were identified and must be in place for educational programs to be successful. That is, the quality in science education is a function of the degree to which programs are supported and perceived positively by relevant constituencies.

Welch (1974) emphasized that contextual evaluation would not only be of value in understanding the system but also in determining needs. Over two decades ago, Stufflebeam (1971) suggested incorporating contextual factors in program evaluation. From this point of view, the evaluation model proposed by Altschuld and Kumar

(1995) recognizes that the life cycle of a program or project in science education is seen as the central core of what is to be evaluated. Since that life cycle exists in a complex mix of social, economic and personal factors, evaluations of large scale science education programs should focus on variables such as organizational climate, evidence that the environment was supportive of change and experimentation, administrative interest in and knowledge of the program, and the availability of resources to enable users to adopt new products and processes. For a description of the evaluation model used in this study, see Altschuld and Kumar (1995).

Procedure

The evaluation of the interactive media teacher education project of Vanderbilt University proceeded as follows. For a description of the Vanderbilt's interactive media project see Barron, Joesten, Goldman, Hofwolt, Bibring, Holladay, and Sherwood (1993). An in-depth examination of background documents was carried out, looking for major issues and potential questions that would seem to be important for conducting site visits and a contextual evaluation of the project. After document review, the ideas emerging from the documents were distilled into a set of key interview questions for the project staff and students. The content of those interview questions included administrative support, financial resources, physical facilities, understanding and knowledge, availability of resources, fit of the program into the environment, and attitude and enthusiasm. A few examples of questions used in the interview protocols were as follows: "In your judgment, what are or would be the long-term outcomes of the project and the use of interactive media; on students, on the faculty/ academic environment?"; "What did you feel that you learned from the interactive media portion of the program? Please be as specific as you can in your answer"; "If another teacher education institution or another area were to adopt a project like this, what specifically would you recommend that they do or consider, and why?" (Kumar & Altschuld, 1996, p. 36-39). The sample selected for interviews consisted of the project director, university administrators, faculty members inside and outside of science education, a school administrator, students currently enrolled in the project-based teacher preparation program at Vanderbilt University, graduates currently teaching in Nashville area schools, a video editor, and a computer programmer.

The interviews took place during 1994-1995 academic year. The evaluators taped all interviews in addition to taking individual notes. Each team member analyzed his interview notes independently. While one team member had tapes transcribed and conducted his analysis from the transcriptions and the notes he had taken, the other member typed interview notes and placed all comments and responses together by question. Hence, by working independently, a degree of independent verification of results was reached. Then, using the following analysis strategy, interview data was examined to create meaning out of the interviews: Coding and the Constant-Comparative Method; Describing the Initial Data Categories; Looking Across the Categories for Emergent Explanatory Themes; and Seeking Verification for the Explanatory Themes (in a second set of interviews conducted approximately six months after the first.).

The evaluation study generated two sets of results: Initial Data Categories (IDC); and Emerging Explanatory Themes. The Initial Data Categories contain a class of responses that were consistent and repeated throughout the interviews as identified through individual analyses of data. Points of overlaps and differences were examined and a consensus list of key variables was constructed. An example of several IDCs from one of the interviewed groups is provided below. The following are IDCs from faculty, staff and university administrator interviews: Student learning; Student opportunities to learn; Instruction; Effects upon instructional staff; Institutional effects. The Emergent Explanatory Themes on the other hand are points that span across the Initial Data Categories. They explain connections and ideas, and provide a picture of the overall context of the interactive media project of Vanderbilt University. They are: Administrative support; Osmosis/Permeation of project ideas into the environment; Student perception on campus; Student perception in schools; Technical support; Organizational climate; and Critical Mass (especially in regard to the number of individuals participating in the development of interactive media instructional products).

Evaluative Conclusions

The evaluation study led to the following conclusions. Both current students and former graduates strongly perceived that the interactive media-based science methods courses influenced their understanding of discovery science and reflective teaching, and helped them to integrate content into methodology and teach hands-on science. They also felt that real classroom situations often did not meet their expectations of classrooms portrayed by the project videos.

The project seems to receive considerable administrative support within the university environment both in terms of financial assistance, technical support, motivation and incentives for more faculty involvement throughout the university. The project had permeated from science education into other disciplines. Faculty members outside science education (e.g., social studies education, biology) have adopted the interactive media approaches to teaching.

A nourishing environment is critical for successful development and implementation of innovative ideas that call for considerable changes away from traditional classroom practices to educational technology-based instruction in preservice education. Vanderbilt University has provided such a favorable environment for the NSF interactive media project in the form of strong administrative support and readily available technical assistance as apparent in the evaluation. The university administration has committed itself to maintain familiarity with the project and to promote project activities. For example, high ranking university officials have taken interest in presenting the project in national forums and to potential funding agencies. Along with the administrators, the faculty members, graduate students and other staff of the interactive hypermedia project were dedicated to the project resulting in a "critical mass" (that, by virtue of size and deep belief in the quality of the innovation, began to impact the overall context, and forced the environment for innovation). Faculty members outside science education began to adopt the innovation in their classes because they felt that the project ideas and materials provided a timely opportunity to improve their teaching practices. In addition, in comparison to the high developmental costs, the project materials are not very expensive, are well organized, and integrate well into established courses in teacher education.

The semistructured interview approach taken in this evaluation of Vanderbilt University's interactive media science teacher education project has shifted the nature of the study from product- to context-based qualitative evaluation of contextual (or environmental) variables. To improve the evaluation, the terms context and "contextual" variable need to be defined in depth. Also, the interviews could have focused a bit more on contextual variables, and some interview questions could have been streamlined. On the other hand, the evaluation reported here helps to clarify the idea that looking at the context of development is necessary to gain a clearer and full picture of large-scale innovative educational technology projects in science education.

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Teaching Educational Informatics for Students—Future Chemistry Teachers

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Using computers is a way of improving the educational standards of Science and Chemistry teaching. In this respect, different kinds of software make it possible to get better results in instruction compared with traditional methods of education. An important goal of modern education is to develop teachers' abilities to use computers in their classes. It is known that the quality of teacher preparation is the main cause of all successes an failures in the education. This work is concerned with the description of the course "Educational Informatics for Chemists" which is designed to give to its students a basic knowledge of computer applications in the work of teaching.

The course "Educational Informatics for Chemists" includes five principal modules:
1. Theoretical Aspects of Computer Instruction,
2. Programming Languages,
3. Methods of Software Design,
4. Different Types CAI Software in Chemistry, and
5. Internet Applications in Chemistry Education.

The first part of the course gives the most important information about the theoretical basis for computer instruction. The teaching material and the computer as a modern tool for teaching and learning are the two principal concepts in this part. Students learn methods of structuring and restructuring teaching material which are vital in the process of teaching. The structure of the teaching information for computer course designing must be presented in a systemic form based on a systemic approach (Orlik & Vasco, 1995) . This approach is characterized by the transition from cognition of a certain part to the cognition of the whole. In order to develop systematic and scientific thinking in students it is necessary to restructure the content of the new material being studied with the aim of mastering it as an integral system. It is quite important to keep in mind that the modern goal of teaching is to communicate the subject's structure to the student in the most efficient way.

The computer as a modern teaching tool is almost ideal for this aim. For example, the hypertext approach should be characterized in this part of the course. It is known, that this approach to information is based on the creation of a special kind of data representation, which is defined as a fragmentary text with special links between parts. In this system there is the possibility of checking these links to coordinate and change them (Orlik, 1993a). Students learn that the peculiarity of hypertext is that the information is contained in the form of a network of nodes and links. They can be filled with information of different kinds (e.g. text, graphics, video and sound information). Users have opportunities to create new nodes and links in this structure.

The concept of a computer textbook is important in the first part of the course. The characterization of this concept allows the students to understand many of the drawbacks of textbooks and also of some computer education courses based on the principles of the traditional training. The computer allows the elimination of the fixed nature of the textbook. Modern instructional software provides a facility for restructuring educational material at the request of teacher and student. The representation of the teaching information on the screen can also increase the amount of visually organized educational information.

The second and third parts of the course are dedicated to the characterization of programming languages and methods of the educational software design. Students have opportunities to learn the principles of the algorithmic approach and of the structuring of screen information by studying a basic programming language. They can work out their own short fragment of Computer-Aided Instruction (CAI) programs and this activity allows them to better understand main features of this important work. In this part of the course students can also understand that the new educational software in Chemistry must provide the learner with the following opportunities for optimal educational work:

A. To know the contents of educational information in the main section of the course in a visual schematic form.
B. To be able to transfer from the table of contents to the educational contents of subject.

C. To skip a selected volume of educational information if desired.
D. To return to the section in the educational material that was selected previously.

Another problem of great importance is discussed there - the problem of optimal screen representation. This subject is concerned with the problems of screen design, the psychological aspects of information perception and the correct structuring of visual screen teaching material. It is well known that when working with a computer students get tired sooner to compare to the usual traditional learning. To eliminate such a possibility and to improve the teaching and learning opportunities the screen teaching information must be specially structured. It is necessary to eliminate the boring representation of screen information which is based only on text without illustrations and colors.

In this part of the course students learn a modem approach to computer educational software design. They can understand and evaluate the advantages of graphic and multicolor representations with opportunities for the restructuring of the teaching information compared to the classical screen design.

However, it must be admitted that this traditional approach of screen programming is important for countries such as Colombia, where many educational institutions have the hardware with only MS-DOS opportunities without Microsoft Windows. In this case programming in the classical languages is the way to create educational software and there is a lack of these kinds of CAI programs for the different levels of education (secondary school and University) here.

In the fourth part of the course the students work with different types of CAI software in Chemistry, which can be classified according to the following types:
a. Tutorial and consulting programs.
b. Software for knowledge evaluation.
c. Programs for Chemistry computer simulations.
d. Educational games.

Programs of the above mentioned four types allow students to become aquatinted with examples of CAI based on a highly interactive and visual programming with opportunities for true dialog to take place between the student and the computer. For example, some programs show them dynamic interactive multimedia, which lets students explore the world of Chemistry with their own tutor to help them. Many of these programs stimulate students and offer different kinds of help and tools. In working with simulation programs students learn some thing about this type of man-machine interaction when they can handle models of molecules and experiment in Chemistry by modifying parameters. CAI programs for Chemistry exams show them different approaches for the evaluation and auto-evaluation of their learning. For example, educational games are the kind of the software which increases interest in Chemistry and makes it possible to obtain knowledge and skills in the important topic of Chemistry curricula.

The last part of the course is about the Internet applications for Chemistry Education. Students learn about different opportunities to get the information about Chemistry via Gopher and World Wide Web (WWW), on-line courses and discussion groups, as well as more information about chemistry curriculums and software. Some new opportunities for distance education in Chemistry are shown to them too.

Different active instruction methods have been used in this course to improve the student's knowledge. For example, different kinds of schemes that are very useful to reach a better understanding of the theoretical principles and to master key skills (Orlik, 1993b).

Figure 1 represents an example of a scheme of the educational contents designed by the student in the second module of the course. This approach can be an instrument for the generalized perception of abstract notions, and facilities the formation of systematic knowledge. This leads to a more effective mastering of habits and skills and affects the students creative abilities positively.

The course " Educational Informatics for Chemists" allows students to obtain basic knowledge and skills in one of the interesting and important subjects necessary for the instruction and training of teachers.

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GOTO
to repeat till interruption

Example:
10 Print " Maintain CTRL-Break to stop"
20 GOTO 10

CYCLES OF PROGRAMMING

FOR.....NEXT   WHILE....WEND
Example:    to repeat till the sentence
10 CLS      is true
20 FOR Number = 1 TO 10  Example:
30 Print Number   10 WHILE
40 Next Number   20 Print "Maintain Ctrl-Break
to stop"
50 Print " In the exit from FOR... 30 WEND
NEXT is the number "; Number
```

Figure 1. Example of the scheme of educational contents designed by the student.

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Internet-based Intelligent Tutoring Games

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Educators wish students had the same interest in learning academic subjects as they do in playing computer games. Developing computer games that are entertaining, yet educational, pose technical challenges. These include developing a game environment that supports the subject matter being taught, assessing student learning from game-playing behaviors, and having game events respond to individual student learning needs. The present paper describes work to develop a computer game to teach scientific reasoning that is delivered over the Internet. The game context is to solve detective problems in outer space. Detective work is chosen for its similarity to the scientific method. Assessment of student learning is accomplished by using a rich knowledge representation framework capable of understanding problem solving behavior and by having game characters converse with players to probe their reasoning. The scenes in the game teach different aspects of scientific reasoning. The activities and information present in these scenes are driven by student learning needs.

A Framework for Intelligent Tutoring Games

The goal of our work is to embed high quality instruction in the context of computer games so that students can learn in a fun environment. This presents the challenge of creating games that are as fun as those that would compete for students' learning time, yet present meaningful instruction. Because our emphasis is on education, we focused on that aspect first and built the game around it.

The first step in our project was to develop a model of scientific knowledge. Since our goal is not simply to present a science curriculum within the context of a computer game but rather to build the same type of thinking skills in students that scientists have, it is important to identify those skills. This will then drive instructional techniques designed to build similar knowledge in students as well as drive the evaluation of how well students have learned that knowledge.

One of the most important points we wanted to emphasize in the game is that science is more than memorizing facts and formulas, even though most students and lay people perceive science as such. In order to accomplish this, we place little emphasis on factual knowledge, but rather on science as a process of inquiry. As such, scientific problem solving is applicable to a wide range of real life problems, even those that we do not normally think of as scientific. Based on discussions with research scientists, we extracted the following process of scientific inquiry.

The process of scientific inquiry begins with a question that needs to be addressed. This could be whether a particular drug is effective in treating a disease, whether a given candidate is likely to win an election, or who committed a crime. The question directs subsequent inquiries, the results of which will be evaluated according to how well they address the question. The generation of a question may be initiated as the result of some event. There may be a body of scientific research that inspires new research questions, there may be a social issue for which legislators want to know public opinion, or there may be a reported crime that needs to be solved.

The second step is to develop a model of the phenomenon in question. Very often, we cannot directly observe the phenomenon we are investigating. Scientists study atoms they cannot "see"; detectives rarely witness the crimes they investigate. As a result, scientific thinkers develop models that represent their best approximation of the phenomenon as they understand it. Often, investigations look for ways to test these models.

The third step is to develop hypotheses that represent possible answers to the question. To be amenable to scientific investigation, these hypotheses must have observable consequences, and the observable consequences of different hypotheses must be different. Hypotheses are typically concretizations of the more abstract models described above. Often in scientific investigations there are natural "null" and "alternative" hypotheses (e.g., the drug has no effect vs. the drug is beneficial). In detective work, the hypotheses could correspond to different suspects being the actual criminal or different objects being the murder weapon.

The fourth step is to collect data or evidence to distinguish among the explanations or hypotheses being considered. This step is a key discriminator between successful and unsuccessful investigators. Effective information gathering requires understanding what types of information discriminate among the hypotheses, and knowing how to collect this information. Especially important is understanding how one can be deceived by information that is carelessly gathered or analyzed. Discriminating information is information that is likely to have very different values under the different hypotheses. (For example, if a drug is effective, more people taking the drug are likely to recover; if the drug is ineffective, people taking the drug are likely not to differ from people not taking the drug.) Scientists may collect data from performing controlled experiments, by conducting surveys, or through observation.

The fifth step is to analyze the data in order to come up with results that would be relevant to the hypotheses under consideration. This requires not only knowledge of the mechanics of analysis methods, but also the ability to select an appropriate analysis method for the problem at hand. Unfortunately, some science classes teach students a catalogue of methods, practicing each on samples of data, but give little instruction or practice in how to decide which method is appropriate or what data should be collected. At this stage it is important to consider whether any of the current hypotheses is consistent with the evidence or whether one must begin a search for new hypotheses.

The final step is drawing conclusions about the hypotheses in the light of the evidence collected. This involves determining which hypotheses are best supported by the evidence and whether that support is strong enough to draw a definite conclusion. It is often the case that we are not 100% certain about our conclusions (e.g., we do not know whether the patient really did get better because of the drug or whether a convicted person really did commit the crime). In those cases, we adopt conventions about the level of uncertainty we are willing to live with in order to accept and act on our conclusions (for example, in science there is the concept of statistical significance; in law, there is the concept of "beyond a reasonable doubt").

Once we established the concepts we wanted to teach students in the game, we selected a game context. Our goal was to pick something that lent itself well to both a game and the subject matter. We chose solving detective stories in outer space, given the popularity of science fiction among teenagers and the striking parallel between how a scientist thinks and how a detective thinks. Table 1 illustrates this parallel.

Table 1
Comparison of scientific and detective reasoning.

Scientific Reasoning	Detective Reasoning
Formulate a question	Who "dunnit"?
Develop hypotheses or models to answer question	Find suspects, develop scenarios about how crime was committed
Gather information related to hypotheses	Collect clues
Compare measurements to predictions of hypotheses	Forensics; comparison of clues to scenario predictions
Draw conclusions	"Beyond reasonable doubt"

Based on the above analysis, it is possible to create detective stories that will make teaching points regarding scientific reasoning. For example, one could create stories with multiple suspects to teach students how to gather evidence that will distinguish which is the guilty one. This is analogous to having multiple hypotheses that a scientist must collect data for in order to distinguish which one is likely to be correct (e.g., the patient got better because of the treatment, the patient got better on his own, the patient was never sick). One could manipulate the number of clues or their reliability in order to make teaching points about how it is important to collect sufficient data and how biased data can distort one's conclusions.

While it is important to create story lines that will be educational, students have made it very clear to us in focus groups that they typically do not like educational software because the fun factor is missing. We asked them what they thought made a fun game. The following is a summary of their input.

Students in the focus groups spontaneously raised the issues of race and gender. Female students complained that most commercial games were male-oriented. They asked for contexts interesting to girls and for female main characters. Minority students (and some white students) asked for non-white main characters. There were two suggestions for handling the issue of the typically male main character. One is to have the game played from the perspective of the main game character's eyes so that the player never sees the image of the main game character (which presumably is the player). Another suggestion is more creative: to allow the player to create the main game character using a character editor. In this way the main game character could be male, female, black, white or even another species (e.g., an alien from another planet). This game feature would add variety to the game, which was also desirable. Students also suggested a balance of gender and ethnicity of other game characters, a balance we attempted to strike.

The students identified other elements to make a game more fun. First, they suggested variety across sessions so that players would not be faced with the same scenario each time. Ways to do this included changing the contexts (e.g., different planets), changing the mission (have the player do something different), and making the game more complex.

Students also expressed the desire for novelty and surprise. Surprises are unexpected events that may or may not relate to the main game plot. Students also wanted humor. This includes jokes being told by the game characters, funny antics, and bizarre events.

Students wanted few breaks in the action while they played the game. They expressed strong displeasure with games in which the main action keeps stopping for drill on content matter unrelated to the context of the game. Many said their experience with educational games was primarily of this variety. While any game was clearly preferable to standard classroom instruction, they would never voluntarily play such a game outside of class. Students wanted instruction to flow with the game and be instrumental in moving through the game. Math problems that were too time intensive would detract from the fun. Suggestions for addressing this issue included developing "robot assistants" that perform the actual computations while students engage in the reasoning parts of the problem solving. Teachers and scientists agreed that the ability to select appropriate methods and interpret results were more important than the ability to perform correct computations. Of course, learning does require intellectual discipline and a certain amount of plain hard work. Striking an appropriate balance between the "work" and "play" aspects of the game is an interesting challenge.

Students were definitely interested in the quality of the graphics and "special effects." Clearly, any computer game that is going to hold students' interest must have good, colorful, creative graphics.

Students virtually unanimously expressed the desire to see some sort of combat/shooting in the game. Even the female students wanted this feature. In fact, when a detective game was chosen as the context, students did not want simply to arrest the criminal—they wanted the chance to shoot it out. It was noted that this type of scene could be used as reinforcement for successfully going through the more "educational" parts of the game.

One game feature that is very important to the students and is present in virtually every commercial computer game is performance feedback. Whether the player is competing for points, promotions, or racing against the clock, these types of feedback motivate students to perform to the best of their ability as well as give them feedback on their progress. In our detective game, performance feedback in the form of promotions: the player progresses from apprentice detective to master detective and in the process solves more complex cases.

Finally, students want the game to be challenging and to become more difficult as they improve. Virtually every commercial computer game has increasing levels of difficulty. This may mean facing "bad guys" at a faster rate or solving more complex problems. Fortunately, this type of game characteristic works especially well in our framework of a detective game that teaches scientific reasoning. The students can progress through more difficult cases requiring more advanced levels of scientific reasoning.

The framework we have presented so far would lead to the creation of an educational computer game that presents a science curriculum in a fun way to students. However, our concept is that the game should tutor the student. By this we mean that the game should continually be assessing the student's level of understanding and evolving the scenarios to meet student learning needs. This is what we mean by the term "intelligent tutoring game".

Assessing a student in an open-ended environment is a challenging process. Current performance assessment faces a similar challenge. With performance assessment, educators receive scoring rubrics that describe different levels of proficiency. The educator then evaluates the students response against the rubric. Unfortunately, this is not suitable for a computer game as the descriptions of the proficiency categories tend to be too imprecise for a computer to match to a student's behavior and the scoring process does not specify the cause of the student's weaknesses. Our goal is to assess the student in such a way as to bolster the instructional process.

This still leaves the challenge of understanding a student's strengths and weaknesses given very open-ended behavior. Because the number of possible action sequences a student can take is prohibitively large, there is no way to encode the "correct" solution path for each case. Rather, we must decide, based on the learning objectives of the case presented to the student, what are the general characteristics of a sound problem solving approach.

For example, if the learning objective is to teach students how to distinguish which of two hypotheses is likely to be correct, then we expect a student to look for evidence that can not only confirm one of the hypotheses but also disconfirm the other (i.e., rule it out). Therefore, the game can monitor which pieces of evidence the student collects and how they relate to the suspects provided. The game should detect whether the student has collected the appropriate evidence regardless of the order in which the information was collected or the other actions the student took while playing.

It is important to note that simply observing behavior does not, in and of itself, identify the thought process that lead to that behavior. A student may deem a piece of information important for reasons other than those that relate to the teaching objective. A student may omit collecting a piece of information because she does not realize it is available even though she knows that she needs to collect it. Therefore, it is important for the game to be able to determine when these sorts of events are happening. Our solution to this challenge is to have the game characters themselves probe the students as part of their interactions with them. Simple probes such as "who do you think are likely suspects?", "what evidence are we looking for?", "why aren't we picking up that object and having it analyzed?" can shed light into the student's thought process.

Once the game has determined where the student's level of proficiency is, it can make decisions on how to evolve the scenarios to enhance student learning. For example, if the student is correctly solving the cases and demonstrating mastery of the learning objectives, she can progress to more difficult cases that embody more challenging learning objectives. On the other hand, if he is failing to meet the learning objectives, the game can offer several forms of remediation. One is to have the game characters themselves offer instruction by making suggestions and offering wisdom, e.g., "Gee, I don't think we've ruled out the possibility that the Martian could have done it." or "That witness wasn't very reliable. I don't think we should believe him." A second way is to change the stream of events dynamically. For example, if the student fails to rule out that a second suspect could have committed the crime, the game could plant a decisive piece of evidence and literally change the perpetrator to the second suspect. This could be brought to the student's attention when he makes an arrest. His sergeant may report that another detective searched the second suspect's house and found the murder weapon and then instruct the student on why it is always important to rule out other suspects, not just get evidence on the one she thinks is guilty.

An Internet-based Intelligent Tutoring Game

A prototype of an intelligent tutoring game has been developed and placed on the World Wide Web (WWW). It can accessed through RDC Publishing's (a division of Research Development Corporation) home page at http://www.RDCPublishing.com. In the game, the student joins a problem solving team to solve a mystery. The teammates serve as co-problem solvers as well as mentors when the student needs instruction.

The game is written in HyperText Markup Language (HTML). The student views each screen and then clicks a forward or backwards arrow to move forwards or backwards through the story. At several points in the story line, the student is asked to make decisions. These could either be decisions with respect to what path to follow in solving the mystery or to perform quantitative problem solving. The choices the student makes will influence what path the story takes. In the cases where students are asked to solve problems, their answers are used to assess whether they need any remedial instruction. In cases where remedial instruction is provided, students follow a separate branch of instructional activities off the main story line. Upon completion of the remedial activities, they join the main story line in the place they left off. The student then follows the story line to its completion or until additional remediation is needed. By the time the student reaches the end of the story line, s/he will have completed the entire lesson embedded in the story as well as any remediation that was required along the way.

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Modelling Student Reasoning in Science Education with Computers: A Concurrent Coordination

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Student model is one central component of Over-the-Shoulder Advisor Systems (OSAS), Intelligent Learning Environment (ILE) and intelligent interface design. This paper tackles the student modelling issue by means of an overlay model: student knowledge is represented as a subset of expert's knowledge (Carr & Goldstein, 1977). However, departing from the traditional sequential and centralised models, our approach brings to bear on distribution of the learner and expert models and on concurrent interpretation of students' actions through multiple points of view. On the one hand, learner and expert models are distributed throughout many autonomous agents. Each agent is devoted to one single tiny piece of knowledge (Leman, Giroux and Marcenac, 1995). On the other hand, agents might simultaneously and locally interpret a student action under different viewpoints. Furthermore, agents can communicate and exchange information to assess their conclusions; however, using a distributed overlay model still calls for mechanisms for uncovering implicit reasoning steps from explicit student actions.

After giving a short description of the test-bed expertise, the fundamental issues are discussed:

a. How to represent a student reasonning in a distributed model?
b. How to build the student model at run time?

Modelling Student Reasoning with Agents

Using a Multi-Agent Approach to Model a Student

To illustrate our approach, a sample geometry domain was investigated. In geometry and more generally in problem solving, there are as many correct paths to a solution as there are viewpoints on a problem and a domain. For instance, to build a square with rules and compasses starting from a given line, there are at least three solutions: draw a circle and then three perpendicular lines, draw two circles and two perpendicular lines or draw three circles and only one perpendicular line:

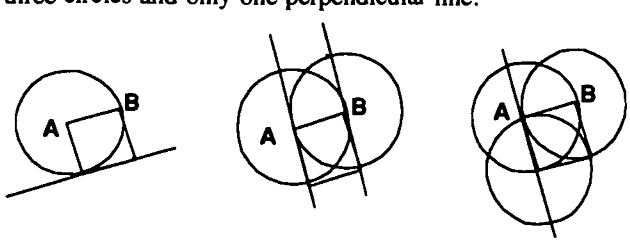

Figure 1. Three different solutions to build a square.

Trying to solve this problem, a student draws several figures and may follow different plans at different times. To undercover the really followed train of thoughts out of the student local actions, we have to consider these plans simultaneously as hypotheses about the student reasoning process until one appears as the good one. To do so, hypotheses are compared to the solutions provided by experts, each one standing as a different viewpoint. A multi-agent approach to student modelling appears as a natural framework to tackle the representation and co-ordination of multiple solutions as multiple viewpoints, to carve the system according to the locality and wholeness of actions and to consider concurrently various alternatives. As a result, our multi-agent architecture addresses the modelling of both student thought process and student knowledge. It brings up several advantages, in particular for complexity reduction, concurrent examination of multiple viewpoints and real-time evolution.

Agent Types in the System

To build the student model while solving a problem, we need on the one hand a way to look at student's actions and on the other hand a mechanism able to analyze these actions and to store the results. So two kind of agents have been designed: *spies* agents observing and reifying student actions, and *task* agents analyzing actions and building the model.

As framework, an epiphyte information system is used and its current programming platform EpiTalk (Pachet, Giroux and Paquette, 1994). In our prototype, a student is interacting with a single application providing functions needed to build basic geometric figures as points, lines and circles. Using EpiTalk terms, this application constitutes the *host*. The epiphyte system is the multi-agent system which models the student reasoning processes. The evolving structure of the multi-agent system mirrors the student reasoning process.

Spy Agents. Spies are reactive agents. They do not embody any sort of reasoning. They do not state by their own what is relevant and what is not. They restrict themselves to look at the host, pick up the student actions and transmit this information to interested task agents. Task agents stand at the heart of the system. They are in charge of distributed student modelling.

Spies can be inserted anywhere into the host. But there are many actions that can occur within a host (resize a window, draw a line, etc.) and these are surely not all of relevance for the purpose of teaching geometry. Therefore we must achieve a good balance between an exhaustive spying of student actions, likely to drown relevant information into a noisy flow, and a too succinct one, likely to produce a too gross view on the student cognitive activity.

In our prototype, spies focus their attention on geometric figures a student can trace. For each basic geometric action provided by the interface, a spy agent in charge of detecting it is associated. So all basic geometric actions available to the student are supervised. When a spy detects an action, it first screens the relevant ones to intercept, and if appropriate, then transfers a reification of the action to interested task agents. The reification specifies the action name (*Draw-Circle*), arguments (*with centre (150,200) and radius 50*), the time when the action occurred and other information.

Our protopype, both the host and its associated epiphyte system, is implemented in Smalltalk-80. Spies are first inserted into the host. When a student performs an action, it is achieved though message passing. The spy first receives the message, reifies it, sends the reification to task agents and forwards the message to its real destination. The destiny processes the message and sends back result to the spy. The spy registers the results and finally returns the result to the initial sender. In this way, the host behavior is not modified. So required information on student's observable behavior is available, and task agents have to process it.

Task Agents. A multi-agent system analyses the student "primitive geometric" actions in order the infer a distributed model of its reasoning process. Since this analysis is conducted from the viewpoint of the task the student has to perform, we called these agents *task agents*. To organize and ease student modelling, two kind of task agents are considered:

1. S-agents, addressing static knowledge (knowledge on concepts). In geometry, concepts are the figures (circle, square...) and properties (a square's, edges are equal...) the student should know about. S-agents own tiny pieces of static knowledge on the domain. In achieving its task, a student builds up complex static knowledge out of simpler static knowledge. In the student model, S-agents are used both to model the knowledge compulsory for the task and to check if this knowledge is mastered by the student. This representation scheme bears many advantages for managing new knowledge, forgetting knowledge and reducing complexity. As a result, static knowledge is distributed across the task agents which hold together a part of the student model.
2. D-agents, addressing dynamic knowledge (knowledge on functional aspects of concepts). In geometry, theorems belong to this category. The D-agents hold knowledge used to build new knowledge. A D-agent receives S-agent(s) in input and produces S-agent(s) in output. Again as a result, dynamic knowledge is distributed across the task agents which hold together another part of the student model.

Reasoning Graph

To complete the student model, we need first to know how static and dynamic knowledge are linked and second how these links are mastered by the student. This information is indeed embodied into the structure of the multi-agent system resulting from S-Agents and D-agents. This overall structure acts as what we called a *reasoning graph* . A reasoning graph is usually hierarchical by nature and may be compared to some sort of plan.

In our test-bed, each solution to a problem is expressed through a reasoning graph. In Figure 2, we give an example of such a graph, the problem being to build the perpendicular median of segment AB:

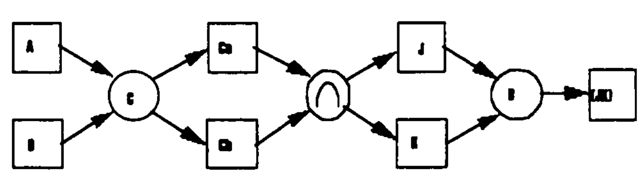

Figure 2. An example of a reasoning graph.

The reasoning graph describes an expert viewpoint on the problem. To build the perpendicular median of two points A and B, one has to build two circles with centre A (*Ca*) and B (*Cb*) respectively, then build two intersection points (J and K) between Ca and Cb, and finally draw the perpendicular median.

Building the Student Model at Run Time

A Distributed Overlay to Model the Student

A distributed overlay algorithm is used to build the student model. Reasoning graphs act as models to overlay. Their associated multi-agent systems reflect the state of the overlay process. Any spied action could be recognized as part of one or many reasoning graphs. Knowledge on the student is distributed across the agents. While modelling, each agent interpret information according to its own more or less local vantage point on the problem to solve. First, spies locally collect raw information and route it to interested agents. As reasoning graphs are hierarchical, leaf agents process it and may send their conclusions to their superiors. So as information sifts up, agents abstract it and the perspective on the student thought process enlarges. Thus, this bottom-up interpretation of the reasoning graph naturally reflects levels of abstraction.

For a given problem, many solutions can exist and many paths can lead to one solution, each path or solution resulting from a different viewpoint on the problem. Modelling a student reasoning process and knowledge becomes far more complicated. The system has to decide which path or solution the student is pursuing. Within our framework, one solution or one path is expressed through one reasoning graph. For instance, suppose our problem is "to build a square starting from two given points". Several solutions are possible and Figure 3 illustrates these three main solutions.

As we have seen before, these three solutions are expressed in three distinct reasoning graphs. At run-time, three multi-agent systems are generated, one for each graph. Each student action is then analyzed concurrently by the three multi-agent systems. Step by step, the chosen solution emerges. Ambiguities are resolved as soon as information becomes available. Even better, a student can follow a rather erratic course, trying one path, abandoning it for another, coming back to the first, and so forth. The multi-agent systems will naturally adapt to and undercover the right one(s) at the right time.

Modelling Students Reasoning

As long as the student follows explicitly step by step the reasoning of the expert, there is no problem. But exercising problem solving abilities, the student soon becomes more knowledgeable, and the OSAS is faced with unexpected sequences of actions.

Is the student wrong? Has the student made a jump in his reasoning process? Has the student found an unrecognized solution? If the student problem solving abilities are improving, the problem is two-fold: first, identify the S-Agents and D-agents that have been by-passed, and second, to model this *expertisation* behavior.

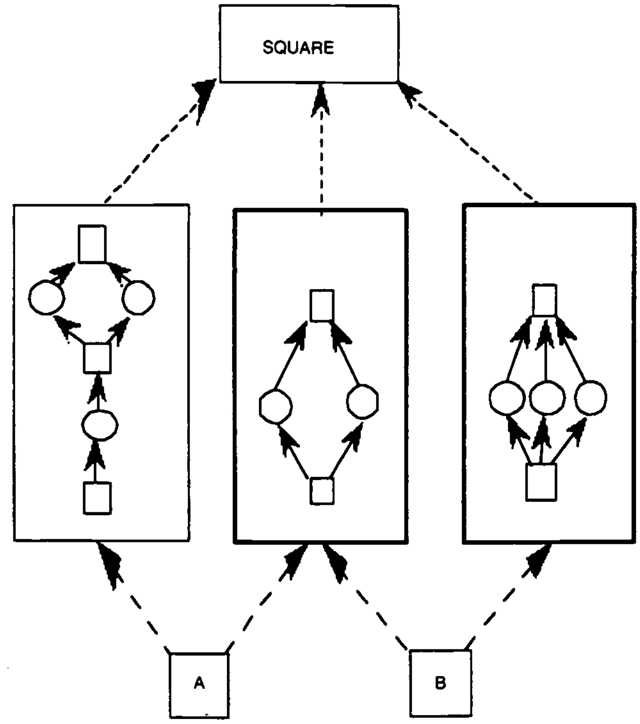

Figure 3. The solutions expressed with agents.

Recognizing the Master in the Student. We called "expertisation" the recognition and the modelling of this brand-new student behavior. For this purpose, a new type of agent is introduced: R-agent. R-agents model complex reasoning involving multiple S-agents and D-agents. The expertisation may be seen as a reflective operation on knowledge (Smit, 1983). Expertisation acts as a synthesis operation while going from a R-Agent down to S-Agents and D-agents act as an analysis operation.

In our test-bed, for the same example, Figure 3 gives a possible expertisation: a new R-agent (named Med) is created and is represented with only one agent, expressing the reasoning made by a student to build the perpendicular median.

The algorithm proceeds in two steps. At first, if the student has really jumped a sequence of reasoning steps, the system has to establish it and to take it into account. In trying to undercover those steps, the algorithm first tries to get a hand on both ends of the inference chain. So it looks for a higher place in the graph that could be considered as reached by the student. This is equivalent to finding a sub-graph that may be subsumed by an R-agent. Although the research of a sub-graph is known to be NP-complete, this is not actually a hindrance. We actually work with little graphs; the graphs are quite constrained and some properties computable beforehand and heuristic helps controlling the search. When the starting node is received, the algorithm searches for an equivalent path in another reasoning graph which has been marked as mastered. If such a mastered path exists elsewhere, this is done.

R-Agents as a Way to Represent Reasoning. However if we cannot conclude that all the shunted reasoning process (both concepts and chaining of inferences) is mastered, we then focused on each component, that is S-agents and D-agents. We use a distributed scheme to establish that knowledge modelled by each by-passed agent (X1, X2,..., Xn) is really mastered. Each by-passed agent is in charge of finding evidence that knowledge is mastered. He gathers opinions of other S, D or R-agents related to the same knowledge than his. For this, he communicates with agents that owns various parts of the student model. Naturally their answer can be various and even contradictory, and so conflicts are possible. To solve conflicts, we use belief factor: B_X. (0_B_X_1, B_X=1 represents completely mastered knowledge). Each S-agent and D-agent manages such a belief factor for knowledge. Each agent manages three belief factors Bp, Bg and Br.

Bp is related to the knowledge of the agent taken in isolation. It represents *properly* belief. It is computed as the mean of the belief in agent X within solutions where it is involved, weighted by the belief of each solution (which corresponds to a classical probabilistic approach)

$$\mathrm{Bp}(X) = \frac{\sum_i Bg(X_i)Bp(X_i)}{\sum_i Bg(X_i)} \quad (1)$$

Bg is related to the knowledge of the agent but under the scope of the solution that uses it. Bg remains the same for all agents involved in the solution. It's a *general* belief. It compares the intrinsic value of different solutions. Since solutions differ both in their sources (they are provided by experts of different experience) and their intrinsic value (for instance, some may be more aesthetic).

Br is related to the importance of the agent in a solution. In a reasoning, all the steps are not the same importance. With Br, we distinguish the *relative* importance of each agent in the same solution.

Once the belief in each agent has been computed, we gather results and attribute belief values for the shunted path. General and relative beliefs are respectively given by (2) and (3) formulae:

$$Bg(R) = Bg(Xi) \quad (2)$$

$$Br(R) = \sum_i Br(Xi) \quad (3)$$

To attribute properly belief, we balance the belief of each agent Xi by his importance in the current solution. So, we obtain:

$$\mathrm{Bp(R)} = \frac{\sum_i Br(Xi)Bp(Xi)}{\sum_i Br(Xi)} \quad (4)$$

Then we create a new R-agent with a belief factor with value B_R. Then the brand-new R-agent is introduced in the multi-agent systems and linked to appropriate agents and this R-agent is now a new alternative to solve the problem.

As a tutorial and validation strategy, the creation of an R-agent could be postponed by the presentation of new problems in order to verify that some part of involved knowledge has really been mastered. The important point is that expertisation allows modelling the evolution and the complexity of student knowledge.

Concluding Remarks

We have presented in this paper an original approach to recognize and represent complex student reasoning. A first step consists in a distributed overlay algorithm, while the student follows, step by step, an expert's reasoning to solve the problem. Expert reasoning are described in reasoning graphs and each node is represented by one agent. When student's behavior comes close to expert's behavior, a new agent with new factor of belief is introduced to model his reasoning.

Actually further researches are under investigations in our team. They principally try to answer the following issue: how to design tutoring strategies exploiting a distributed student model?

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SIMULATIONS

Section Editor:
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Over my seven-year tenure as simulation section editor, I have watched this area develop in several important ways. Our simulation builders have tapped the expanding array of technological advances to create a pool of preservice training aids that continues both to expand the scope of simulation applications in teacher education and also to refine the utility of the simulations that are already being used. For example, during the current decade, simulation research and development at the Curry School has yielded an entirely new "breed" of Windows-based simulations that, as described in one of this section's papers, focus on helping our preservice teachers develop effective lesson-planning skills. Over the same period, our basic teaching skills simulation has evolved into a tool for sensitizing our teachers-in-training to individual learner differences such as gender and ethnicity. Let's view some of the highlights of the innovations and refinements that are reported by this year's contributors to the annual's simulation section.

Rebecca Brent, a long-time colleague from East Carolina University, focuses on a very practical teaching issue—preparing for the opening days of school. Her *Simulated Opening of School* (*SOS*) package has been refined extensively over the past five years. As preservice participants complete the most current version, they engage in as many as seven activities whose content ranges from the opening faculty meeting to class enrollments. Rebecca's soon-to-be published SITE monograph will be most helpful to teacher educators interested in employing *SOS* in their programs.

Troy Isaak, at Millersville University, used Authorware to create another very practical training tool, the *Pine e-mail* simulation. Specific modules, by coupling screen displays that simulate the campus network with clear instructions and feedback, help students to learn fundamental e-mail skills ranging from logging on and off the network to saving and deleting messages. The fact that this simulation is replacing all classroom introductory e-mail instruction at the university attests to its training utility.

The third paper illustrates the cooperative efforts of physics and education faculty members to create a simulation particularly helpful to preservice science teachers. From the Universiti Sains Malaysia, Fauziah Suliaman and Ahmad Nurulazam Md. Zain discuss a Pascal program named *Walde* which is designed to provide preservice science teachers with a clear example of energy conservation. The specific task centers on analyzing the heat transfer process in 12 wall designs.

Emyr Williams, at California State University, Long Beach, has been studying the impact of a multimedia instructional package on undergraduate physical education students' ability to analyze and diagnose throwlike behaviors. Participant attitudes about the multimedia instruction were positive. Williams speculates that future research may find that multimedia applications in this area are most beneficial when they are used to supplement rather than to replace traditional instruction.

Two Windows-based simulations from the University of Virginia are described. Yu-chu Yeh has developed the *Computer Simulation for Teaching Critical Thinking* (*CS-TCT*). This flexible Visual Basic program is designed to increase preservice teachers' professional knowledge and skills in teaching critical thinking. Activity centers around a lesson in which teacher-participants try out various techniques to increase critical thinking in 12 very diverse students. Extensive feedback is linked to teacher actions. Initial research findings support this tool's effectiveness in improving participants' knowledge and skills in this important area of instruction.

In a second paper from the University of Virginia's Curry School of Education, Amie Sullivan, Yu-chu Yeh, and Harry Strang discuss refinements and continued field testing of the *Teaching Decisions* (*TD*) simulation. The current version of this Visual Basic program allows preservice participants to engage in a variety of lesson planning tasks from assigning pupil spatial locations and lesson activities to deciding what the teacher will do during the lesson. As with previous Curry simulations, extensive post-participation feedback is provided. This paper's most provocative findings relate to the variations in lesson-planning patterns that experienced teachers exhibit—patterns that future preservice teachers will benefit from studying.

Over the past 27 years, Harold R. Strang has been an educational psychologist in the Curry School of Education at the University of Virginia. He teaches courses in human learning and development. For more than a decade, he, several collegues, and a number of graduate students have been developing and conducting research on computer-based teaching simulations. Harold Strang is a faculty member of the Department of Educational Studies in the Curry School of Education at the University of Virginia, 405 Emmet Street, Charlottesville, VA 22903.

Simulated Opening of School

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The opening days of school are critical in preparing for a successful school year (Evertson, Emmer, Clements, Sanford, & Worsham, 1989). They can be particularly challenging for beginning teachers, who must teach students a wide range of classroom, playground and cafeteria rules and procedures, plan lessons, perform initial student assessments, attend faculty meetings and in-service workshops, work cooperatively with other teachers to arrange classroom schedules and times for pullout programs, get necessary supplies, make initial contacts with parents, arrange desks and centers, and put up decorations and bulletin boards. Many new teachers are unprepared for this whirlwind of required activity and so must learn to manage it by trial and error.

Simulated Opening of School (SOS), a SITE monograph currently in press, is designed to prepare preservice teachers for the realities of the opening of school. SOS is a role-playing simulation that has been used by over 1200 elementary and middle grades preservice teachers and by eight different instructors during a five-year development period. In SOS, students are assigned as teachers at Alpha Elementary School and work step by step in 3-5 member teams through the first few days of school. The complete simulation takes approximately 8-10 hours of instructional time, but many of the activities can stand alone to provide meaningful one- or two-hour experiences.

Participants in SOS experience two faculty meetings and plan the physical arrangement of their classrooms to provide smooth traffic patterns and optimum learning environments. They anticipate their supply needs for the entire year and arrange to get needed supplies and equipment. While planning lessons for the first two days, they incorporate the development and teaching of rules and procedures, events that are vital to establishing and maintaining an orderly classroom where effective learning can take place. Then they role-play the first day of school, discussing possible events and actions. They learn that the opening of school is a time that calls for flexibility and cooperation with fellow teachers.

SOS is ideal for use in classroom organization and management courses, methods courses with a management component, or curriculum courses. It is immediately applicable to elementary education, but can be modified for middle grades, early childhood, or special education programs. Along with written instructions for the activities, the SOS monograph has accompanying computer files that help create realism within the simulation by enabling teacher educators to personalize all handouts with student names and to modify materials to fit many different classroom settings.

Activities

Instructor lesson plans for each of the seven activities in SOS include (1) purpose of the activity, (2) steps needed to prepare for the activity, (3) detailed explanations and directions for each part of the activity, (4) debriefing questions for class discussion, (5) descriptions of written products prepared by participants during the activity, (6) suggested class time, and (7) variations.

Activity 1: Opening Faculty Meeting

Preservice teachers frequently have misconceptions about the teacher workday period before the opening of school, believing they will have plenty of uninterrupted time to prepare their rooms and plan lessons. They are also usually unaware of the major role of the principal in influencing the operation of the school and the working climate for the faculty.

During Activity 1 participants take part in a mock faculty meeting for the first teacher workday of the new school year. The "principal," who may be a former principal in the community or a faculty colleague, conducts the meeting during which participants are given a schedule of activities for the workdays and are confronted with committee assignments, duties before and after school, broken copy machines, and other common aspects of teacher life in an elementary school. They also hear about new district initiatives and are given a motivational speech about the beginning of the school year. Activity 1 stimulates students to think about the role of the principal. They identify possible characteristics of their first principal and strategize ways to work effectively with all types of leaders. Computer files are available for all of the handouts, allowing instructors to personalize duty assignments with student names and to modify materials to reflect changing initiatives in local schools in which students will complete field work.

Activity 2: Schedule Construction

Most preservice teachers have worked in classroom settings where scheduling decisions have already been made before their arrival. They have usually not seen a master schedule for a school or thought about construction of the daily class schedule.

This activity acquaints participants with the constraints of school scheduling as they work with a master schedule, lunch schedule, and time requirements for each content area. A database program allows instructors to personalize the master and lunch schedules with participant names. Each grade level team must consider optimum times for teaching, realistic work periods, and breaks, as they seek to reach agreement on a common schedule for the school day.

Activity 3: Floor Plans and Supplies

The purpose of this session is to introduce participants to the types of classroom environments they may face in their first teaching positions. Participants have blank floor plans of their classrooms with variations due to location in the building and the grade level for which the room was designed. They also have lists of the furniture and supplies in their rooms. Some rooms are fully equipped with many supplies appropriate to the assigned level, and others have inadequate or inappropriate supplies. Working in grade-level teams, participants examine the supplies and furniture they have, assess what they need, arrange with fellow teachers to acquire needed supplies, and sketch the arrangement of furniture and desks in their classrooms. Teams also construct a letter to parents about the supplies children should bring to school.

Activity 4: Lesson Planning

Most preservice teachers have many experiences with planning individual lessons but almost none with planning for a whole instructional day. The first few days of school pose even more planning challenges because the teacher must set the tone for the classroom and learn about the academic levels and abilities of each student.

This activity acquaints participants with lesson planning for the first two days of school. Participants share ideas about appropriate activities to include in the opening days, including reviewing content from the previous school year, team building, and establishing rules and procedures. They also learn about fire drill procedures and discuss other safety concerns associated with the opening of school.

Activity 5: First Day of School

Most preservice teachers have not had an opportunity to experience the opening of school except as students. In Activity 4, participants planned for the first day. Activity 5 allows them to test the feasibility of their plans and to experience the flow of the first day. The instructor systematically goes through the events of the day, posing typical problem situations such as the arrival of a student who speaks no English, a delayed lunch schedule, and a student complaining of a stomach ache. Participants offer individual solutions and generate additional ideas as a group.

Activity 6: Class Enrollments

Beginning teachers often accept their first job with little understanding of how teachers are assigned to a school and the impact of enrollment on the individual classroom teacher. During Activity 6, participants meet as a staff to discuss an imbalance in class sizes within the grades. The principal helps participants understand that teacher allotments are made based on enrollment and gives them an opportunity to suggest various strategies for addressing the problem of class size imbalance.

Activity 7: Reflection and Final Debriefing

A crucial part of any simulation is debriefing (Christopher & Smith, 1987). Simulations often elicit strong feelings in students as they grapple with unfamiliar and sometimes intimidating situations. In SOS, debriefing takes place individually, in small groups, and in the entire class group. The final activity encourages participants to make sense of the total SOS experience by reflecting on these questions:

- How did you feel during SOS? Did your feelings change as the activities progressed? How?
- What are the most important things you learned during SOS?
- How do you think SOS compares with what will really happen to you during the first few days of school?
- What was it like to work in a team? Do you think real teams will be like this?

In SOS, all the teachers were students in a class and unfamiliar with what was going to happen. What may be different if you are the only new teacher in a school? What might be taken for granted by your principal or other teachers? To whom could you turn for help? What could be improved about SOS as a class simulation? What should definitely stay the same?

Contents of the Monograph

The SOS monograph contains:

- A rationale for using SOS, background information on simulations, and suggestions for preparation before beginning the simulation.
- Instructor lesson plans with detailed directions for each of the seven activities.
- Instructions for using diskettes, which are available in PC or Macintosh formats. Text files include a Welcome Back memo from the principal, grade and room assignments, a schedule for the opening teacher work days, master and lunch schedules, a duty roster,

instructions to the leaders of each grade-level team, listings of the contents of each classroom, a memo of fire drill procedures, and memos to teachers on the first day of school and after one week. A database file facilitates the personalization of most handouts with participant names. Graphics files include a school floor plan and blank floor plans for each classroom. Instructions for the principal in Activities 1 and 6.

- Sample lesson outlines for the first days of school for Grades 1 and 4.
- Listings of first day problem events for elementary and middle school.
- Annotated references on the opening of school and classroom management for beginning teachers.

Conclusions

Simulated Opening of School offers many benefits for the participants. It focuses preservice students' attention on the most important aspects of the opening of school, including classroom preparation, scheduling, and teaching rules and procedures. It includes a wide variety of problematic situations, including getting new students, dealing with anxious parents in kindergarten and first-grade classrooms, being without needed supplies, and making last-minute scheduling decisions and adjustments. By introducing preservice teachers to these simulated situations, SOS prepares them for the real experiences and equips them with many problem-solving strategies. By emphasizing grade-level team work, SOS helps the participants develop skills associated with working in groups, something teachers routinely do. Finally, through debriefing and reflective writing, SOS leads students to take more considered approaches to professional decision-making.

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Developing a Customized Pine E-mail Simulation for Student Training

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During 1994, the university began the process of upgrading the campus network by connecting major buildings with fiber optic cable and installing a dedicated e-mail server. Currently, all academic buildings and office buildings are on-line, and the final phase of wiring all the dormitories is nearing completion. The usage of the university network increased dramatically once the academic buildings that house the student computer labs went on-line. Use of the e-mail system became part of many faculty curricula and assignments, thus necessitating the generation of large numbers of new student network accounts within a short time frame at the beginning of each semester. Also, once students learned that networking and internet facilities were available, many requested an account to correspond with friends at other academic institutions and to stay in touch with family.

To get a new network user account, students were required to take an hour training session for the purpose of learning the fundamentals of the Pine e-mail, the current e-mail system used by the university. However, with the large demand for new user accounts, the classroom training sessions proved to be problematic for several reasons:

1. *Training facilities*: The computer labs accommodate only 15-20 students at a time, and trainers had to compete with other computer lab uses such as regular classroom instruction.
2. *Individual differences*: Students in the training sessions had a wide range of skills and background knowledge about technology and the subject.
3. *Retention*: Practicing the learned networking skills as soon as possible after the training session is essential. Immediate access to the network was often delayed because of class or work schedules, and much of the information was forgotten.
4. *Scheduling conflicts*: The training sessions were not always offered at convenient times for the new users or at times when the training was needed for class assignments or work.
5. *Turnover*: Approximately 1900 potential new users enter the university system each year. Accommodating this number through classroom sessions with current resources could not be done.
6. *Network instructional staff*: The university at present does not support a staff committed to network training. Individuals who are trainers are also responsible for other computing duties.
7. *Alternative methods of instruction*: Not everyone learns well in large groups. Novice users often feel intimidated and overwhelmed with the new technology. They feel lost in a class situation and require more individual attention and time.

Network Training Solution

The method used to resolve the network training problem was to utilize the technology as a means of delivering the network training on-site when needed by the user. A customized computer simulation of the campus network was developed during the summer of 1996 by the author and a student helper. The simulation provides students with experience in using the campus network before actually logging onto the university system.

The Pine E-mail Simulation

The Pine e-mail simulation was created with Authorware 3.5 and is available for both Windows and Macintosh platforms. The simulation requires about 2 megabytes of hard disk space and runs on a local area network. The network simulation consists of a series of modules that include Creating Your Username, The Internet Address, Logging On/Logging Off, Reading Your Mail, Replying to Messages, Composing Messages, Saving & Deleting Files, and Printing Files. Each module provides users with experiences likely to be encountered when using the network.

The basic screen design for the simulation consists of two parts. The top seventy-five percent of the screen simulates the appearance and functions of the campus network. The bottom portion of the screen displays instructions and feedback. As students perform networking tasks, their input is evaluated and the feedback is displayed in a feedback frame or box.

Since the simulation is customized for Millersville's University campus network, the design also incorporates the names, phone numbers and e-mail addresses of computer staff where appropriate. For example, messages in the "Reading Your Mail" module contain important information about the system and include information about whom to ask or call concerning networking problems.

Students must complete each module successfully before going on to the next. Upon completion of the simulation, a user agreement form and a verification form are printed. The user agreement form includes university policies and rules governing the use of the campus network. The verification form contains the new username generated from the student's name and identification number, full name, address and phone number. The student signs the form, turns it in to the computer center, and the new user account is generated within two working days. For those who forget how to do any of the basic tasks associated with Pine e-mail, the e-mail simulation also contains a review section. The review does not print a verification form.

Current Status of the Campus Network Simulation

The Windows version of the simulation was installed in three computer labs during September 1996 and tested with approximately 500 students. Student reaction was very positive. The time needed to complete the simulation ranged from forty minutes to two hours and depended largely upon previously acquired computer knowledge and skills.

Because of the success with the initial group of students, all classroom introductory e-mail training sessions were suspended in October 1996 and replaced with the computer simulation. This results in a considerable saving of time for the computer center staff (approximately 120 training sessions per year) which can be put to use in other critical areas.

Currently, plans are underway to make a version for faculty, staff and administration. Since the username generation is done differently, several modules will need to be modified. The time frame for implementation of the new version is the summer of 1997.

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Designing Thermal Optimum Wall by Simulation for Energy Conservation

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With the Malaysian economy undergoing sustained growth of more than eight percent annually for the last eight years, the demand of electricity is increasing and is expected to rise in excess of 10 percent annually. Energy played an important role in the country's development and with greater industrialization, the demand for energy as a necessary component will continue to expand at a much faster rate than at present. In line with one of the main aims of the World Solar Summit in 1996, there is a need to encourage efficient use of energy in Malaysia to prolong the lifespan of available resources. Rahooja, Hassan, and Saleem (1990) found that heat gained due to conduction and convection into a particular building was 38.15 percent of total heat gained. Energy consumption in buildings could be saved through better designs of walls.

Computers have been used in teaching for about three decades. With the advent of microcomputers in the late 70's, the trend of using computers for instruction has increased. This trend is still continuing as powerful and cheaper microcomputers such as Pentium and Power PCs become more readily available. Computers are currently being used for the teaching of various disciplines such as pure science, applied science, social science, humanities, arts and music, and language.

In the teaching of science, instructional software has been developed mostly for drill and practice and tutorial. More simulation, data collection, and data analysis software needs to be developed to enhance science education and to promote higher-order thinking skills among students. McDaniel, McInerney, and Armstrong (1993) implied that the computer should also be used to meet emerging educational goals which stress cognitive processes. Such a goal can now be met with the new powerful microcomputers.

Simulation software provides students valuable experiences in the classroom or the laboratory. This software illustrates hypothetical or real-life situations which would not be possible through lecture, demonstrations, or experiments, due to time constraints, dangers linked to experiments, or the high cost of equipment. Using such software, students can manipulate the variables and observe the results immediately, and they can repeat the process as often as they wish. Computer simulations can play an important role in encouraging students to 'predict, experiment and explain' so as to better understand science concepts (Champagne, Klopfer, & Anderson, 1980). Hence, students can discover how scientifically correct their conceptions of certain phenomena are. Students can become active rather than passive learners.

Choi and Gennaro (1987) found that computer-simulated experiments could substitute for traditional laboratory experiments and that students would perform equally well. Moreover, computer-simulated experiments take half the time required for traditional laboratory experiments. In other words, computer-simulated experiments are efficient and cost-effective.

Walde is simulation software based on these theoretical assumptions. This paper will illustrate Walde as an excellent example to preservice science teachers in teaching energy conservation through simulation. Educators in Malaysia as well as in the rest of the world need to be concerned with developing energy-conscious citizens.

Walde

In the process of designing a building, one important consideration is the thermal comfort of the future residents of the building. By minimizing heat flow through the walls, a certain comfortable temperature can be maintained and energy can be conserved. Consequently, less electricity will be used for air conditioning, resulting in greater preservation of resources.

The purpose of this software is to design an optimum thermal wall for energy conservation by considering the comfortable temperature maintained in a particular room. One main factor that contributes to maintaining comfort is heat introduced into the building. Therefore, analyzing the process of heat transfer through the wall becomes very important.

The building materials used in the analysis are the ones commonly employed by engineers and architects. Material and building costs were also analyzed. Additionally, ferrocement and hollow bricks, which are not commonly used as building materials, were analyzed. The outside temperature was assumed to be 32 degrees Celsius, which is the average temperature in Malaysia, and the room temperature was assumed to be 20 degrees Celsius with air conditioning.

A simple iterative numerical method is used in the analysis (Johnson & Riess, 1982). This method generates a sequence of values that converge to the true solution through the use of an initial guess within a certain range. The error of this method is very small and thus gives an acceptable approximation.

A Pascal program called Walde was developed to analyze the heat transfer process in the wall for twelve different designs. Some of the walls were designed with air gaps. The program interactively asks for input parameters such as height and length of the wall, surface area of certain partitions in the wall depending on the particular design, materials used and duration of time for calculation of total costs. The program calculates annual and capital costs, including labor. The cost of air conditioning is taken as MR 0.24 per kW-hr, the normal residential rate.

Simulation Results

The results portrayed the effect of using ferrocement as an alternative to the common clay bricks. One of the designs with an air gap seemed to be the best design with its selected materials. A close second is a design which has three layers. From this study, it is found that walls with a certain number of layers provide good insulation and low annual costs. However, the design must also be analyzed to meet aesthetic preference and budget needs. Low annual costs are important, but the capital costs must also be considered. It is also beneficial to add certain metal supports at strategic locations to ensure strength and durability of the wall.

Conclusion and Discussion

This study aimed to analyze and design the exterior wall of a building for the purpose of conserving energy used for air-conditioning. Results indicated that heat gained through the walls due to conduction and convection is significant. Therefore in order to improve the thermal efficiency of the house, it is imperative to improve the walls by employing alternative designs and using thermally efficient building materials.

This simulation software could be used by science educators as an excellent example of a simulated experiment to preservice science teachers. Walker and Hess (1984) suggested that simulation can be a useful tool for students and teachers in learning and teaching science. Walde is software that is an economical alternative instead to having students construct walls. Preservice science teachers need to be shown how Walde can be used in teaching heat flow and energy conservation by having a group of two to four students running the simulation. In order to achieve the thermal optimum wall design, students must discuss the possibilities before running the simulation Students can learn cost-effectiveness in designing the optimum wall. They can compare the annual cost saving that resulted in certain designs by inputting values for height and length of the wall, surface area of certain partitions in the wall, materials used and the duration of simulated time for the calculation of the total cost. This process can be repeated as many times as students wish. Thus, using Walde, students can conduct the experiment as many times as they like. It is cost-effective and will save time for both teachers and students. Moreover, it provides a good example to preservice science teachers on using computers to teach skills, attitudes, and knowledge related to energy conservation.

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Skill Analysis Training in Physical Education: A Multimedia Approach

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The ability to observe and to accurately analyze movement skills is fundamental to effective teaching in Physical Education (Barrett, 1979; Kelly, Walkley, & Tarrant, 1988; O'Sullivan, Stroot, Tannehill, & Chou, 1989). Unlike coaches who specialize in sport specific movement forms, physical educators are typically confronted with a large variety of movement forms to analyze and diagnose. Although sport-specific training programs have been successful in developing analytic abilities of preservice physical education teachers (Kniffen, 1985; Halverson, 1987; Rush, 1990; Wilkinson, 1986), the variety of movement forms encountered by physical education teachers, as well as the time available to teach qualitative assessment, precludes a sport-specific approach. Recent skill analysis dissertations completed at The Ohio State University (Johnson, 1990; Matanin, 1993) suggest the potential for a mechanical approach to the analysis of skill (Kreighbaum & Barthels, 1990), otherwise referred to as a performance principle approach.

Theoretically, developing analytic and diagnostic competencies through a performance principle (mechanical analysis) approach would decrease the time required for students to become competent observers. A multimedia approach as opposed to a lecture approach to instruction offers another means by which the time required to acquire mastery of instructional content may be more efficiently (Falk & Carlson, 1991) and flexibly used. Combining the attributes of multimedia instruction, namely the efficient and flexible use of time, along with a performance principle approach to instruction, offers the potential for a time-efficient means of developing analytic and diagnostic competencies.

The purpose of this study therefore was to investigate the effectiveness of a multimedia (laserdisc) performance principle (mechanical analysis) training protocol on subjects' ability to analyze and diagnose throwlike skills. This study also examined the extent to which subjects' analytic and diagnostic skills generalized to untrained throwlike movements.

Method

Subjects

Six students enrolled in physical education undergraduate classes volunteered as subjects for this study. Subjects were selected on the criteria that (a) they were able to comply with the schedule requirements for the training program, and (b) they had not taken any undergraduate skill analysis, biomechanics, kinesiology or physics related classes.

Apparatus

A Panasonic SVHS Professional/Industrial Video AG-460 (at a shutter speed of 1/250th of a second) was used to videotape the throwing performances. Two Panasonic AG-7650 video cassette players and a Panasonic AG-750 editing deck were used to edit videotapes. The instructional equipment consisted of a Macintosh Quadra 700 with 20 Mega bytes of Ram and a 350 Mega Byte hard drive, a standard 13" Apple color monitor, a Pioneer Laservision Player LD-V4200, and a 13" Panasonic Video Monitor CT-1331-Y. The instructional modules and probes were developed using Authorware Professional (version 2.0, 1993).

Procedures

Development of the intervention package

The independent variable was developed in the following way: (a) selecting throwlike movements, (b) determining the performance principles for throwlike movements, (c) videotaping the throwlike movements, (d) cataloging the video performances of the throwlike movements, (e) selecting videotape performances for inclusion in the study, and (f) developing the multimedia program.

The throwlike sport movements selected for this study were representative of sport skills taught in middle school physical education classes in Franklin County, Ohio. Six overarm throwlike skills were integrated into the multimedia intervention and main probes (softball, tennis smash, volleyball serve, football, basketball, and javelin). Three untrained skills were integrated into the generalization probe (badminton smash, soccer javelin throw, and tennis serve). Selection of the applicable performance principles was attained by: (a) determination of the fundamental principles related to all throwlike movements (Kreighbaum & Barthels, 1990), and (b) the presence of these performance principles to varying degrees of significance in all throwlike sport skills taught in middle school physical education curricula. The four performance principles selected were magnitude of force, point of application of force, horizontal direction of force, and vertical direction of force.

Nine middle school (6-8) student performers were selected by their physical education teacher to represent high-, medium-, and low-skilled students from each grade level. Student throwers were videotaped from a side-on angle (90°) throwing from left to right, and from a rear-view angle (180°). To lessen the potential for external distractions (McPherson, 1990) the demonstrators were filmed in front of a plain blue background (Kelly, et al., 1988).

A review of the videotapes of 910 throwlike movements resulted in the elimination of 351 poor quality clips. The 559 remaining videoclips were then classified into five categories: correct performances, and four performance principle error categories (magnitude of force errors, point of application of force errors, horizontal direction of force errors, and vertical direction of force errors). A videotape was then edited to include these videoclips along with an inventory (cross referenced to the original SVHS videos) describing each performance.

The validity of each clip's inclusion in the study was initially determined by three groups of reviewers. The inclusion criteria were as follows: (Group #1) a middle school physical educator agreed that the performance was representative of throwlike movements at the middle school level; (Group #2) at least three of the four doctoral students concurred with the researcher's classification of the performance principle error; and (Group #3) a researcher with prior experience in performance principle research agreed with the identification of the performance principle error. After cross referencing reviewers' feedback, the 215 videoclips that remained were edited from the original SVHS videos on to a master tape. This second generation tape (containing 19 minutes of actual footage) was then pressed into a laserdisc.

On receipt of the laserdisc the researcher created an inventory of each throwlike performance using a Hypercard stack. Buttons were created (enabling the researcher to instantly view each clip) for each videoclip performance. These buttons were then placed onto correct performance cards (Hypercard) and four performance principle-specific incorrect performance cards (magnitude of force errors, point of application of force errors, horizontal direction of force errors, and vertical direction of force errors) for both the main and the generalization components of the study. The Hypercard stack categorization process enabled the researcher and a skill-analysis reviewer to compare and contrast performances more effectively. As a consequence of this review process in which performances were viewed at normal, slow and very slow speeds, a framework for the diagnosis of throwlike errors evolved. This framework viewed the throwing action as a sequence of four movement phases (preparation, weight transfer, body rotation, & follow-through) and was based upon motor learning research conducted by Roberton and others (DiRocco & Roberton, 1982; Halverson, Roberton & Langendorfer, 1982; Roberton, 1978). The diagnosis framework for this study required observers to identify the throwing phase in which the first form error occurred. To be diagnosed as a body rotation error, both the preparation and the weight transfer phases would have been flawless. Any arm sequencing errors occurring after the identification of prior flaws would not be categorized as the primary error, as errors in prior sequences would take precedence.

After developing this diagnosis framework, a motor learning reviewer was then asked to confirm the researcher's and a skill analysis reviewer's diagnosis of initial phase errors. This process resulted in the exclusion of another 17 clips, i.e. clips where the motor learning reviewer disagreed with the researcher and skill analysis reviewer's diagnosis. Assignment of the 198 remaining clips to either the probe or module components of the study was determined by chance. Clips were matched according to topographic similarity—e.g., softball throws, where the performance principle error was magnitude of force, were grouped together. From these clusters of similar clips a random selection process was used to determine each clip's inclusion in the probe or module component of the study.

Instructional Display

Geneva font was used for the instructional displays. The font size varied from 18-20 for the main body of the text and 20-36 for headings. Text background was predominantly white, while the text itself was predominantly black. Occasionally, white text on a black background was used to highlight components of the instruction. Additionally, animated diagrams were incorporated into the modules.

Program Control

The multimedia modules were externally paced with cognitive processing time (Canelos, Dwyer, Taylor, Belland & Baker, 1989). Presentation of the textual information required an approximate reading rate of 300 words per minute. Depending upon the context of the interaction, subjects were either presented with a continue button to progress more quickly to the next screen, or they were occasionally required to interact a predetermined number of times in order to move on.

After formative testing, it was discovered that the presentation of video from the laserdisc would occasionally freeze. Consequently each screen that included a video presentation had to be programmed to circumvent the freeze problem.

Outline of the Probes

Main and generalization probes consisted of 41 and 33 randomly sequenced videotaped performances respectively. Examples of correct performance, the four types of performance principle errors, and throwing form errors from each of the four throwing phases were included in all probes. Subjects, when presented with a videoclip performance, were required to indicate whether or not the performance was correct or incorrect. If subjects indicated that a performance was correct, the next performance would be presented. If subjects indicated that a performance was incorrect they were then asked to indicate which performance principle was deficient, and which of the four sequential throwing phases first exhibited a form error.

Subject response data were collected by embedding calculations for every possible response that an individual could make (Williams, 1995). For data collection purposes, each videoclip was given an identity number which was embedded into the calculation icon for each performance.

Outline of the Modules

Each performance principle training module included: (a) introductions and definitions, (b) examples of correct performances (both normal image and zoomed image), (c) examples of incorrect performances with a comparison of correctly performed and incorrectly performed phases of the throw, (d) an embedded test with feedback, and (e) a mastery test (80%) to exit. Subject pairs receiving less than 80% on the mastery test were given a review of the instructional content and were then required to retake the mastery test. No specific intervention on the diagnosis of errors was programmed; instead, examples of throwing phase errors were presented in each module.

Prior to data collection, subjects were required to participate in two computer familiarization sessions. The first training session familiarized subjects with the use of the mouse and the keyboard; the second familiarized subjects with a multimedia (laserdisc) mode of instruction.

Research Design

The design used for this study was a multiple baseline (Cooper, Heron, & Heward, 1987) across four performance principles: (a) magnitude of force, (b) point of application of force, (c) horizontal direction of force, and (d) vertical direction of force.

In single subject research, the interpretation of graphic data is achieved by a systematic process of examination known as visual analysis (Cooper, et al., 1987). Visual analysis of data is conducted to answer two questions: (1) whether a consequential behavior change occurred, and (2) to what extent the behavior change can be attributed to the independent variable. Attributing change in behavior to the independent variable is determined by examining data variability, changes in data levels, and data trends.

Subjects completed nine main probes, one generalization probe and four performance principle modules. Probes were used to measure subjects' ability to (a) discriminate correct from incorrect throws, (b) identify performance principle errors, and (c) identify throwing sequence errors. Probes were taken individually by subjects, whereas the instructional modules were completed in pairs. Main probes were administered weekly before and after each intervention. The final main probe was administered in the week following the last instructional module which was then followed by the generalization probe. Sequencing order of clips for each probe was determined by random selection.

Analysis of Data

Two types of data were analyzed for this study—probe scores (single subject design) and subjects' attitudes toward multimedia instruction (questionnaire). Subjects' responses to each probe were saved in a file and subsequently reorganized by identification number for later analysis. To ascertain subjects' attitudes toward multimedia instruction, a questionnaire (Chou, 1990) was administered immediately following completion of the generalization probe.

Results

Major Findings

Discrimination Scores

Although subjects' scores for discriminating between correct and incorrect performance improved after intervention and also generalized to untrained throwlike skills, the baseline discrimination scores were high at the start (66%-93%). (See figure 1.) As a consequence of the review process, the majority of clips included in this study were obviously correct or incorrect. Consequently, the task of discriminating between correct and incorrect skill performance was relatively easy.

Analysis Scores

Baseline scores for correctly determining the main performance principle error for incorrect throws were generally low. An interesting pattern of subject responses occurred immediately following each intervention. Generally subjects attributed performance principle errors to the subject matter (magnitude of force, point of application of force, horizontal direction of force, and vertical direction of force) of the most recently completed instructional module.

For example, immediately after the introduction of the point of application module (second intervention) , five of the six subjects' scores for correctly identifying magnitude of force errors (first intervention) decreased while the attribution of errors to the point of application performance principle increased.

Overall subjects' performance principle error detection scores increased for all performance principles; however, the accuracy scores were moderate at best, ranging from 39-58%. Performance principle probe scores varied across the six subjects, and each subject's performance scores varied across the four performance principles. As with Matanin's (1993) study, the inaccurate identification of performance principle errors increased after intervention; however this inaccurate association of errors to specific performance principles generally decreased as the study progressed. For the generalization probe (throwlike skills not included in the instructional modules), the overall mean generalization scores for each performance principle were close to or above the main post-intervention levels for all performance principles, with the exception of point of application of force which was lower in the generalization probe.

Diagnosis Scores

Similar to Rush's (1990) findings, baseline scores for diagnosing which phase of the throwing sequence (preparation, weight transfer, body rotation, and arm sequence) was incorrectly performed first were low. Without knowledge of the fundamentals of throwlike movements, subjects were unable to diagnose performances prior to instruction. Examples of preparation, weight-transfer, body rotation and arm sequencing errors were integrated into each of the instructional modules. The diagnosis procedure employed in this study required subjects to determine the first phase of a throwing sequence to exhibit form deficiencies. Visual inspection of the data illustrates that the ability to diagnose errors varied across subjects, and each subject's diagnostic proficiency varied from one throwing sequence phase to another. Overall the data indicate that subjects were ineffective in diagnosing throwlike movements.

Data from this study show that overall subjects' generalization probe performance scores were comparable to post-intervention probe mean scores for three of the four performance principles, and all four of the throwing sequence phases. Nevertheless the analysis (performance principle) and diagnosis (throwing sequence) scores for both the main and generalization probes were moderate at best.

Questionnaire

In addition to a Likert type questionnaire (Chou, 1990), subjects were also required to write concluding comments on their multimedia instruction experience. Subjects' attitudes toward the multimedia instruction were positive. Subjects' perceived that they had learned the content of the multimedia modules. A portion of subject One's written comments are quoted below.

> I thought that learning by multimedia was helpful. I learned a lot of information in a relatively short period of time. I feel as if I am knowledgeable enough now to help others, and pass on the skills that I've learned. (Subject 1.)

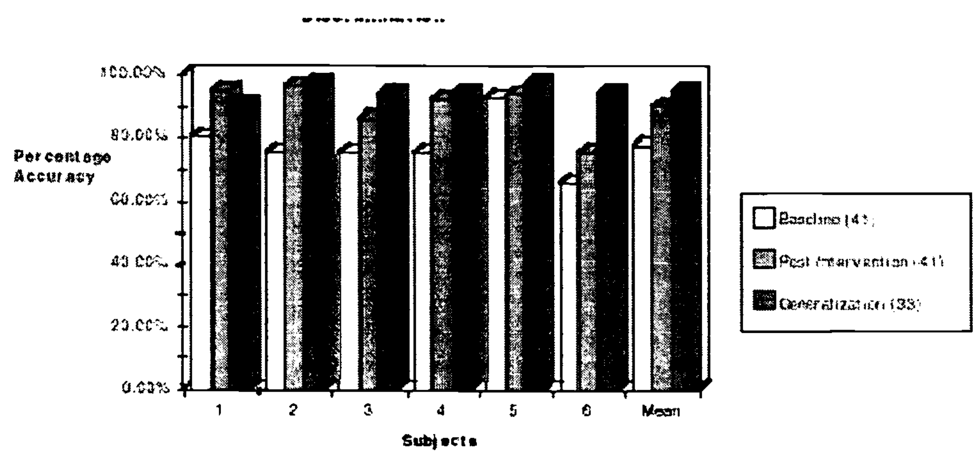

Figure 1. Overall discrimination accuracy across probes.

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Discussion

Probe scores suggest that subjects failed to master the instructional content presented to them through the specific multimedia instructional format employed in this study. Either the way in which the acquisition of knowledge was assessed and/or the interventions themselves were relatively ineffective. The probe format in this study allowed subjects to select only the one performance principle error (the main error). In hindsight the development of a probe enabling subjects to select in order any performance principle errors they had detected would provide a more complete description of subjects' analytic abilities. Similarly, when diagnosing errors in throwlike movements, the most obvious errors are frequently consequences of earlier errors in the movement sequence. Having subjects initially identify all errors demonstrated by the performer, then recognize the first phase in which these errors occurred, may have provided different results. Although diagnostic skills were incorporated in the modules, direct and sequential interventions developing subjects' abilities to initially detect preparation errors followed by weight transfer, body rotation and then arm sequence interventions errors may prove to be more effectual.

Implications for Physical Education Teacher Educators

Research has indicated that both critical element and performance principle approaches are effective. Physical education teacher education skill analysis researchers may more profitably use multimedia applications to supplement lecture-based instruction as opposed to developing comprehensive multimedia applications to replace it. Using multimedia applications to supplement lecture-based instruction may provide a means to capitalize on the capabilities of technology, while avoiding the time-consuming process of developing comprehensive instructional programs.

Although the lecture time available at the undergraduate level may preclude a critical element sport-specific approach, the development of sport-specific instructional CD-ROMS may provide a practical solution to the development of analytic and diagnostic competencies outside of University-based lecture instruction. For practicing teachers and/or novice coaches, sport or activity specific multimedia based instruction, specifically CD-ROM based programs, may fulfill an instructional need.

The development and quality of materials in the field of physical education teacher education will rely on those within educational institutions and publishing companies affiliated with the field. The time required to develop multimedia instruction is immense. My experience in developing the instructional components for this study leads me to believe that the development of multimedia applications in physical education requires a collaborative team approach. Multimedia development teams comprised of programming specialists, content experts, instructional designers, formative evaluators and film/video experts may potentially decrease the production time required to develop instructional materials and enhance the quality of instruction.

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The Impact of a Computer Simulation on Critical-thinking Instruction

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Many studies suggest that effective teaching can significantly improve students' critical thinking (e.g., Ennis, Millman, & Tomko, 1985; Knight, Wexman, & Padron, 1989; Williams, 1987). Professional knowledge (Michelli, Pines, & Oxman-Michelli, 1990) and positive teaching behavior (McBride & Knight, 1993) are crucial to the success of critical-thinking instruction. Since field activities contribute to the acquisition of knowledge and skills (Grossman & Richert, 1988; Ketty & Sellars, 1996), practice in school settings can be invaluable in helping preservice teachers to acquire the knowledge and skills necessary for teaching critical thinking. Implementing this instruction in school settings, however, is often very difficult. Fortunately, computer simulations are beginning to provide an alternative setting for teachers-in-training to become competent cultivators of critical thinkers. Pioneering research in this area, Yu-chu Yeh has developed the Computer Simulation for Teaching Critical Thinking (CS-TCT). CS-TCT training is based on the assumption that teachers, through mindful learning and reflective teaching, will improve their professional knowledge and thus develop effective strategies for teaching critical thinking.

There are two objectives in this study. First, the impact of the CS-TCT simulation on teacher training in critical-thinking instruction will be determined. Second, the relationship among teachers' involvement in the training, change in their professional knowledge, and change in their positive teaching behavior in critical-thinking instruction will be assessed.

The CS-TCT Simulation

CS-TCT participants complete the following four activities: Enter demographic information, teach a lesson, evaluate their students' performance, and review feedback reports. The program-defined students, six boys and six girls, represent three different ethnic groups: African-American, Asian, and Caucasian. They are also preset to vary in motivational level and critical-thinking ability.

The CS-TCT simulation includes the following key features:

1. *Classroom setting.* The program simulates the actions of twelve students in a classroom setting.
2. *Interesting teaching material.* During the simulation, teachers interact with students by presenting important issues in a story.
3. *Broad flexibility.* Teachers can employ many different strategies in interacting with their students.
4. *Mindful learning.* Teachers receive reminders and research-based knowledge designed to promote their acquisition of professional knowledge and skills in teaching critical thinking.
5. *Reflective teaching.* Teachers review profiles in the form of bar charts that are designed to increase self-awareness and to encourage future use of effective teaching behaviors.

Professional Knowledge and Positive Teaching Behavior in Critical-Thinking Instruction

Effective teaching is built on a foundation of professional knowledge (Grossman & Richert, 1988). Two types of professional knowledge are essential for teaching critical thinking: "content knowledge for critical thinking" and "pedagogical content knowledge for critical thinking." Content knowledge for critical thinking involves teachers' understanding the elements of critical thinking, the factors that influence critical thinking, and the relationships among these concepts. Pedagogical content knowledge for critical thinking encompasses teachers' knowledge of available materials and resources for teaching critical thinking, students' understanding of critical thinking, effective strategies for teaching critical thinking, and self-awareness of personal teaching behavior.

Numerous studies have confirmed that teaching behavior profoundly influences students' learning of critical thinking (e.g., Knight et al., 1989; Kolstad, Briggs, & Hughes, 1992; Rice, 1992). Knight et al. (1989) found that teachers' direct instruction in critical thinking influenced the way in which third- and fourth-grade students selected and applied critical-thinking skills. Three properties of teaching behavior contribute to cultivating critical thinkers. These properties relate to (a) improving students' prior knowledge, (b) promoting students' critical-thinking dispositions, and (c) improving students' critical-thinking skills.

As for the relationship between professional knowledge and teaching behavior, Robinson (1995) found that existing knowledge and experience strongly influenced teachers' development and use of teaching strategies. Increasing teachers' knowledge, therefore, is fundamental for bringing about change in their teaching behavior.

Based on the literature review, the following two hypotheses are proposed:

1. Following a training session, teachers will improve their understanding of professional knowledge pertaining to the teaching of critical thinking, and they will employ more positive teaching behaviors related to critical thinking.
2. Teachers' involvement in the training session will influence their change in professional knowledge and positive teaching behavior for critical thinking; moreover, the teachers' professional-knowledge change will influence their teaching-behavior change.

Method

Participants

The participants included 75 preservice teachers enrolled at the Curry School of Education, University of Virginia. The mean age of the participants was 19.73 (*SD* = 2.37).

Instruments

The CS-TCT and a 6-point Likert questionnaire, "The Questionnaire of Professional Knowledge for Teaching Critical Thinking" (QPK-TCT), were employed during this research. CS-TCT records provided measures of the teachers' promotion of (1) student critical-thinking dispositions, and (2) student use of critical-thinking skills. The first measure's behavioral components included giving positive feedback, providing cues, and showing physical closeness. The second measure's six behavioral components included allowing time for reflection before requesting an answer, demonstrating examples before employing practice, asking higher-order questions, giving explanations when demonstrating an answer, reviewing the material after the completion of a lesson section , and conducting group discussions. Each behavioral component was scored on a 0 to 1 scale. QPK-TCT measures addressed two aspects of professional knowledge pertaining to teaching critical thinking—"content knowledge for critical thinking" and "pedagogical content knowledge for critical thinking." QPK-TCT response options included "strongly disagree," "disagree," "slightly disagree," "slightly agree," "agree," and "strongly agree."

Procedures

All participants completed the CS-TCT in a computer laboratory. After a brief introduction to the simulation, a QPK-TCT pretest was administered immediately followed by a 15-minute demonstration and practice session. Next, participants engaged in the computer simulation. Finally, participants completed the QPK-TCT posttest.

Experimental design

This study employed a pretest-posttest control group design. Participants were randomly assigned either to an experimental or to a control group. Participants in both groups completed pretests and posttests. Only participants in the experimental group, however, completed the treatment designed to promote the effective teaching of critical thinking. The content of the treatment included five text files of research-based knowledge concerning effective instruction of critical thinking, two teaching profiles of personal performance during the simulation, a review of effective teaching of critical thinking, and several reminders that contributed to mindful learning and reflective teaching.

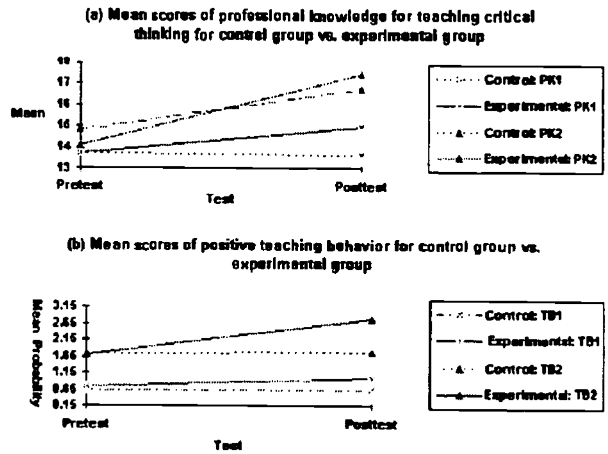
Statistics

One-way (Group) multivariate analyses of covariance (MANCOVAs) were employed to examine the training effect on the teachers' change in critical-thinking instruction. Group refers to the control and the experimental group, and covariances refer to pretest scores of the dependent variables being tested. Moreover, a path model of structural equations was applied to test the causal relationship of the variables displayed in Figure 2; difference scores were employed to represent the factor scores of the teachers' changes in professional knowledge and positive teaching behavior.

Results

In this study, effectiveness in critical-thinking instruction is defined by professional knowledge pertaining to the teaching of critical thinking and by positive behaviors related to this teaching. Figure 1 displays the mean scores of the professional knowledge and positive teaching behavior for both the control and the experimental group.

The first MANCOVA, which examined the overall CS-TCT training effect on teachers' effectiveness in critical-thinking instruction, yielded a significant group effect (Wilk's l = .87, $p < .01$). CS-TCT training yielded a significant improvement in teachers' effectiveness in critical-thinking instruction. Subsequent analyses of covariance (ANCOVAs) yielded significant group effects on both professional-knowledge change ($F(1, 72) = 4.54$, $p < .05$) and teaching-behavior change ($F(1, 72) = 9.52$, $p < .01$). The comparisons of least-square means revealed that teachers in the experimental group acquired more professional knowledge and employed more positive teaching behavior for critical thinking than did teachers in the control group.



Note. PK1: content knowledge for critical thinking. PK2: pedagogical content knowledge for critical thinking. TB1: teaching behavior for promoting students' critical-thinking dispositions. TB2: teaching behavior for improving students' critical-thinking skills.

Figure 1. Mean scores of professional knowledge and positive teaching behavior for control vs. experimental group

A significant group effect on the teachers' change in professional knowledge pertaining to teaching critical thinking was found, Wilk's l = .88, $p < .05$. Subsequent ANCOVAs, however, yielded a significant effect only for the first factor of the professional knowledge—content knowledge for critical thinking, $F(1, 72) = 9.26$, $p < .01$. The least-square means indicated that teachers in the experimental group acquired more content knowledge for teaching critical thinking than did teachers in the control group.

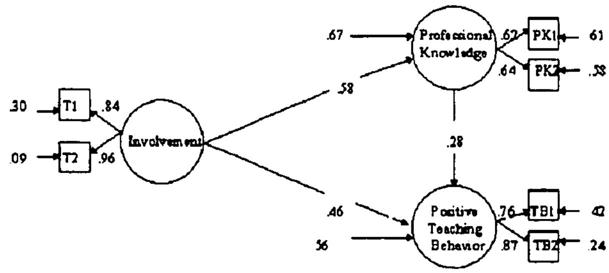
Moreover, the training was found to be effective in increasing the teachers' employment of positive teaching behavior for critical thinking (Wilk's l = .87, $p < .01$). Subsequent ANCOVAs yielded significant effects for both types of the teaching behavior, $F(1, 72) = 4.74$, $p < .05$ and $F(1, 72) = 10.98$, $p < .01$, respectively. The least-square means comparisons revealed that teachers in the experimental group employed more positive teaching behavior for promoting students' critical-thinking dispositions as well as for improving students' critical-thinking skills than did teachers in the control group.

In testing the path model of teacher training in critical-thinking instruction (see Figure 2 for the path structure), an analysis of structural equations yielded a non-significant c^2 value ($c^2(7, N = 75) = 2.63$, $p = .917$) and satisfactory fit indices (Goodness-of-fit Index = .988, Adjusted Goodness-of-Fit Index = .967, and Root-Mean-Square Residual = .025). These results suggest that the proposed model is a "good-fit" model. An inspection of Figure 2 reveals that (a) the teachers' involvement in the training directly influenced their change in professional knowledge and positive teaching behavior (the loadings are .58 and .46, respectively, $ps < .001$); (b) the teachers' change in professional knowledge significantly influenced their change in teaching behavior (the loading is .28, $p < .01$), and (c) professional-knowledge change mediated the teachers' involvement in the training and their teaching-behavior change.

Conclusions

CS-TCT training resulted in improving the teachers' effectiveness in critical-thinking instruction, in increasing their professional knowledge about teaching critical thinking, and in enhancing their use of positive teaching behavior during critical-thinking instruction. More specifically, this training yielded an improvement in the teachers' content knowledge about critical thinking and an increase in their use of teaching behavior related to improving both critical-thinking dispositions and skills in their students. While teachers significantly increased their content knowledge about critical thinking, they did not increase their pedagogical knowledge about teaching critical thinking. This finding most likely reflects the fact that pedagogical content knowledge addresses a much broader scope of understanding than simple content knowledge—a scope that involves teachers' responding to students who have different needs in different content areas.

In conclusion, the findings from this study reveal that a computer simulation can be an effective tool for improving teacher instruction in critical thinking. To maximize a simulation's instructional impact, however, fundamental factors such as guided practice, research-based knowledge, and self-awareness must be taken into account. Future research needs to explore the influence of an additional factor, teaching efficacy. Numerous studies have found that teachers' beliefs in their teaching efficacy are associated with their instructional activities and supportive teaching behavior (e.g., Dembo & Gibson, 1985; Housego, 1992). Furthermore, Garcia and Pintrich (1992) concluded that teaching efficacy is fundamental in effective critical-thinking instruction. Such findings strongly suggest that simulation-based training in critical-thinking instruction can produce more lasting effects if it raises teaching efficacy as well as imparting skills and knowledge.



Note. Involvement: Involvement in training. Inv1: time spent in reading professional knowledge for teaching critical thinking. Inv2: time spent in reading personal teaching profile. Professional knowledge: change in professional knowledge for teaching critical thinking. PK1: change in content knowledge for critical thinking. PK2: change in pedagogical content knowledge for critical thinking. Positive teaching behavior: change in positive teaching for critical thinking. TB1: change in teaching behavior for promoting students' critical-thinking dispositions. TB2: change in teaching behavior for improving students' critical-thinking skills.

Figure 2. A path model for teacher training in critical-thinking instruction.

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USING A COMPUTER SIMULATION TO EXPLORE TEACHER LESSON PLANNING

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Computer simulations offer a unique opportunity to research ways to improve teacher education. Over the past fifteen years, Curry Teaching simulations have been used to study preservice teachers' acquisition of a variety of important professional competencies. Early research focused on fundamental skills such as administering lesson-related feedback and lesson pacing (Strang & Loper, 1985-86). During this period, research addressed teaching domains ranging from preschool (Strang & Meyers, 1987) to elementary education (Strang & Loper, 1983) to special education (Kauffman, J.M., Strang, H.R., & Loper, A.B., 1985). More recent studies have extended Curry simulations' focus beyond teachers' use of basic skills to include their more global communication patterns (DeFalco & Strang, 1994) and their sensitivity to individual student learning styles (Strang, Sullivan, & Yeh, 1995). In the most recent research strand, Strang (1996) explored the use of the graphically rich Windows-based Teaching Decisions (TD) simulation to study lesson planning patterns of preservice and inservice teachers. The current study continues research along this strand.

Description of the Planning Simulation

The latest Visual Basic version of the TD Simulation enables participants to conduct a pupil familiarization task and specific lesson planning tasks.

Pupil Familiarization

The familiarization task allows the participant to study key characteristics of the simulation class' six software-defined pupils before making any planning decisions. Via simple mouse clicks, the participant can link pupil names and pictures to key personality and academic characteristics. Individual pupil note lists can also be easily constructed. These window-lists are immediately accessible during any of the subsequent phases of the lesson planning.

Pupil Spatial Assignments

The spatial assignment task enables the participant to position each pupil in the classroom, to select aids including a blackboard or a computer, and to determine with whom, if anyone, the pupil will work during the lesson. These assignments (or reassignments) are accomplished via click-and-drag actions.

Pupil Activity Assignment

This task enables the participant to assign lesson activities to each pupil or pupil group. A spin button facilitates tapping a master list of 8 activity options to create pupil or group activity assignments. An additional option is also provided for adding participant-authored activities to the list.

Teacher Commitments

This final task allows the participant to decide the amount of time that the teacher plans to spend working with individual pupils, groups of pupils, and the entire class. As with activity assignment, a spin button facilitates the mechanical aspect of this decision-making process.

While the task sequence listed above maps out a logical decision-making path, each participant has complete freedom to move to and from any task at any time during the simulation. Likewise, previous decision-making information (the notes collected on individual pupils or spatial, content or time assignments)is immediately accessible via a single click.

Research Questions

This exploratory study addressed three sets of questions. First, the lesson-planning activities of the two samples of experienced teachers were compared. It is important to note that one sample was drawn from a group of teachers who were beginning an off-grounds master's program in teacher education; the second was drawn from a group of teachers who were completing the off-grounds program in a different setting. Specific planning differences across the two sites were assessed via a series of analyses of explicit planning variables that included:

1. pupil spatial assignments with the simulated classroom;
2. pupil time allocations assigned to specific lesson activities; and

3. teacher time commitments to individual pupils, to work groups, and to the entire class.

The second question area addressed the relationship between the teacher planning variables and major teacher demographic variables. The third and most important question area concerned the types of planning patterns that teachers exhibited during their decision making. The entire data set was submitted to an analysis that would reveal whether such patterns existed, and if so, this analysis would further depict the major characteristics of the patterns.

Method

Participants

The samples for this exploratory study were drawn from two groups of experienced teachers enrolled in a University of Virginia off-grounds master's program in teacher education. Classes were held at sites in two metropolitan areas in central Virginia. These classes typically contain teachers from all grade levels who vary widely in teaching experience. During the summer of 1996, 53 students completed the lesson-planning simulation as a laboratory requirement in a learning and development course. Site A participants included 17 female and 5 male students who were beginning their graduate program in education; site B participants included 28 female and 3 male students who were completing the program. The participants displayed from 1 year to 29 years of teaching experience ($M = 8.12$, $SD = 6.74$).

Procedures

The class at each site was introduced to the lesson-planning task through a brief verbal explanation linked to clear visual depictions of upcoming activities displayed by an LCD projection unit. Next, groups of from 10 to 12 participants cycled through available computer work stations at 90 minute intervals. Each participant first completed a simple keyboard registration process and then reviewed simulation navigation instructions. The participant, assuming the role of a fifth-grade teacher, proceeded to complete the task of becoming familiar with individual pupils and the specific decision-making activities that comprised three lesson-planning tasks. The participant controlled both the task sequence and the amount of time devoted to each task. During the navigation process, major lesson-planning actions were stored in a sequential data file for future analysis. After completing the tasks, the participant clicked an *Exit* button to finish the simulation. Completion times ranged from 30 to 60 minutes. A short individual debriefing immediately followed the completion of the planning simulation. After all participants at a site had completed the simulation, they received a 30-minute group debriefing during which the entire class' collective results were viewed and discussed.

Statistical Analyses

A number of statistical tests were employed to address the three sets of research questions.

Site Differences

T-tests assessed group differences on three spatial assignment variables: computer assignments, blackboard assignments, and group assignments. A 2(site) by 4(activity type) loglinear model tested the interaction between the two sites and the four activity types. In this analysis, site designated the two teacher cohorts, and content type referred to four activity categories derived from Bloom's taxonomy of the cognitive domain (Woolfolk, 1993). These categories included knowledge, comprehension, application, and analysis-synthesis. Individual activity cell frequencies represented the number of teachers whose most-employed activity was defined by the cell's descriptor. A 2(site) by a 3(teacher commitment) loglinear model tested the interaction between the two sites and four teacher time commitment measures. Individual cell frequencies represented the number of teachers whose most-employed time commitment was to individual pupils, to groups of pupils, or to the entire class.

Planning-demographic Variables Relationships

Pearson correlation analyses were employed to explore the relationships between three demographic variables and the major simulation-generated planning variables. Demographic variables included gender, teaching-grade level, and years of teaching experience. Planning variables included the three spatial assignment measures, allocation measures for the four activity categories, and allocation measures for teacher commitments to helping individual pupils, groups of pupils, and the entire class.

Global Planning Patterns

Cluster analyses were performed on the entire data set to identify variable patterns that broadly defined how teachers approached the lesson planning task.

Results

Results obtained from analyses of group differences revealed that teachers at site B (where participants were completing the program) assigned more of their pupils to work with each other than teachers at site A (where participants were beginning the program), $t(51) = -3.01$, $p < .01$. No significant site differences emerged from t-tests applied to variables that defined teachers' use of blackboards or computers, $ts(51) = .09$ and $.87$, respectively, *ns*.

Regarding activity assignments, the loglinear model analysis yielded a significant group by lesson activity interaction effect, $c^2(3, N = 53) = 14.97, p < .01$. For site A, the analysis of simple main effects did not yield a significant difference, $c^2(3, N = 53) = 6.73$, *ns*. For site B, however, an analyses of simple main effects revealed a significant difference in teacher frequencies across the four activity categories, $c^2(3, N = 53) = 12.52, p < .01$. Teacher count was high in application activity and low in comprehension activity. No significant differences resulted when site comparisons were made across each of the four activity categories.

Regarding teacher commitments, the loglinear model analysis yielded a significant site by commitment interaction effect, $c^2(2, N = 52) = 20.23, p < .01$. For both sites, analyses of simple main effects revealed a significant difference in teacher commitment frequencies across the four categories, $c^2s(2, N = 52) = 27.91$ and 9.17, respectively, $ps < .01$. For site A, teacher count was higher for individual pupil commitments than for group or class commitments. For site B, teacher count was higher for individual pupil and group commitments than for class commitments. Further analysis revealed a significant site difference for teacher class commitment, $c^2(2, N = 52) = 8.07$, $p < .01$. Teacher count was lower on this variable for site A participants than for site B participants.

Only one significant relationship emerged when the 10 lesson-planning variables were compared with the three demographic variables. Female teachers were more likely than male teachers to assign their pupils to computer stations, $r(51) = .30, p < .05$.

Relating to questions pertaining to lesson-planning patterns, the results of cluster analyses yielded three distinct groups. The 3 teachers comprising the first group had relatively long teaching careers, were relatively low in assigning pupils to work together, and were relatively high in committing themselves to interact with the entire class. The 32 teachers comprising the second group had relatively short teaching careers and were relatively high in committing themselves to interact with groups of pupils. The 14 teachers comprising the third group were relatively high in both assigning pupils to work together and in committing themselves to work with individual pupils.

Discussion

Several interesting conclusions can be derived from the results of this exploratory study. First, it appears that teachers in the two target sites differed in their approach to the planning simulation. Teachers at site B (those completing the graduate program) stressed more cooperative pupil interactions and showed a more distinct activity assignment pattern and more complex teacher-time commitment assignments than did teachers at site A (those beginning the program). These group differences may merely reflect site conditions, or they may suggest that experiences within the master's program influenced the teachers' attitudes concerning the importance of cooperative learning, application-based activities, and personal involvement at all levels of student interaction.

Distinct patterns emerged from the cluster analysis even though this statistic was applied to only a few preliminary variables. Teaching experience and four decision-making variables defined the three clusters. The first and smallest cluster included participants with relatively long teaching careers who gravitated toward committing their time to the whole class and tended to de-emphasize the importance of pupils working together. The second and largest cluster included participants with relatively short teaching careers who preferred to work with groups of pupils. The third cluster included participants who emphasized cooperative learning while providing teacher help to individual pupils.

The strength of the results justifies the continuation of this research strand. We are particularly interested in better understanding the variations in strategies that experienced teachers employ in their lesson planning. Discovering additional variables for inclusion in cluster analyses is a first step toward achieving this goal. An initial viewing of the data files of individual participants produced several promising additions to the current pool of variables. These additions included teachers' note-taking behavior, use of classroom equipment, and activity authoring.

In conclusion, the results of the current study provide important insights into the way that experienced teachers plan lessons. To add clarity to the current strategic profiles, however, not only must additional variables be added to the existing pool, but the study must be replicated with a variety of teacher cohorts. The information we learn about successful lesson planning from our experienced teachers will become part of the feedback that our preservice teachers will receive as they continue, during the TD simulation assignment, to develop their own personal planning strategies.

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SOCIAL STUDIES

Section Editor:
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The papers presented in the social studies section offer a variety of ideas regarding the successful integration of technology in social studies preservice and inservice education. A theme running through each of the papers focuses on the potential power of technology for transforming social studies education. Suggested applications in the papers include internet and telecommunication, software use, and multimedia project development activities. Important issues and trends are also discussed in each paper with a strong emphasis placed on preservice teachers and students having a variety of hands-on experience with the technology.

Ledford and Hattler suggest that technology should be a tool to enhance the relevance of social studies for students. Their paper outlines internet applications in social studies methods and offers sample web sites that students included in planned units. The authors state that technology skills enable teachers and students to meet the challenges in education and the world.

Murray also focuses on internet applications for preservice teachers by integrating a variety of activities in social studies methods including e-mail, information seeking, listservs, and on-line mentoring. The author conducted a study of students' attitudes regarding computer and internet usage through a pre and post application survey. Initial findings indicated positive change among participants. Additional data analysis is forthcoming.

Cole Slaughter discusses a project that integrates multimedia and information literacy in social studies methods. The author developed a survey to determine student attitudes regarding technology. A model consisting of structuring, acquiring, analyzing, and synthesizing information (SAASI) was also designed to faciltiate awareness of computer technologies. The author concludes by suggesting that educator-librarian partnerships can offer much in advancing information literacy and technology integration.

White suggests the merging of constructivism and technology to provide a transformative approach to social studies education. The author proposes a variety of technology applications in preservice social studies including telecommunications, software reviews and application, project development using authoring and presentation tools, and applications with students in classrooms. Integrating technology with the constructivist model including, modeling and applying, reflecting, involving students actively, and developing a community of learners is proposed.

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MAKING CONNECTIONS: SOCIAL STUDIES METHODS AND THE INTERNET

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Social studies teaching today presents challenges for teachers, new and experienced, with increased demands from our society and the world. Documents of reform such as Goals 2000: Educate America Act and Curriculum Standards for Social Studies (1994) call for a type of social studies instruction different than most preservice teachers experienced in their own schooling. Moreover, the National Council for the Social Studies (1992) in its standards for the preparation of social studies teachers, emphasizes the need for deliberate planning in the social studies:

> ...courses in social studies methods should prepare prospective teachers to select, integrate, and translate knowledge and methodology from history and social science disciplines in ways appropriate to students in the school level they will teach and give attention to the goals unique to the social studies and those shared jointly with the other areas of the school curriculum. Students should also be able to teach social studies utilizing a variety of curriculum approaches and in different types of settings.

To prepare teachers for the future, we must model the use of technology as a tool to connect the social studies to the world that is relevant to the student.

In the past social studies teachers were slow to integrate computers into their teaching. This was partially due to the limited amount of social studies software (Schug, 1988). However, the most meaningful learning takes place when students interact with concrete materials. Students have greater understanding when experiences are meaningful and manipulable. The computer environment offers equal, perhaps even greater control and flexibility to young students (Clements, Nastasi, & Swaminathan, 1993). Computer-based telecommunications through the Internet and on-line services provide tremendous potential for social studies instruction, involving students as active learners.

Testimonials abound from students and teachers concerning the usefulness of technology in the classroom. Teachers have reported that students as young as kindergartners use and eagerly await their turn on the computer. Young students can work in small groups and concentrate on computer learning tasks for long periods of time. Certainly, the potential for both learning and teaching has been minimally realized with technology as it is used today in social studies classrooms. Current social studies methods' textbooks focus on the computer software for games, simulations, and databases. Limited discussion on the potential of the Internet is found (Chapin & Messick, 1996; Maxim, 1995; Michaelis & Garcia, 1996; Parker & Jarolimek, 1997).

What role can the Internet play in social studies instruction? Frankly, the value of the Internet lies in its users. Access to the Internet is available to both preservice teachers and students alike. The Internet stimulates curiosity and eagerness to learn. On-line, all students and teachers enter into a world beyond the walls of the classroom where they discover geography, social studies, politics, history, and current events. Unique opportunities for teachers and students include collaboration with other classrooms around the world, as well as accessing and retrieving information for use in their own classrooms. By connecting to the world via the Internet, preservice teachers, side by side with their students, overcome the traditional barriers of the classroom or building.

Preservice teachers use the Internet to find resources for a thematic unit, a requirement in the social studies methods course. Prior to this course, preservice teachers had an introductory Internet experience. To further explore the ever-growing possibilities of Internet resources of lesson plans, primary sources, documents, and data collection is their present assignment. The preservice teachers navigate through a myriad of links as they interact with on-line resources. Then, they integrate their Internet findings into social studies units.

Some examples of Internet resources included in preservice teachers' units were:

The Census Bureau: http://www.census.gov

Students examine information about any city in the United States by accessing this Web site. Census data helps students discover the needs of the people of the city which they investigate. Population data answers questions for students about the number, ethnicity, and age of people who live there. Relevant subjects on-line include: county and city data book, county profiles, economic information, household economic statistics and voter registration.

The Constitution:
http://www.1m.com/~cjp/whig/Constitution.html
This location provides the complete text of the Constitution of the United States and the amendments. By using this site students can explore the document to make discoveries about the electoral college.

The Jefferson Project:
http://www.voxpop.org/jefferson/
The Jefferson Project is a comprehensive directory of on-line politics. Included are mailing lists of web pages for the White House and all members of Congress. Two features include Netgrams and The Zipper. The Zipper allows you to enter your zip code to determine the members of the House and the Senate that represent you. It also allows you to communicate directly via e-mail or visit their home page. Students can send messages to the President or any member of Congress.

Map Quest: http://www.mapquest.com
Students can visit the small towns and cities of our country. They can plot an imaginary school bus trip to each location from their own hometown by using Trip Quest. This feature provides city-to-city directions and interactive maps. By opening Map Room, students can sharpen their knowledge of cartography.

Smithsonian: http://www.si.edu
This location, giving the history of the institution, links students to the 16 Smithsonian museums and the National Zoo. Its graphics bring this on-line tour of the Smithsonian to life.

Thomas: http://thomas.loc.gov
This site is a service of the U.S. Congress through its library. Floor activities are published each week. Major legislation, by topic, and bills, by number, can be followed. Bill texts from the 103rd and 104th Congresses can be read. Committee reports and home pages for members of the U.S. House and Senate are included. Historical documents, such as the Declaration of Independence and the Constitution, are accessible at this location.

Washington Post:
http://www.washingtonpost.com
Students can read and discuss the latest national and world news. In addition, students can locate updated weather reports to examine the weather at a variety of locations.. Stock quotes and other financial and business topics can also be accessed.

Welcome to the White House:
http://www.whitehouse.gov/WH/Welcome-plain.html
The White House location provides a variety of information about the President and the Vice President, the Virtual Library containing White House documents, audio speeches, photos, and White House for Kids sections containing helpful hints for students to become more active and informed citizens.

Yahoo News Summary:
http://beta.yahoo.com/headlines/current/news/summary.html
Students can read the top news story of the day by contacting this location. Yahoo News Summary includes ten news headlineswith a paragraph about each.

If we are to meet the challenges in education, we must provide preservice teachers with the skills and opportunities provided through technology. As preservice teachers create effective units using the Internet, they begin to take advantage of the possibilities its resources provide. It is therefore incumbent upon all educators to modify traditional curriculum to reflect contemporary technology and explore cyberspace.

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Internet Activities for Preservice Social Studies Teachers: An Exploratory Investigation

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Butler and Clouse (1996) note that each generation is presented with new technology that promises to be a cure-all for our instructional needs. In the 1940's the technological device promising to solve education's problem was the radio. During the 1950's it was television and late in the 1960's the computer was touted as being able to make student learning painless and more comprehensive while increasing productivity and excitement in the classroom. As we approach the conclusion of this century, the microcomputer is still being hailed as a technology that can revolutionize classroom teaching.

Becker (1986) reports that during the short period between 1983 and 1985, U.S. schools quadrupled their numbers of microcomputers from about 250,000 to over one million. Ross (1991) indicates that the most current statistics available indicate that of all U.S. middle and high schools, 95% and 97% respectively, use microcomputers for instruction. However, Risinger (1996) concludes that social studies teachers are the biggest laggards in utilizing microcomputers and information technology in the schools.

Searching to discover why social studies teachers are considered to be laggards in using microcomputers, White (1988) found that lack of training opportunities was a significant inhibitor of greater technology use. His research also found that teachers did not believe that there was sufficient inservice or preservice preparation for integrating microcomputers into social studies teaching and curricula. Moursund (1992) concludes that the need for our educational system to empower teachers to make appropriate and effective use of computer related technology is well documented.

Purpose

This paper will describe an exploratory effort (by an instructor with minimal experience with microcomputers) to introduce and assess the implementation of selected internet activities for preservice teachers in an undergraduate social studies methods course. Prior to mid-January, 1996, my experience with microcomputers was limited to word processing and a brief introduction to e-mail. I had no e-mail experience outside my own institution and I had no experience with listservs, or internet information seeking strategies.

As I started to explore the possibilities of the internet and as my own skill in the use of microcomputers started to develop, I concluded that the social studies methods students needed to be empowered to become proficient in using several computer applications relevant for professional educators. I designed a set of class activities dealing with computer applications to promote the sense that these preservice teachers could learn any new computer application without anxiety or excessive amounts of time or energy. I was hopeful that the activities would also promote an image of a professional teacher using computers to make teaching and learning more productive for themselves as a professional and for their students as learners.

Sample/Data Collection

The sample for this exploratory effort consisted of the twenty-five students (20 males; 5 females) who were enrolled in the social studies methods course during the 1996 Fall semester. Five students reported that they had prior experiences with e-mail and internet information seeking strategies. In an attempt to determine student perception of their overall knowledge of using microcomputers prior to class activities on computer applications, they were asked to indicate their knowledge on a 5-point scale (1= "none", 2= "minimal", 3= "adequate", 4= "more than adequate", 5= "superior"). The pre class activities mean for overall microcomputer knowledge was 2.52, placing the sample at mid point between minimal and adequate. The same mean for the five students who reported prior computer experience was 3.8.

Additional pre data collection consisted of administering the Computer Anxiety Rating Scale (CARS) based on an instrument developed by Raub (1981). I used the

Anderson (1996) modification in which the word microcomputer was substituted for computer. According to Anderson (1996), the Cars is a self-report inventory consisting of 10 statements designed to measure computer anxiety. The scale comprises a mix of anxiety-specific statements (e.g., "I feel apprehensive about using the microcomputer") and positive statements (e.g., "I am confident that I could learn microcomputer skills"). The scale is scored on a five point Likert scale (1= "strongly agree", 5= "strongly disagree"). The anxiety-specific statements were subsequently reverse scored before calculating anxiety scores. The scores range from 10 to 50. A score of 30 is used as the breakpoint between low scores and high scores on the computer anxiety scale. Those who score 30 or less are considered to be not anxious about using the microcomputer. Scores in excess of 30 are taken to indicate moderate to extreme anxiety about using the microcomputer. The pre class activities mean for the CARS was 22.68 which means that the class can be characterized as fairly comfortable with computers. Only four students scored in excess of 30 on the pre test.

Computer Activities

E-mail

During our initial class session we spent time in the microcomputer lab where each student activated their e-mail accounts and practiced sending messages to one another. Students were asked to select a special issue of *Social Education* for an upcoming assignment and I asked them to e-mail me before our next class session and provide a complete bibliographic citation for the issue they selected. Each student successfully completed this assignment.

Information Seeking Strategies

The next class session provided students with instruction for using search engines to seek social studies information and how to access a World Wide Web (WWW) site when they know the Uniform Resource Locator (URL) or address. During the week, I met with students in small groups to provide them opportunities to practice the information seeking strategies. The assignment for the information seeking segment of the computer activities was to select a social studies topic suitable for students in grades 5-12 and to identify 5 Internet/Web sites that focus on the topic. I want them to critique the information found in terms of whether they feel it would be useful/not useful to them as a teacher.

Listserv

The next activity was to ask each student to subscribe to a listserv for high school social studies teachers. I selected the H-HIGH-S listserv because it is the most active of the listservs to which I subscribe. Subscribers receive 10-15 posts each day. The H-HIGH-S listserv is described as a discussion group designed to facilitate an ongoing exploration of curriculum, instructional strategies, and educational resources involved in teaching history, social studies, and related subjects in secondary schools. I have asked students to use the listserv as a resource and no assignments were made for making a set number of posts to the listserv. Students were encouraged to send messages to the listserv if they felt that a response was appropriate. As an assignment, I asked students to select a thread that appears on the listserv, represented by at least 10 posts, and summarize the different points of view represented by the posts. As a soon to be teacher, I want them to reflect on these ideas/suggestions and discuss their response to the topic/issue. As always, I want them to provide a rationale for their response.

On-line Mentor Activity

The final computer activity was to assign each student to an on-line mentor. The on-line mentors are social studies classroom teachers from across the U.S. and Canada. I secured teachers to serve as mentors by sending a post to three social studies listservs and the response from classroom teachers was extremely positive. I had response from 35 teachers who were willing to participate with my class of 25 students.

The positive nature of the response to my request is reflected in the following excerpts from posts received from teachers. One teacher said: "This sounds like something neat and I am willing to help out in whatever way I can" (personal e-mail communication, July 19, 1996). After receiving an initial post from a student in my class, an on-line mentor posted me: "Shortly after I received your letter I also received a letter from my student. This is a very unique experience both for the student and myself. Thank you for inviting me along for the ride" (personal e-mail communication, September 11, 1996).

The students are expected to communicate by e-mail with their on-line mentors at least once a week until the end of the semester (12 weeks). I am asking students to summarize the topics discussed with their on-line mentors and to reflect on what they carry away from these discussions and why these ideas are important to them.

Tentative Conclusions

Although I have not had an opportunity to view and reflect on all the data related to this exploratory investigation, I feel that the outcome will be positive from both the preservice teachers and the on-line mentor teachers. An on-line mentor teacher recently posted me:

Your student and I have been keeping in touch almost daily. It has turned into a great intellectual discussion of all the major areas of education. From your student, I have had the opportunity to assess my own educational values of almost 33 years. Your idea was a great one - an on line education course. (personal e-mail communication, November 9, 1996)

I also noticed a listserv message which addresses the potential of the on-line mentor aspect of this project. A teacher posted:

> Has anyone ever thought of connecting themselves with a teacher-partner through this listserv? I recently thought about all of the benefits a permanent teaching "buddy" would bring to both teachers, schools, classes, and students. Would anyone care to dance with me (be my teaching buddy)? (i.e., to share ideas, contact each other on a daily basis, discuss new web sources, strategies, controversial issues, relate differences in school administrations, theories on teaching history... (H-HIGH-S Listserv Digest, October 21, 1996)

Only one student has indicated to me that discussions with the on-line mentor teacher have not been as productive as the student anticipated. The student feels that the on-line mentor was very quick to reject the value of questions initiated by the student during the exchange of posts.

Two students reported positive initial interactions with their on-line mentors in regard to the H-HIGH-S listserv. In one instance, in an early post to the student, the on-line mentor suggested to the student that it would be a good idea for a preservice social studies teacher to subscribe to the H-HIGH-S listserv. The student was excited to be able to communicate with the on-line mentor that our entire class had already subscribed to H-HIGH-S. The other student mentioned to the on-line mentor that our class had subscribed to the H-HIGH-S listserv and described the posts that were on the list. The on-line mentor responded by asking how to subscribe and the student reported how good it felt to be able to provide the information for the on-line mentor.

Work In Progress

This is a work-in-progress and I will not collect all of the assessment data until the end of the Fall semester (12/13/96). Quantitative data will consist of pre and post scores on the Computer Anxiety Rating Scale and a self report of knowledge of using microcomputers. I will also collect data on how they have used the microcomputer during the semester. Qualitative data will be provided by reviewing student reflections on the listserv and e-mail mentor assignments, and a series of open ended questions that I will ask each mentor to respond to at the conclusion of the project.

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Incorporating Information Literacy and Multimedia in Elementary Social Studies Methods

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The acronym, SAASI (Structure, Acquire, Analyze and Synthesize Information) describes the partner-ship that heightens prospective teachers' awareness of communication and computer technology. Following a presentation in an university library of the SAASI concept, information literacy, the World Wide Web (WWW) and CD-ROM multimedia, students gain hands-on experience by independently exploring the electronic encyclopedias and social studies Web sites available. The course instructor schedules in-class time for teamwork and hands-on experience using a computer in an elementary social studies setting. Also, future teachers go to various computer labs on campus and in their communities to practice using electronic mail (e-mail) to provide feedback for the required presentation.

From examining the students' reactions to all aspects of the classroom strategy (presentation, demonstration, and independent exploration of multimedia technology) in the last three years, feedback supports the idea that the library field trip has a positive impact on awareness. The following are some student comments that provide a sample of the types of responses the educational technology field trip evoke.

Table 1.
Sample Responses from E-Mail

- I have always resisted technological changes. I learned, however, of the many benefits that technology can have in the classroom, and only hope that my own intimidation will not affect the use of technology, in my future teaching career.
- I learned a great deal about CD-ROM. I also learned of the different maps and pictures and children's books.
- The use of computers for research is overwhelming and I sometimes feel as if I don't know where to begin. As a result of demonstrations in class, I feel more at ease about using computers, but realize it requires practice and time.
- I especially liked to look at the CD-ROM. I was never exposed to this information and I was excited at the prospect of being able to use it in my unit planning. I also appreciate the tour given throughout the library showing all the useful data and materials that I could use to supplement my unit plans.
- I learned a lot about the new technology that will hopefully be available in my classroom. The CD-ROM software is amazing!
- I was amazed by the "electronic encyclopedia" on CD-ROM!
- Actually, this is my first time using E-Mail and I'm kind of excited. I went through this about three times before I got it right.
- The presentation on media resources was very helpful. I learned how to use some of the multimedia and internet services, I have never used before. Earlier today I did some exploring on my own. I found lesson plans and pictures I can use for future lessons and units.
- I was fascinated by the capabilities of the CD-ROM! I have since visited the "electronic encyclopedia" in the Media Resources Department.
- I especially enjoyed learning more about the internet. We are using the internet in my Pedagogy 2 class and I had very little prior knowledge on the topic.
- ...the library field trip was informative. I have never used a CD-ROM, but I've always wondered about them. I can see how a child would really enjoy using a CD-ROM in the classroom. Also, it is so easy. I was very surprised by that!

These comments from prospective teachers who were enrolled in elementary social studies, suggest a clear direction for implementing computer technology in the curriculum to prepare future teachers.

Methodology

To assess information literacy skills, the course instructor and the university librarian designed a 21-item questionnaire. All students enrolled in the author's sections of elementary social studies completed the questionnaire during the second week of the semester. The types of data collected in the study over a three year period (1994-1996) include students' demographic information for 120 students and a Yes/No response to 17 items dealing with their awareness and hands-on experiences with computers and communications technology. For example, the study collects data on prospective teachers' familiarity with: facsimile, e-mail, the World Wide Web, and CD-ROM multimedia. Four of the questions ask students to name an educational journal in each of three designated categories of writing; for example, scholarly, practitioner, and popular treatment. These items give the SAASI team the opportunity to collect information on the types of journals students group in the three categories.

The course instructor discusses various definitions of information literacy in class prior to the scheduled field trip to Media Resources. Immediately following the field trip, the instructor uses a series of open-ended questions to debrief each class and facilitate student interactions to evaluate the importance of the trip. The class uses the remaining class time to become familiar with the computer, and sign-up for hands-on activities with teams. The instructor observes the student teams during class, only offering assistance when asked. In the following two weeks, students communicate their reactions to computer technology using their electronic mail (e-mail) accounts.

Figure 1 displays the changes in the percentage, between 1994 and 1996, for prospective teachers responding to items that deal with their familiarity of computers.

Prospective Teachers: 1994-1996
Familiarity with New Educational Technology

Technology	1994	1995	1996
CD-ROM	18%	31%	41%
Videodiscs	26%	17%	11%
Databases	36%	42%	25%
Modem	21%	46%	46%
Internet	21%	54%	73%

Figure 1: Prospective Teachers: 1994-1996. Familiarity with New Educational Technology

The Setting and Pre-Service Teacher Profile

Indiana University of Pennsylvania (IUP) is a comprehensive regional university in southwestern Pennsylvania. IUP offers a broad range of undergraduate, masters and doctoral level programs, and is the second largest institution in Pennsylvania that prepares teachers. Starting as a normal school in 1875, IUP has grown to approximately 14,000 students. The major education programs, Early Childhood and Elementary Education, are housed in the Department of Professional Studies in Education. Approximately 150 elementary education students responded to the questionnaire. The respondents are mainly female (74 to 83 percent), college seniors (80 percent) who have attended Pennsylvania public schools in rural and suburban areas. Ninety-eight percent of all students enrolled in elementary social studies are Caucasian, which is typical for elementary classroom teachers.

Description of the SAASI Partnership

Enabling future teachers to develop competencies in computer technology is an essential responsibility of teacher preparation programs (Hess, 1990; Cole Slaughter and Knupp, 1993.) To respond to this challenge, a social studies educator and a university librarian initiated a partnership using the acronym, SAASI (Structure, Acquire, Analyze, and Synthesize Information). The SAASI partnership is designed to heighten prospective teachers' awareness though hands-on experiences and independent exploration of the available computer technologies.

Figure 2 illustrates the SAASI partnership model by describing the acronym and information processing skills.

A SAASI PARTNERSHIP

S ▪ *structure addresses how information is organized or put together.*

A ▪ *acquire addresses how to obtain the information.*

A ▪ *analyze requires students to critically examine the information and ask questions such as:* What is it? *and* What is the information telling me?

SI ▪ *synthesize information requires the student to make the information part of her/his own database by integrating it into a cohesive whole.*

Figure 2. A SAASI Partnership

In our discussions of SAASI, we use the term *multimedia* to mean an integrated package such as CD-ROM or interactive video discs. We have introduced Geography Pal Ted in CD-ROM fomat to model how integrating technology in elementary social studies classrooms can be a powerful tool to engage young children in social studies.

Information Literacy and Multimedia - The Approach

As a theme, information literacy is a often discussed concept and there are differing viewpoints. A number of people from library science and teacher education have been involved with defining information literacy and how its concepts can be integrated into the teacher education curriculum (Breivek, 1991; Fielder & Huston, 1991; Behrens, 1994; Lenox & Walker, 1994; ASCD Update, March 1995). This study uses the concept of information literacy from Doyle (1992) who defines it as the ability to:

- recognize a need for information,
- identify and locate appropriate information sources,
- know how to gain access to the information contained in those sources,
- evaluate the information obtained, and
- organize the information; and use the information effectively.

The strategy to incorporate information literacy and multimedia into social studies education examines the following aspects of being information literate:

- knowledge of various sources of social studies information,
- understanding how information is structured in these sources, and
- skill in delivering instruction using multimedia technology.

The decision to implement a classroom strategy to integrate information literacy and technology into the social studies classroom is an effective way to provide positive contact time with the computer and involve future teachers in exploring CD-ROM multimedia.

Discussion - Summary

The in-class survey results measuring information literacy suggest that prospective teachers continue to employ traditional media such as video-tape, camera, transparencies and the slide projector, which are twice as familiar to them than newer educational technologies such as a CD-ROM drive and a modem. Approximately, eighty-seven percent of the students enrolled in social studies have used a personal computer and a printer. Compared with their familiarity using camcorders (82.1 percent), the CD-ROM multimedia technology is half as familiar (41.1 percent) as a tool to future teachers enrolled in a elementary social studies course.

The SAASI classroom strategy to incorporate information literacy and CD-ROM technology in social studies supports changes in curriculum philosophy that implements traditional media. The students' responses indicate a positive contact with computers which suggests that incorporating technology in unit planning for pre-student and student teaching experiences is a possibility. By presenting the concept of information literacy in the context of research and unit planning, prospective teachers increase their awareness of the different ways to deliver information given the various sources of information, many of which are technology based. From the reactions to the field trip for educational technology and the incorporation of CD-ROM multimedia to deliver instruction , it would appear as if an educator-librarian partnership has a great potential for advancing information literacy and integrating technology into education. This must be a goal in elementary social studies and in teacher preparation programs.

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PRESERVICE TO THE "REAL WORLD": TRANSFORMING SOCIAL STUDIES THROUGH TECHNOLOGY

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Integrating technology throughout all levels of social studies education including preservice teacher education and K-12 classrooms is vital if we are interested in a transformative rather than a transmission or traditional approach to social studies. This paper discusses the status of social studies education, status of technology integration within social studies education, and provides models and examples for transformative approaches to technology integration in social studies education. The goal is to suggest that technology can provide opportunities to make social studies education empowering and transformative, but meaningful, student-centered, constructivist approaches are vital. It is also suggested that the transformative approach begin in teacher education with empowering technology and constructivist integration.

Social studies education remains dominated by tradition. Students are forced to participate in traditional endeavors dominated by direct instruction and an expanding environments and often chronological curriculum, designed decades ago. Social studies instruction remains primarily teacher centered, with lecturing, reading the text, completing questions, and taking tests the dominant activities (Ellis, Fouts, and Glenn, 1992). A question is whether this traditional arrangement facilitates the development of students who can think for themselves and participate as responsible citizens in a changing world. Students are now challenging the relevance of social studies education. We must begin making a difference first in teacher education.

The National Council for the Social Studies recently established new curriculum standards for social studies (National Council for the Social Studies, 1994). "The integrated study of the social sciences and humanities to promote civic competence" was adopted as the formal definition for social studies. The new curriculum standards are organized into a framework of ten themes incorporating fields of study that correspond to relevant disciplines. These new standards provide direction for a more transformative approach to social studies education. Social studies methods should follow the lead.

The general goal of this endeavor is to stress the importance of technology integration throughout all levels of social studies education by focusing on the need to begin in teacher education and ensure support once teachers enter the "real world." The intent is to demonstrate examples for successful application and initiate a dialog for continued improvement. Examples include evaluating and using commercial software and multimedia, evaluating and developing projects using interactive software including Hyperstudio and Powerpoint, and interacting with the world wide web.

Starting with Preservice Education

Social studies teacher preparation is often questioned regarding the issue of meeting the needs of prospective teachers and educational needs in our society. As a result, many alternative approaches have emerged to address this issue. Traditional pre-service programs in colleges of education must change to meet the needs of educating teachers for our society. The state of Texas has assisted this effort by requiring school-based teacher education and establishing the Centers for Professional Development.

Such efforts provide impetus to the needed changes, but if pre-service courses are still taught traditionally in K-12 schools, little relevant teacher education is occurring. Often one finds courses taught through direct instruction or transmission of knowledge with students only observing in the school-based classrooms (O'Loughlin, 1989). Instruction in schools is primarily the transmission of knowledge rather than the process of interaction and construction of knowledge (Shor & Freire, 1987). The goal should really be to model effective teaching and learning, thus the pre-service methods courses should focus on a transformative approach.

This transformative approach to teacher education requires massive restructuring of the way we have always done things. Key elements include modeling "powerful" pedagogy that requires teaching and learning that is meaningful, integrative, value-based, challenging, and active (National Council for the Social Studies, 1994).

Related components to be integrated suggest aspects of constructivism that include modeling/applying, reflecting, involving students actively, and developing a community of learners (White, 1995). Constructivism empowers students to ask their own questions and seek their own answers (Brooks and Brooks, 1993). We cannot continue to teach the way we were taught! The integration of technology can play a central role to the achievement of transformative social studies.

Survey and Interview Results

The resulting social studies education courses were developed from four years of teaching similar courses and from surveys and interviews from pre-service teachers taking the course. Surveys were administered to 415 students at three large state universities over a four year period. Students were asked to agree or disagree with a series of statements using a Likert-type scale, with 1 representing strongly disagree and 5 representing strongly agree.

General findings indicate that pre-service teachers feel that social studies education focuses on knowledge and comprehension (74 % chose agree or strongly agree), direct instruction (83% chose agree or strongly agree), is text-based (78% chose agree or strongly agree) and is boring (86 % chose agree or strongly agree). Fifty-three percent (53%) agreed or strongly agreed that social studies should be critical and controversial. Fifty-eight percent (58%) agreed or strongly agreed that process is more important than product in social studies.

Survey findings also indicate that pre-service social studies teachers have mixed feelings regarding the successful integration of technology in teacher education, but feel that it is important in teaching. Students feel similarly in regard to student-centered approaches in social studies education. The findings indicate that close to 100% of the pre-service social studies teachers feel a student-centered approach is "definitely" important and that both technology integration and student-centered instruction "definitely" facilitates relevant social studies education. Students generally had mixed feelings regarding the value of all methods courses and teacher-centered instruction in schools.

Additional comments from survey participants included calls for additional technology integration and instruction in pre-service teacher education and more modeling of "constructivist" ideas. Concerns expressed included the need for continued technology and constructivist follow-up once students have their own classrooms. The survey findings are supported in random interviews from survey respondents. Sample responses follow:

"Social studies is rarely taught, and when it is, all you see are lecturing and dittos."

"The most creative thing I've seen in schools is playing Jeopardy to review for a test."

"We've got to do a better job with technology. It can really make a difference."

"Students just seem to tune out when the teacher always lectures during social studies time."

"Involving students in their own learning must be the approach in social studies education...technology helps with this."

From Preservice to the "Real World"

General goals for all levels of social studies education emerging from the previous information include developing an understanding and appreciation for social studies, developing creative, challenging, and student-centered applications for use in the classroom, and developing an awareness of transformative approaches to social studies education.

A constructivist or student-centered orientation to teacher education is important if we are to encourage students in schools to develop problem solving and critical thinking skills, and to apply, analyze, synthesize, and evaluate knowledge, skills, and attitudes. Pre-service teachers should engage in these processes throughout the entire teacher education program if we have any hope for a transformative approach in the schools themselves. To transform teaching, teachers need to implement experiential learning in their classrooms (Hope, 1996).

According to White (1995), general goals for teacher education should include providing experiences and expectations that help teachers develop professionally, facilitating constructivism through modeling and applying, reflecting, involving students actively and developing a community of learners, generating a passion for teaching and learning, developing critical thinking and problem solving skills, and integrating transformative, non-traditional curriculum and instruction.

Technology is a major component of a constructivist approach and should be integrated throughout a social studies education. Information technologies motivate, provide variety, promote meaningful learning, and facilitate interactive instruction (White, 1992; Faison, 1994). Goals for integrating technology in teacher education beyond introductory courses according to White (1995), include developing an awareness of available hardware and software for use in schools, evaluating hardware and software available for use in schools, applying packaged software during all preservice teacher education experiences, applying emerging technologies including multimedia and telecommunications during all preservice teacher education experiences, developing and applying lessons and units integrating technology, and engaging in problem solving activities regarding technology issues in schools.

The instructors should practice constructivism by indicating that students should be responsible for constructing their own learning. The focus of all activities is practical application into the classroom.

Social studies teacher education should be project-based and process oriented including the development of social studies projects focusing on general social studies activities, inquiry, literature, technology, simulations, learning centers, and cooperative learning. A thematic focus is also essential if we are to model expectations for the preservice teachers' future classrooms. Students should be involved through a negotiation process in deciding course projects, themes, discussions, and assessment.

Technology integration should play a central role throughout the social studies. There really needs to be access to a lab or computers in the classroom. Even one computer that can be used as a learning center, presentation tool, or web access machine would offer huge possibilities. It is important that the instructor apply technology throughout the course and that technology be integrated in all projects. Commercial software integration in units, multimedia development, management through technology, and web integration are each powerful applications that will facilitate a transformative social studies. Preservice teachers and all students must be provided hands-on opportunities with technology and to integrate it in their teaching.

School-based teacher education programs are definitely a step in the right direction if an important goal for prospective teachers is promoting meaningful classroom interactions. Pre-service teachers must be provided ample opportunities to interact with students in classrooms in a variety of ways. Having methods class take place out in the field is also a good thing, but they must not be taught traditionally.

The merging of technology and constructivism offers much hope for the future of social studies education. A constructivist orientation to teacher education is important if we are to encourage students in schools to develop problem solving and critical thinking skills, and to apply, analyze, synthesize, and evaluate knowledge, skills, and attitudes. Pre-service teachers should engage in these processes throughout the entire teacher education program if we have any hope for a constructivist approach in the schools. It is important to note that teacher education doesn't stop with the granting of a degree or license. Schools and universities must make a concerted effort to improve their relationships to facilitate lifelong teacher education. Technology integration could and should assist with this endeavor.

Integration Examples

Teacher education faculty must model and apply constructivist praxis and preservice teachers must be actively involved at all levels of the teacher education program for constructivism to have any chance in our schools. Modeling and applying constructivist ideas in social studies education should be accomplished by both the instructor and students. The role of technology in modeling and applying should include demonstrations by the instructor and students, integration of technology into daily activities, and application of technology by students into class projects and field experiences.

Examples might include demonstrations of exemplary packaged software for instructional or management use or the application of more powerful and interactive authoring and multimedia programs. Daily use of technology is essential, as is the development of technology classrooms. With technology classrooms students could work individually or in small groups at technology centers designed to enhance class activities and projects. Students should also be asked to integrate technology into demonstrations or lessons for the class and field experiences.

Reflection is another essential component of a constructivist teacher education program. Technology lends itself very favorably to individual and group reflection. Students should be asked to reflect often in class and through a variety of methods. Word processing is an obvious method for reflection, but emerging technologies such as E-Mail, the Internet, and blank databases are other arenas enabling reflection.

Examples applying emerging technologies could ask students to send e-mail messages to each other and to the instructor, as well as over the Internet, reflecting on various issues essential to preservice teacher education. Technology links between the university and the schools for sharing and reflection should also be a goal for teacher education. Again, this should be integrated as a daily, or at least weekly activity in teacher education programs.

A particular goal in the design of social studies curriculum is the development of critical thinking and problem solving. Controversy is good in the social studies, therefore a value-based and challenging curriculum promotes reflection. The philosophy is that teachers should make time and in their classrooms to promote the development of relationships for individual and shared reflection. Every activity and assignment should have a reflection component built in with all activities and projects shared to encourage critique and further reflection. This can be accomplished through a variety of assignments individually, in small groups, and in the whole class discussions.

Another important component of constructivist programs is active student involvement. It is absolutely essential that teacher education programs move from instructor dominated modes to student centered methods of instruction. The integration of technology on a daily basis facilitates active student involvement. Class activities should be project based where students work individually or in cooperative groups to complete relevant activities.

Examples might include research projects, lesson and unit planning, development of learning centers and other student-centered projects, and activities integrating management, commercial software games and simulations, and multimedia software, as well as emerging technologies. Cooperative learning activities where students are encouraged to use the computers to gather research or interact through e-mail or the Internet to acquire information or ask questions programs would facilitate the integration of technology and constructivist ideas in teacher education. The application word processing, database, authoring, presentation, or multimedia would also help to achieve the goal of integration.

An essential component of a constructivist social studies classroom is student-centered, active involvement. This has been addressed somewhat in the sections on modeling and reflection. The intent is for students to be responsible for constructing their own learning by having a social studies a curriculum that facilitates active involvement. The suggestion is for social studies education to be project-based. Each project chosen can be modeled by the instructor and students present completed projects to class in small or large group format for reflection.

Possible projects related to the curricular themes might be presented to the students at the beginning of the semester for discussion. The class chooses projects to complete, prioritizes the projects and adds projects of their own. Examples for projects might include technology applications, simulations, community-based activities, problem solving, and other student-centered active learning activities. Specific social studies related topics and themes for projects, groups activities, and discussion within the class can be based on the new thematic stands for social studies mentioned earlier.

Developing a community of learners is also a major component of constructivist programs. Although addressed in modeling and applying, reflecting, and involving students actively, developing a community of learners is probably the key to a successful constructivist program and should be highlighted. Again, the integration of technology on a daily basis assists in the development of a community of learners. Technology labs and technology classrooms with computers available for a variety of uses including learning centers and project development facilitates the development of community.

Through the use of applying and modeling, reflecting, and involving the students actively, a social studies instructor will lay the foundation for a classroom comprised of a community of learners. A vital and relevant social studies curriculum can really assist in developing a classroom community. It is vital that the classroom environment and structure include the following components: creativity, humor, choice, variety, challenge, adaptation, and non-traditional curriculum and instruction in social studies.

A technology integration model consistent with the transformative, constructivist focus, described at length above, that includes the process of reviewing, exposing, modeling, applying, constructing, and evaluating involves students in the entire learning situation so that a change in attitudes regarding technology can occur. The real value of educational technology can be experienced by students who are able to apply technology in new situations. Students can become experts in various applications and are thus able to teach the applications to others. It is vital that technology be integrated throughout the social studies curriculum and be used by the students during all units.

Conclusion

We must strive to make social studies more meaningful for our students. The domination of the transmission of knowledge and traditional model in social studies education, has hindered education in this country. Social studies education should be modeled after a constructivist approach which stresses applying and modeling, reflecting, involving students actively, and developing a community of learners with a technology focus.

The integration of technology is important in teacher education; it is absolutely essential in a transformative, constructivist teacher education program. The major components of modeling and applying, reflecting, involving students actively, and developing a community of learners is facilitated by integrating technology. Our teachers and ultimately our students will then be better prepared to meet the future. Only through these approaches will we facilitate meaningful social studies and develop civic competence, empowering teachers and students, and thus establishing a new tradition. Transforming, not transmitting, needs to be our goal.

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SPECIAL NEEDS

Section Editors:
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As I read through the various articles in this section, I noticed an overall theme of 'technological curiosity' which was incorporated into many of the author's ideas. It is good to see that we have accepted technology as one of the tools which should be included in the arsenal of education. We are utilizing, manipulating, and adapting technologies to meet the continually changing needs not only of our students, but our colleagues and ourselves, as well.

Many practicing educators are returning to school to learn how to use these technologies in their classroom. Excitement is high about the potential for reaching those students who were once thought to be unreachable. More schools are getting the equipment and connections needed to access the Internet. More teachers are using technology. Does this mean that all is well?

I often cringe when I hear that company X has donated its ten year old 286/2MB computers with one 5 1/4" floppy drive to school Y. (Note to the CEO of Company X: Here's a suggestion - Buy new Macs and give them to the schools! Remember that these students may be working for you in the future.)

Every quarter I have teachers I work with who still don't have ANY type of technology in their classroom. I see fourth and fifth graders shuffled off to the computer lab once a week for forty-five minutes, simply because it's their allotted time. I show teachers how to access and incorporate the Internet into their classroom curriculum, knowing full well that their classrooms are neither wired nor connected. Yet, I am constantly amazed at the spark which appears with these teachers. Some of the same teachers who didn't have ANY technology in their classroom return and tell me of grants, and moneys which they have received and used to put technology in their classes. They tell me of watching the excitement in their students as they access the Internet or get e-mail from their parents or a friend in another city.

As an educator, I see a growing awareness of the importance of making all of our teachers not only aware of the potential of technology but active technology users. As I read through each of the varied articles in this section, I find new ideas and new insights into ways that I can become a better teacher. The authors provide a wide spectrum of information which provides additional perspectives in which to view difficult educational experiences. As I read through these articles, I find myself learning new ways to approach issues which I face nearly every day in my teaching.

I do think that Opie would have been a better student if Helen Crump had today's technology available to her. And then Andy wouldn't have had to take away his bicycle for making poor grades. These are just some of the questions that I was never able to ask in school.

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Technological and Methodological Issues in Teletraining: The EXPERTISE Experience

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Recently a new tendency has appeared on the labor market through the use of linked computers called telework; timidly in Belgium and in Italy, more in other countries. There are estimates that more than 60% of the work implied in the production of goods is the processing of information. This information is increasingly computerized. The possibility of teleworking is therefore huge in principle. The employer can benefit from savings in investments and consumption in buildings and furniture and a large flexibility. For the worker, one invokes also the flexibility that allows for better conciliation of work, family obligations and leisure. The diminution of travel is to the advantage of the whole society by decreasing the pollution and bottlenecks and to the advantage of the worker in avoiding the loss of time and money, the fatigue and the stress. The different advantages for the worker also benefit the employer through theoretical increase in productivity and quality of work.

For persons whose handicap reduces mobility, telework is an obviously attractive solution. For those whose mobility is reduced, or that request frequent assistance and care, telework from their domicile or the institution where they work is practically the only solution to participate through an active contribution in the economic life and to find a broader socialization. For a mobile person, telework can involve less social relationships compared with on-site work could offer; but, for handicapped persons isolated by the impossibility of usual work relationships, telework allows a significantly larger socialization compared to their isolation (Volpentesta, 1995). Therefore, for these handicapped persons, telework offers a unique chance to break out of the barriers of their handicap. Of course, teletraining is the first necessary step to prepare disabled people for telework; it makes trainees familiar with technologies, methods and organizational structures for teleworking activities.

EXPERTISE (EXchange and Promotion of TElematic and Robotic Technologies for vocational training and employment of the dISablEd) is a transnational project to promote high-level formation and employment of handicapped people in the HORIZON/EMPLOYMENT Initiative of Europe Union. It involves numerous regions of different European countries (Spain, Germany, Austria, Belgium, Italy) and its main objectives are to provide effective tools and innovative methodologies for the vocational training and employment of disabled people using the most recent technologies to promote exchange of technology and knowledge among all European regions involved in the project. In particular, in Wallonie e in Calabria, we've focused our attention on teletraining and teleworking. In the rest of the paper we discuss: the technological infrastructures used at Le Réseau (Wallonie - Belgium) and at Brutium (Calabria - Italy) to support project activities; telematic services which are used either as communication media for distance education and as means for teleworking; didactic methodologies; and, some considerations about first results.

Technological Infrastructures

Regional occurrences of the project in Wallonie (Belgium) and in Calabria (Italy) are based on the same starting architecture that has led to similar infrastructures, even if they have some technical implementation differentiations. Project activities are hosted in a vocational center, where most training activities take place, and in some peripheral nodes (non-profit organizations and trainees' homes) for distance training and net services delivery.

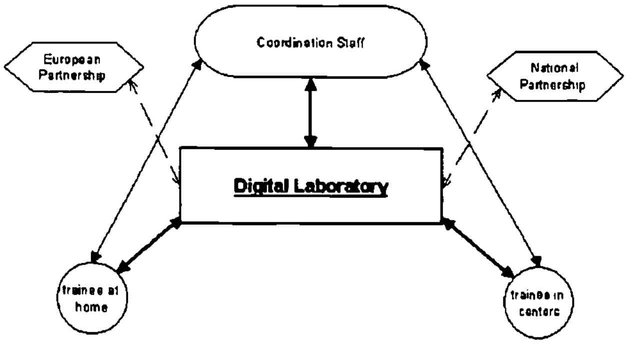

Figure 1.

The main purpose is to have a place where trainees can meet and configure telework modules. As shown in Figure 1, a digital laboratory has been set up in the center and can be accessed physically or virtually, with a remote access, by trainees. A coordination staff is always available to a trainee for tech or medical assistance. In the digital laboratory, a set of Web/FTP servers are installed for local Intranet and world-wide Internet users; the purpose is to make available a group of services to the trainees and to disseminate project results and some works developed by trainees themselves.

The labs aims to give many different kinds of support to disabled persons: selection and integration of new software/hardware technologies and useful utility tools; as vocational guidance site;

- as an interface to possible interested enterprises which need teleworker;
- in coordination of training and work activities;
- in management of the technical infrastructure;
- to arrange a physical place for periodic meetings and socialization;
- to make available a place where trainees can deploy part of their working modules;
- to make available computing and telecommunication resources;
- as a router and gateway to ISDN and Internet;
- to activate base network services as file transfer and e-mail;
- to promote local services;
- to disseminate information on available technologies;
- to adapt workplaces for disabled people;
- to create job opportunities for qualified handicapped people.

Both centers, in Wallonie and in Calabria, use multimedia personal computers and workstations to enable audio/video interaction. Noted below are brief characteristics of each technical solution; some miniature differences in technological implementations can be noted. At Brutium we have installed a LAN extended all over the rooms in the laboratory building. The LAN is a Fast Ethernet 100Mb/s to allow video/audio conferences inside the lab. A gateway to Internet at 64Kb/s. We've plugged in to the LAN 15 Win95 Net Clients PC all with audio capabilities, two of them have speech recognition software, three have video grabbing cards, two have CD-R drivers for multimedia production. We've also configured three Internet servers one Intel Linux, one Intel Windows NT 4, one PA-RISC HP-UX. As additional accessories we make available digital cameras, color printers, scanners, VGAtoPAL converters, VCRs and a LCD projector. Moreover, all recent Multimedia Technologies, Intranet and Internet facilities have been set up. We have provided the possibility, for people with severe handicaps, to remotely attend lab activities (teletraining) via HFTV and Intranet technologies. At Le Réseau we've given each student at the site where he/she is receiving the teletraining (home or institution) a PC Pentium 133 with 16Mb RAM, CD -ROM drive, sound card, Windows 95 and a printer. In our center, (where we are also providing vocational training in classrooms) all the (about fourty) computers (trainees, trainers, administration) are linked in a LAN Thin Ethernet 10Mb/s. At the software level, it is a mixture of Windows 3.11 and Windows 95, with a Windows NT 3.51 server. Our server is equipped with a DIVA Quadro ISDN card from Eicon Technologies, providing eight channels (four 2-channels Basic Accesses). The remote students also have a Basic Access to the phone company and an ISDN card in their computer.

We do not use Internet or other private networks. People can get relatively inexpensive Internet access through analog telephone lines but ISDN Access is only proposed at corporate rates which are still rather expensive. Instead, the remote students call our server directly over telephone lines. Belgium is a small country. Even with (not so long) long distance calls, we pay less thanwhat we would pay to the Internet access providers (plus local calls).

In both training centers we focus on outcomes concerning professional profiles in the following sectors: digital audio-visual production; system and network administration; office and home automation; software design and prototyping; CAD, computer graphics.

Telematic Services

Some basic and advanced telematic services have been made available to teachers, tutors, and trainees as support in teletraining and management/coordination procedures and to promote socialization through entertainment. Such services have been based on the usage of suitable telematic software tools.

The first set of tools integrates Internet technologies. In particular it essentially consists of some Internet modules and interfaces between them (Fasano, Frega, Greco, & Volpentesta, 1996). On the Internet side we've built-up a Mailing List (to broadcast e-mail messages among Internet

Horizon subscribers) and a Web Board (to let users browse all messages and bulletins from the WWW). Other tools, we've called WebRöbots (Frega, 1995), let users publish full HTML pages

without requiring HTML knowledge at all (Della Gala, Frega, & Volpentesta, 1995; Frega, 1995); they consist of a pages slider/randomizer and a HTML editor online with preview and upload utilities; another tool is essentially a multi-user program that allows anyone with a Java-capable browser to draw on the same canvas for collaborative drawing (Frega, Greco, Pisculli, & Volpentesta, 1997). At Giuda Lab, we've developed an entertainment shell where we inserted a couple of interactive card games online (Frega, Greco, Pisculli, & Volpentesta, 1996). The system may be regarded as an environment that allows users to communicate with each other by a chat service, while they are playing some card game on a virtual table.

The last prototype we have developed and used in EXPERTISE is MAGDA: a multimedia collaborative agenda (http://tre7.deis.unical.it/magda/magdafrm.htm). At a local level the agenda is used as a support tool for project management: to coordinate teachers, tutors, trainees and their teletraining activities; didactic collaborative work; to allow trainee groups to create and present multimedia material about topics selected and scheduled by teachers and tutors. At a transnational level, the agenda is used to setup European partners meetings; to give each subscriber a view at meeting schedules; and, to multicast messages to predefined workgroups.

We do not use videoconferencing. As mentioned below, our training is largely practical. Trainees and trainers interact mainly by sharing directories and files, by e-mail and by telephone. We felt that videoconferencing was not the priority in our situation. Another issue related to videoconferencing is that this medium is most appropriate to broadcast real-time teaching. On the contrary, we want to allow our remote disabled students to adapt their time schedule to their particular situation and their learning rhythm.

Didactic Methodologies

In the starting phase of the project most of the trainees didn't have a clear view of what computers are, what they are used for in the economical world, and how they themselves will fit in. Still, if they did come to us, they had a project or some hope to find a job after training. It is along their training that we're examining and developing their project with them. We help them to gradually better understand where they desire to go and what training is needed to go there. There is no a priori program (except for the first weeks). The program is tailored to each individual following his/her needs, inside what the centers are able to offer.

In regard to the didactic method we use, it is very different from classical one-way knowledge transfer from one teacher to all students; it's quite individualized anyway. Trainers give few classical lessons. They give explanations on some points and then tasks that allow students to try by themselves. This is the method that we are transposing in teletraining, providing multimedia materials instead of spoken information and instructions: the trainers give to distant trainees explanations and instructions through the network to allow them to work autonomously, in principle, for one day. These works are retrieved, through the network, to be evaluated by the trainer who then decides the next step. Of course, writing information and complete instructions are large undertakings and we are searching for all existing pedagogical tools that could ease the task for us; this is alsotrue for the work in the center, because all the time that the trainers can save by using the existing pedagogical tools is more time devoted to individual follow up. "On the job" individual training and group collaboration are also encouraged by providing network applications and communication tools for promoting exchanging with other EXPERTISE partners. Trainees are also encouraged to use e-mail between them. Distant and in loco trainees keep track on the agenda through recording all oftheir training activities. This diary can be accessed at any moment by the staff. Meanwhile, a recording software traces all actions on the computer.

Formation

Since we deal with persons with more severe handicaps, we think that the training could be slower. Some of them receive care that takes a good part of their daytime. For its content, the training benefits from the competence that both centers have developed. Globally, the objective is to master the use of networked computers and traditional software in business work (word processing, electronic publishing, spreadsheets, databases, accounting software) which would, in turn, give access to a large variety of jobs in the tertiary sector. Other possible training orientations are analysis and programming, the computer-assisted design (CAD) or computer graphics. Possible basic training shortcomings are taken in account in the project to make it accessible to the largest number, including the most disfavored.

Conclusions

In this paper we have discussed some technological and methodological solutions that we have adopted for the execution of teletraining actions in a european international project.

Issues about such solutions have dealt with: a telematic infrastructure (Internet/WWW/BBS) linking all interested sites and relevant public and private institutions (for ex. HANDYNET nodes) involved in the project; experimentation of teletraining and other distance education activities; usage of telematic software tools in order to support teletraining and management/coordination procedures;

and, providing technical aids to prepare people with sever handicaps to telework.

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Collaborative Drawing in Educational Environments via the World Wide Web

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Collaborative drawing (CD) have received much attention from researchers and tool developer in last years (Peng, 1993). Observational studies of group interaction in sharing a drawing space have been led to design requirements for CD tools. Many of them have been embodied in research prototypes and commercial applications (Krueger, 1982).

On the other hand, the World Wide Web (Web) has emerged as a popular and powerful infrastructure for group-oriented activities. Thus, it has seemed useful to us to make avaiable on the Web a CD tool which satisfies some of those design requirements.

CODEE is the name of our prototype, and it has been developed at GiudaLab to support distance education and teletraining activities during the execution of Expertize (Exchange and Promotion of Telematic and Robotic Technologies for vocational training and employment of disabled), a trans-national project to promote high level formation and employment of handicapped people in the Horizon Employment Initiative of European Union.

The following paper presents: the basic set of functionality we have implemented in CODEE; the CODEE architecture and client-server communication protocols; usage scenarios and a first observational study future works about some extension which take into account lessons we have learned during the usage of CODEE.

Tool Functionality

In contrast to other approaches on the Web oriented to support synchronous painting activities on a same space (Krueger, 1982), our tool is a multi-user program for asynchronous drawing on multiple-shared canvases; each of them can be accessed by an authorized group.

The tool embodies classic functions that can be normally found in most draw programs. In a vertical toolbar on the left of the drawing area, a user can select among five type of objects: rectangle, circles, lines, freehand and text. Rectangles and circles are available in both outlined and filled style. A sixteen-color palette is available on the same toolbar. Objects can be selected and then deleted, resized or moved on the document. Moreover they can be grouped together in order to enable complex objects manipulations and locked to avoid further modifications.

Multiple documents can be simultaneously present on the client side, a user can select any of them and move/copy objects from one to another. Figure 1 illustrates the client interface.

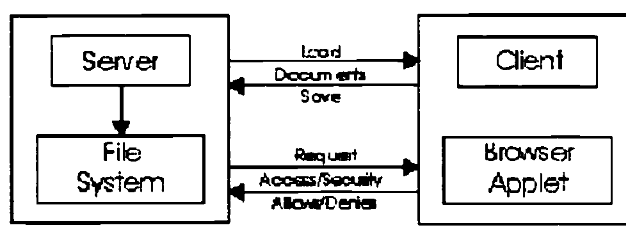

Figure 1. The client interface.

A file menu provides options to save, load and delete documents. A group-oriented password system is provided as a support to collaborative work; actually members of a group share the same drawing space and documents in this space can be accessed only by them. Figure 2 shows the interface for groups management.

All documents are grouped in directories, stored on the remote server file system, and can be accessed by any Java-compatible browser.

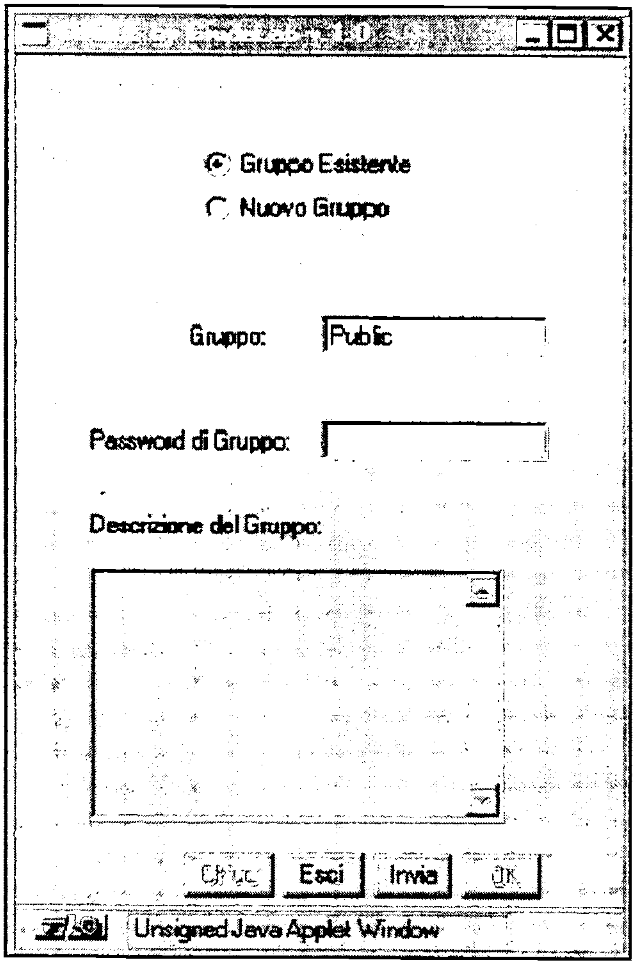

Figure 2. Interface for users groups management Architecture and Protocol.

CODEE is based on the client-server paradigm (see Figure 3). The server consists of a Java stand-alone, multi-threaded application which manages the communication with Java applet clients via sockets. The servers primary function is the management of a shared work space (basically a dedicated file system) where graphical documents are organized and stored for successive retrievals; moreover, a password system protects both individual and group works. The tool client side runs as an applet in any Java compatible Web browser.

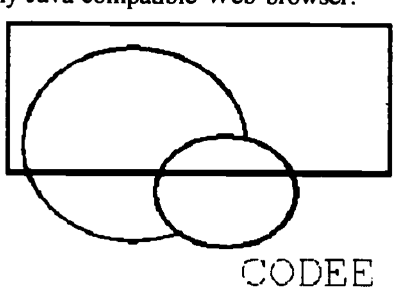

Figure 3. CODEE architecture.

The client applet and the server application communicate by using a statefull protocol over TCP/IP through Java Socket and ServerSocket classes.

The server makes available to a client the following functions: list of available files, load a file, save a file, delete a file, create a new users group, control user access. The client-server communication protocol consists of the following steps:

1. The server is ready and listening on a predefined port (called randevouz port) waiting for a client request.
2. When the server detects a client connection on the port, it sends an "OK" string and sets a new bi-directional communication channel for the rest of the session; moreover it forks a child process (thread) to handle this session and goes back listening on the randevouz port.
3. After receiving the "OK" signal, the client sends a service code (i.e. sends "FL" for a list of available files).
4. After receiving a code, the server sends a sync signal, then sets itself ready to send the requested data (in the example above, a file list).
5. The client waits for the sync signal then sets itself ready to receive the data.
6. Once the data are transferred, the server sends an "OK" code in the case of successfully transmission or a "BAD" code to notify any error condition. As a final step the server sends a "BYE" and closes the connection.

Usage Scenarios

EXPERTISE (EXchange and Promotion of TElematic and Robotic Technologies for vocational training and employment of the dISablEd) is a transnational project to promote high-level formation and employment of handicapped people in the HORIZON/EMPLOYMENT Initiative of Europe Union. Such a project aims at providing effective tools and innovative methodologies for the vocational training and the employment of the disabled by exploiting most recent results in the area of information and rehabilitation technologies. In our sub-project participants have been split up into groups composed by social assistants and disabled persons in order to better organize and control teletraining activities. Moreover each group is supported by a tutor and all workgroups are supervised by a teacher.

Teletraining activities are supported by a distributed technology infrastructure which connects a digital lab center to peripherals nodes. Some of them consist of specific tasks to be performed by using distributed information tools; CODEE is one of them. In particular, we have considered two possible usage strategies: as a media of asynchronous graphical communications, as a tool for collaborative design management. In the first case, CODEE turned out to be a useful tool for improving communication among group members. In the second case, it made possible to collaboratively carry out simple drawing exercises in some training modules. CODEE is available at http://sungiuda.deis.unical.it/java/HTML/Draw/.

Future Works

In some ongoing work we are trying to extend the tool capabilities. Such extensions deal with the implementation of two different interfaces; one for the trainees and one for the trainer. In fact, the trainer needs a way to control the actions of the trainees and to direct groups composition. The integration of suitable features to enable an easier access to people with some kind of disabilities, and the integration of a mail system to enhance the communication among groups members and to handle FAQ collection and distribution will also be useful tools.

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Better Than a Hunch: Technology and Teachers' Informal Decision-making

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Educational assessment formulates conclusions about the nature and extent of a particular student's academic difficulties to develop appropriate intervention strategies (McLeod, 1982; Salvia & Ysseldyke, 1988). Informal investigative techniques supplement test information to evaluate hypotheses as to what needs to be retaught and how knowledge already mastered could serve as a point of departure for instruction.

Diagnostic probing is one informal strategy used to specify a student's procedural knowledge. For example, an experienced teacher might ask a small number of questions and, depending on the student's responses, pose additional items to delineate what the student understands and form hypotheses as to what concepts or procedures are problematic.

Explicit models, such as generalizability theory (Cronbach, Gleser, Nanda & Rajaratnam, 1972), provide a means of evaluating conclusions based on formal tests. However, justifying conclusions reached using informal probes often depends on more nebulous foundations, such as "common sense" or experience. While the conclusions may be valid, an objective review would deem arguments that appeal to common sense less than compelling; moreover, without a common frame of reference, the expertise of proficient assessors is difficult to communicate. Consequently, practitioners develop their own insights, leaving unrealized any potential for the analysis of individual difficulties to become a more distinct and comprehensive body of knowledge.

Goal of the Research

The goal was to develop and evaluate a provisional model to represent inferences about the content-specific knowledge of individuals. The inferences depict processes proficient practitioners employ to justify judgments made using diagnostic probes. The skill area selected was adding and subtracting fractions and mixed numbers. The model was viewed as an analogue for the procedure experienced diagnosticians use in deciding if administering a particular item would provide information that could not be safely inferred from observations already made. The problem of selecting appropriate probe items was conceptualized as one of using a student's observed performance on a set of questions to predict whether that individual would correctly respond to particular questions in a finite "universe" of items.

Model of Inference Concerning Individual Performance

A model depicting inferences must be consistent with ways practitioners justify their judgments. The investigator observed experienced diagnosticians and interviewed them about collecting information and basing decisions on their observations. Their reasons for selecting probe items were frequently framed in terms such as "if Fred was correct answering questions like 5/7 + 2/9 =, I could be fairly safe in predicting he would correctly answer 1/3 + 1/3 =." When asked about the basis of such judgements, relationships between specific skill elements figured prominently in their explanations. For example, a judgment could be expressed in the form, "If a student can add two fractions in which the common denominator can be found by multiplying the denominators of the terms in the question, he should be able to add two fractions that already share a common denominator."

Propositions developed for the study had two components:

1. an assertion predicting whether a given student would correctly answer a specific question; and
2. a reason for the prediction, based on the procedural knowledge needed to respond to the questions.

Predictive Assertions

A predictive assertion pertaining to two hypothetical sets of items, A and B, would be "if the student has correctly answered all four questions in set A, the student will give a correct answer to question 1 in set B." The questions of set A constitute the "predictor set," while question 1 of set B is the "target item."

Reasons for Assertions

Analyses of procedural knowledge needed to add and subtract fractions and mixed numbers (Birenbaum & Shaw, 1985; Novillis, 1975) were used to generate reasons for predictions. Fifteen procedures, describing three types of functions, were defined. Preliminary transformations involve procedures (designated 1 - 7) to change terms in a question into equivalent terms with common denominators. Core operations (procedures 8 - 11) represented knowledge needed to add and subtract fractions and mixed numbers sharing the same denominator. Transformations of interim results identified knowledge (procedures 12 - 15) needed to express answers in correct form.

The solution to a particular item was represented as a sequence of procedures. For example, the question "3/8 + 3/8 =" could be solved by (a) adding two fractions with the same denominator (Procedure 8), and (b) transforming the interim result, 6/8, to express the final answer in proper form (Procedure 14). Its solution sequence could be expressed as (8 14).

Propositions made predictions about how a prototypic individual would respond to a finite set of items, an adaptation and extension of the inference strategy described by Scandura (1973; 1977) for constructing structural learning theories. To operationalize the propositions, sets of items were systematically generated, and a solution sequence was specified for each question, such that questions in an item set shared the same solution sequence. Thus, for example, the items 3/4 + 3/4 =5/6 + 3/6 =8/9 + 4/9 = 7/8 + 3/8 = comprised an item set for which the postulated solution sequence was (8 13 15). An item's solution sequence was viewed as a possible (but not the sole) path to a correct response. Further, it was not assumed that a given student followed this procedural sequence could generate an answer.

In outlining a theory of performance testing, Scandura (1973; 1977) used the principle of inclusion to limit the number of items administered. The present study distinguished between complete and partial inclusion of postulated solution sequences in formulating reasons for assertions. Complete inclusion served as a rationale for propositions in which all procedures in the target item's solution sequence were a subset of the predictor set's solution sequence. For example, one proposition predicted that an individual correctly answering all four questions for items such as "5/6 + 9/14 =" would correctly answer "7/8 + 3/8 =." The reason given was that the target item's solution sequence (8 13 15) is a subset of (6 8 13 15), the solution sequence of the predictor set.

Partial inclusion provided a rationale when some, but not all, elements of the target item's solution sequence are also elements in the predictor set's sequence. For example, it was asserted that those correct answering all four items in set with questions like "5/6 + 9/14 =" would answer "2/5 + 3/4 =" correctly. The reason given was that the solution sequences of the target item (3 8 13) and the predictor set (6 8 13 15) have procedures 8 and 13 in common.

Reasons using partial inclusion were stated in two parts. The first identifies elements of procedural knowledge shared by both sequences. The second asserts that students for whom there is evidence that a more advanced element is available should also have a related, but less complex element, as part of their repertoire. Thus, if one can solve problems in which the lowest common denominator (LCD) is the least common multiple of the given denominators (Procedure 6), one should be able to solve those in which the LCD is the product of the given terms' denominators (Procedure 3).

The Investigation

The study used propositions to assess the extent to which the inferential strategy made valid predictions about whether individuals would be correct in answering specific items from a finite "universe." At issue was the extent of variability in intra-individual patterns of performance. The predictive success of the propositions also served to evaluate the adequacy of the model developed to account for performance in the skill domain under investigation.

Method

Each proposition was considered a hypothesis to be investigated. Propositions were tested using responses by 481 subjects from six predominantly rural school divisions in the Canadian province of Saskatchewan. All but a small percentage were in the seventh grade. Each of the six groups took a different test, though all tests had items requiring addition and subtraction of fractions and mixed numbers. Each student answered between 112 and 116 questions, distributed over four sessions, each lasting about 45 minutes and given at one-week intervals .

Questions were arranged in two sections, with items calling for addition of fractions and mixed numbers in one, and subtraction of fractions and mixed numbers in the other. Students were asked to solve the questions, to show the steps they used to obtain the answer in the space provided, and to express answers "in lowest terms".

Variables

Propositions were differentiated in terms of the type of prediction (affirmative or negative), operation (addition or subtraction), number type (fraction or mixed number) and degree of inclusion (complete or partial). The accuracy of each assertion was evaluated using prediction analysis for examining cross-classified categorical data (Hildebrand, Laing, & Rosenthal, 1977) to indicate the extent to which use of a subject's responses to the predictor set resulted in reducing the percentage of incorrect predicted outcomes on the target item.

The dependent variable for evaluating each proposition was the percentage reduction in predictive error, defined as the percentage of observations for which a given proposition incorrectly predicts the outcome on the target item. This measure compared (1) the percentage of errors observed when a subject's known status on a predictor set was used to anticipate outcome on the target question with (2) the percentage of errors that could be anticipated if a proposition of the same scope and precision were to predict performance on the target item without reference to a subject's status on the predictor set.

Scope is defined as the proportion of the population for which it is possible for an assertion to make an error in predicting outcome on the target item. Precision refers to the specificity with which each category of the predictor set can be located with respect to outcome on the target item. Its effect is estimated in terms of the unconditional probability that a prediction is in error, and is a direct reflection of a target item's difficulty.

Data Analysis

The predictive accuracy of each proposition was evaluated on the basis of participants' intra-individual patterns of response. Data were analyzed in four steps:

1. the response to each item was scored as correct or incorrect;
2. each subject's status was determined on the set of predictor items specified in the propositions being evaluated;
3. respondents were cross-classified according to whether they were correct or incorrect in their response to the target item for each proposition; and
4. the rate of predictive success of each proposition was evaluated to determine if the percentage reduction in predictive error was greater than could be anticipated on the basis of chance.

Results of each prediction were summarized in contingency tables. Each proposition was tested under "ideal" conditions, so that only subjects correct in answering all four items on the predictor set were used to evaluate affirmative propositions. Conversely, only those incorrect in answering all four questions in the predictor set were used to evaluate negative propositions. This restriction was imposed to permit testing of relationships postulated by the model without confusions arising from inconsistent patterns of response. The rate of predictive success for each proposition was evaluated against the null alternative ($p<.001$) that use of the subject's known predictor status resulted in no reduction in percentage of error in predicting outcome on the target item.

Results

Table 1 summarizes the performance of the negative propositions according to the number type, operation and degree of inclusion. Percentages corresponding to the number of hypotheses accepted and propositions committing no predictive errors are indicated in parentheses.

Table 1
Summary for Negative Propositions

Hypotheses Tested		Research Hypotheses Supported		Hypotheses Committing No Errors	
	#	#	%	#	%
Complete Inclusion of Solution Sequences					
Addition of Fractions	97	90	(93)	79	(81)
Addition of Mixed Numbers	146	137	(94)	112	(77)
Subtraction of Fractions	90	87	(97)	77	(86)
Subtraction of Mixed Numbers	152	148	(97)	102	(67)
Partial Inclusion of Solution Sequences					
Addition of Fractions	61	59	(97)	56	(92)
Addition of Mixed Numbers	14	12	(86)	9	(64)
Subtraction of Fractions	84	83	(99)	72	(86)
Subtraction of Mixed Numbers	24	22	(92)	18	(75)

Table 2
Summary for Affirmative Propositions

Hypotheses Tested		Research Hypotheses Supported		Hypotheses Committing No Errors	
	#	#	%	#	%
Complete Inclusion of Solution Sequences					
Addition of Fractions	164	109	(66)	59	(36)
Addition of Mixed Numbers	180	113	(63)	59	(33)
Subtraction of Fractions	112	78	(70)	52	(46)
Subtraction of Mixed Numbers	264	157	(59)	—	—
Partial Inclusion of Solution Sequences					
Addition of Fractions	20	15	(75)	9	(45)
Addition of Mixed Numbers	44	29	(64)	13	(30)
Subtraction of Fractions	83	67	(80)	36	(43)
Subtraction of Mixed Numbers	38	24	(63)	15	(39)

Discussion

The inferential strategy viewed an individual's responses as evidence that specific elements of procedural knowledge were available, and used that information to predict whether particular items would be answered correctly. The percentages of negative propositions for which the research hypothesis was supported validates the contention that an individual's observed predictor status can be used to make valid assertions as to what questions the individual would be unable to answer. Moreover, it was notable that a significant number of negative propositions made no predictive errors. The data thus suggest that, when making negative inferences, the strategy appears to rest on a firm foundation. The results also provide suggestive evidence that formulating negative predictions on the basis of the inclusion of specific elements of procedural knowledge represents a viable strategy for constructing inferences to depict the status of individual learners.

In contrast, the summary presented in Table 2 suggests that, in general, affirmative propositions were less successful in predicting outcome on target items. This difference was anticipated, as an assumption is being made that respondents generate answers that are consistent with the availability of procedural knowledge, and that other factors, such as carelessness or incorrect recall of number facts, do not intrude in the process. In practice, however, responses are not "error free." The discrepancy between rates of predictive success for affirmative and negative propositions serves to emphasize that availability of procedural knowledge is a necessary but not sufficient condition for a correct answer.

Initial perusal of the collective success of the affirmative propositions, reported in Table 2, suggested only moderate support for the inference strategy. However, due to the manner in which the dependent variable is defined, there are three situations in which it would not be possible to reject the null hypothesis for affirmative propositions. The first, in which a large percentage of observations are inconsistent with the predicted outcome on the target item, is the only one that would challenge the conceptual foundation of the predictive strategy. Propositions with predictive error rates that exceeded the moderate range (2.5% to 3.5%) comprised only 6% of the propositions evaluated. The second, involving restricted precision, would apply in cases where few predictive errors were made but the difficulty of the target item was low. Percentage reduction in predictive error depends upon the precision of the proposition, which reflects the difficulty of the target item. This relationship reduces the likelihood of rejecting the null hypothesis, even when only a small proportion of incorrect predictions are made. When few make errors on the target item, knowing a subject's predictor status simply provides little improvement in predictive success.

The effect of restricted scope reflects the impact of small sample sizes, when a limited number of respondents satisfy the condition of correctly answering all four questions in the predictor set. In such instances, minor fluctuations in the number of observed errors can seriously influence estimates of an assertion's tenability.

Detailed analysis of the data also identified a group of propositions in which low difficulty of the target item and limited scope interacted to reduce their index of predictive success. While the research hypothesis could not be accepted for these propositions, their performance nevertheless provided qualified suppo rt for the inferential strategy's viability.

The impact of restrictions in precision and scope provide context in considering the performance of the affirmative propositions, and suggest that the inference strategy has greater support than an initial glance at acceptance rates for research hypotheses would denote.

Conclusions

Each proposition made an a priori prediction based on a model of procedural knowledge. The number of tenable assertions suggested that an inferential strategy that predicts whether individuals will correctly answer specific items from a finite "universe" is viable.

As the model of procedural knowledge is explicit, there is support for the contention that making inferences on limited samples of behavior from specific students represents a corpus of knowledge. Stating those inferences in propositional form permitted assertions to be evaluated empirically. Articulating the conceptual basis for each assertion provides a starting point to challenge theoretical assumptions and formulate alternative frameworks.

The propositional structure representing assertions as logical inferences builds on Toulmin's (1972) conceptual framework for evaluating statements of matters of fact. As such, it is sufficiently general to provide a basis for communication, both within education and with other disciplines. Viewing judgments as logical inferences also has important ramifications for the status of individual assessment. One way conceptualizes the assessment of individuals as a process whereby teachers apply crude "rules of thumb" to make judgments about an individual's state of knowledge, so that the resulting conclusions are of unknown validity. Such a view emphasizes the role of the diagnostician's "insight" into the idiosyncratic performances of individual learners, but the process by which that insight occurs remains the province of the particular diagnostician. This investigation represented judgements of diagnosticians as conclusions based on evidence, on patterns of performance open to empirical verification, and considered the basic model for diagnosis to be hypothesis testing. While the role of "insight" is not eliminated in the latter view, its prominence is diminished, as the emphasis is on the extent to which the process is objective and capable of explicit representation. The results suggested that effort expended developing and refining such analytic models could be worthwhile.

The percentage reduction in predictive error, by providing an objective index of the likelihood that a judgment is in error for a given individual, addresses the problem of undetermined validity. One could object that it does not have the inferential power of measures based on generalizability or item response theories; however, a fundamental difference in approach must be kept in mind. Measurement models represent the status of individuals in relation to an underlying trait, universe of items and/or a comparison group. By contrast, the present effort sought to represent judgments of diagnosticians and the specific evidence on which they are based. In doing so, the legitimate functions of measurement models are being neither supplanted nor usurped.

Implications for Research

One dilemma confronting educational diagnosticians is obtaining detailed information about a child's performance while limiting the number of questions asked. Adaptive testing models, in which item selection is contingent upon a subject's previous responses, have built upon the work of Lord (1971) and other theoretical models, including item response theory (IRT), and latent class theories (Macready & Dayton, 1989). Computers have made implementing these models feasible (Weiss & Kingsbury, 1984). The inferential strategy examined in this study provides an alternative for addressing this problem in ways that approximate procedures used by skilled diagnosticians.

Another avenue of exploration would investigate the utility of predictions that do not require completely consistent performance on the predictor set. Consideration of such alternative constraints would increase the utility of the model in realistic contexts. The data gathered from the present study will be re-examined to address these questions.

The public is placing increasing pressure on schools to help growing numbers of students with difficulties in mastering skills, but multiplying the number of teachers is not an option. The potential of computers to provide sophisticated instructional support has just begun to be tapped, and realizing that potential will require a re-examination of how technology can be employed. One of the most crucial aspects of a teacher's involvement with a student is the ability to make effective decisions to guide the student's learning. If technology can make skills of experienced practitioners more widely available, addressing the needs of a broad range of students is a more attainable goal. Progress in that area may produce a corresponding shift in public perceptions.

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EDUCATIONAL TECHNOLOGY : REGULAR, READING AND SPECIAL EDUCATION

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The use of educational technology is becoming commonplace. Classrooms use computers, the Internet and educational software available on compact disks (C.D.) and disks, which include movies, sound clips and musical scores. Laser disk players are also being incorporated into classrooms, sometimes replacing less versatile videotape players. Teachers need to be current in these technologies to optimally benefit students and employ labor-saving technology. This paper will discuss the use of newer technologies in three areas: regular education, reading education, and special education. In addition, a global overview will be offered.

Technology and Regular Education

In the regular education classroom, teachers may have students with learning disabilities, reading problems and other deficits. Programs working with different subject areas are useful and can help students with dictionary concerns, encyclopedia usage and can remediate specific skill deficits.

In some cases, these technologies such as laser disks can facilitate the writing process, and provide students with a quick reference to specific instructional material. In the regular education classroom, even gifted students can benefit from the advanced technology and can pursue independent study on their own, thus freeing the teacher to work with other less able students. In addition, aides can assist students who may have been " mainstreamed " and provide additional assistance toward their goals. Shaughnessy (1996a) has indicated that with mainstreaming and inclusion, there will be more and more students with multiple handicaps being served in the regular education classroom. We need to provide training for teachers as we approach the year 2000. A book edited by Shaughnessy (1996a) details the various realms of education, and reflects on how technology can be integrated and infused into various aspects of education, i.e., gifted education, middle school education, vocational education. Siegel, Good, and Moore (1995) provide an extensive list of various software that can be used by regular educators and special educators. They catalog software by specific streams i.e. assessment, behavior management, methods for literacy, spelling, art, phonics, study skills and writing.

Technology and Special Education

In the special education classroom, many programs can provide one to one instruction and provide a grill and drill format for students needing to review basic concepts. These programs can cover vocabulary, categorization, same/different concepts, word identification by function, and association and can operate in Spanish and English, and will "read" along with the student. With the increase in Spanish speaking students in many sections of this country, this assistance will provide relief for many already overworked, overburdened teachers.

Special education students can be assisted by computer-aided instruction because these programs are self-paced and individualized to the student's area of weakness. These computer programs also allow for additional drill, practice and individualized instruction for special needs students who are often taught in the regular classroom. Research has shown that computer-aided instruction motivates, teaches and empowers special needs students as well as helping to improve their communication skills (Bitter, 1993, Holzberg, 1994).

At a more advanced level, students and teachers may search databases for a wide variety of information.

Students can visit and create worlds including castles, local neighborhoods, the ocean, rainforests and time-travel from the 1600s to today. Some include sample stories and useful factbooks.

Teachers also have a specific program to enable them to write I.E.P's relatively quickly and design classroom setups, grade books and class schedules. Teachers can employ this technology so that they are able to concentrate on teaching and spend less time on laborious paper work and management.

For exceptional students, there are a number of programs which can be used to facilitate language. There are programs which can be used by individuals with impaired motor skills to manage their computer from all aspects with their voice alone; some programs even learn to recognize individual voice patterns, and speeds up after saving extensive voice patterns and tones.

For students with physical disabilities there have been augmented keyboards, touch pads, voice commands, and other technologies which assist teachers towards help students master the physical requirements of computers. Computers also have been a major component of the communication devices used by nonverbal or limited verbal individuals (Bigge, 1991). There is also a body of evidence, that computer-aided instruction can be highly effective when used with students who have learning disabilities (Bahr & Rieth, 1989). There is useful software available to assist special education teachers with administrative duties (Van Geldern, 1991). Other technology, such as programmable keyboards, allow instructors to modify keyboard settings and layouts to meet individual student's physical needs, ranging from the profoundly challenged to students who are simply new to the keyboard. Arrangements such as an alphabetized keyboard can help students overcome fear of using computers and the software run on them.

Another option for the physically challenged student is a "touch screen window," which fits over a regular monitor. The touch screen replaces the use of a mouse, allowing students to make on-screen choices by touching the various appropriate locations on the desktop or within other programs. Teachers can modify the window settings to accommodate a range of motor skills.

There is now a computer program to assess hyperactivity and attention deficit disorder that is objective. It is a computer driven program that can assist special educators and school psychologists in the diagnosis of attention deficit disorder, impulsivity and hyperactivity. In the past this diagnosis was highly subjective in nature. This test which takes about twenty minutes to administer, provides an in-depth print out regarding the performance of the child being tested.

Teachers can also use assessment printouts to locate specific deficits and deficiencies without investing valuable time with item analysis. Many programs now provide such item analyses. This allows the teacher to address individual specific needs immediately following assessment. Other computer generated test protocols offer suggestions for remediation of weaknesses. Technology will increasingly be the best friend of the special education teacher as we approach the year 2000.

Reading Education and Technology

In the area of reading, there are a number of programs which can be modified to suit individual readers needs. Many of these are based on current movies. Once teachers begin to become familiar with the software, they will begin to recognize certain companies which cater to their specific needs. More advanced technologies will be able to help students read faster and with more comprehension. Tachistoscopes, which have in the past been unavailable are now increasingly becoming accessible to classroom teachers. As technology advances, more and more students will have their own computers and C.D. players at home and be able to work at home on assignments employing said technology.

There are some concerns regarding the use of C.D.'s in reading. These programs, on the positive side, are engaging, interactive and motivating. There are often couched in game format, and can provide high success, high stimulation and high feedback. They can be individualized for low learners. On the other side, most are mass market produced. Some of these programs also limit creativity, imagination, and higher order thinking skills. The language in many of these " books " is more talk and verbal than the written language in books. Other programs provide continuous stimulation and visual changes which are not available in books. There are explosions, clicking, loud stereophonic music, and songs (often linked to the movie) and the images change every few seconds. In effect what we have is television in the schools, and we all know what type of wasteland and talking heads are on television. What is often lost with these programs is the ability to create in one's mind. There is some concern as to whether students will be able to transition back to actual books after being exposed to these programs. Is society abandoning books in favor of movies and animation? And what will be the long term consequences ?

Administrative Concerns

The authors have established an Educational Software Clearinghouse for teachers to preview software prior to purchase. This is essential so that teachers can procure the needed and appropriate materials for their specific students without wasting a lot of time. Obtaining and reviewing educational software is a highly time-consuming effort. Cataloging, storing and updating educational programs requires significant staffing and space to house PC's, Macintosh computers, and the program disks. In addition, space is required for video disk players, printers, supplies, program manuals and maintenance will be required to repair disk drives, hard drives and speakers. On-going up grading will also be needed and in service training for teachers will be absolutely necessary. Even the staff will be required to sharpen their skills periodically. Because programs up date and platforms are continually being modified and improved, the individuals involved will need to keep current. Once teachers and others fall behind, it will become increasingly difficult to "maintain the cutting edge ". Some teachers are even less computer competent than the students. Students like computer animation, whereas teachers may not be comfortable with that mode of instruction.

Security is another minor concern which should be addressed. Obviously, theft can deplete resources rather quickly. One wants students and teachers to avail themselves of this technology, but security is also imperative. There must be staff to monitor C.D.'s and other valuable educational equipment, software and hardware. Licensing and registering copies of software is another administrative headache and involves much paperwork. Legal concerns regarding copyright must be addressed. Siegel, Good and Moore (1995) have discussed the integration of technology into pre-service teacher's curriculum. The technology is out there and available. However, student teachers must be familiar with the technology and be able to use it or else it will simply gather dust.

Obviously research on the use of technology in regular, reading education and special education will become needed. As our technology increases, so will our capacity to conduct classroom research to ascertain the effectiveness of different technological approaches to the remediation of educational problems and deficits. Some programs contain built in systems for monitoring student progress. Teachers can employ many of the statistical packages for comparing student progress across programs.

Summary and Conclusions

This paper has attempted to cursorily review the current use of technology in regular education, reading education and special education. It has discussed some of the main uses of technology with both regular and exceptional children. Teachers should be encouraged to avail themselves of this technology to improve their pedagogy and for the ultimate benefit of their students.

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Slick Tech Tips: How to Polish that Professional Image

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Declining budgets in post-secondary settings have led to a corresponding reduction in secretarial assistance to instructional staff. Faculty members are suddenly finding themselves with a computer and are expected to produce documents that have a professional appearance. In response, they are throwing their hands up in frustration, as their lack of knowledge and experience in page layout places them at a significant disadvantage. For individuals accustomed to being in control, this situation may also contribute to the reluctance of many to utilize the available technology. Some faculty have openly stated that if they simply refuse to do it, the university will have no option but to return secretarial support to the levels to which they had come to expect.

Too often, professionals have taken for granted the skill that has resided in their secretarial pool when it comes to producing a polished looking document, even something as simple as a letter. Now, suddenly placed in the role of having to duplicate these same results through their own efforts, it has become obvious that office professionals were doing more than "just typing." An attractively designed letter, syllabus, or paper is a professional's calling card; their representative to another individual when personal contact is not always possible. A good impression is important.

The Challenge

Within every institution or setting, there tends to be a spectrum of personal skill when it comes to technology. When focusing on those who display reluctance to involve themselves with computer technology, one of the most frequent comments is that it wouldn't make sense for them to spend time using the computer because they are unable to type. Naturally, the urge is to suggest a popular, computer-based typing program which would assist them in acquiring the skills. There is no doubt that the individual who can touch-type has an advantage when it comes to producing a document. Exploring further, though, is important. Given that they would have low to moderate keyboarding skills, the next question arises: what are they going to do with them?

Knowing how to operate a kitchen machine doesn't make one a chef. Along the same vein, knowing how to type doesn't necessarily guarantee an attractive final product; yet, it is often presumed that before someone can produce a piece of which they will be proud, they are first going to have to master keyboarding. Perhaps the reverse is really the way around this. Show a professional how to produce an attractive document their first time out, and just maybe that will serve as the incentive to become more skilled at both keyboarding and computer technology.

Let the final product be the incentive rather than the diligence to master keyboarding eventually leading to a reward. Your aim is to motivate and as Boylan (1996) states, motivation creates momentum. Motivating someone creates "an energized attitude" which in turn leads to motivation. "What's motivation? Getting people excited so that they act in a focused direction" (Boylan, 1996, p. 157). Institutions need to find an array of possibilities that might serve to motivate and engage the individual at the personal level. Change may be mandated from top-down but lasting change only occurs from the inside-out. The individual is the lowest common denominator in the change process, and the most powerful.

Implications

A private conversation with a Dean at a large university recently revealed that this issue is having larger ramifications for post-secondary institutions. His own college had faced secretarial cut-backs a few years before, and faculty were now producing their own documents without guidance. It wasn't until he encountered samples of these documents out in the community that he realized that faculty knowledge of page layout was impacting the impressions people were forming of the university. He saw this as a more serious issue when it came to competing with surrounding institutions for students, especially when it came to contract classes. (Contract classes are situations where businesses or school districts have a population of students drawn from their work place settings and universities are contracted to provide the instruction for those individuals.) His concern was that outside agencies would interpret a poorly designed document as reflecting the skill level of the faculty at the institution.

Williams (1994) produced an excellent resource that addresses the needs of novices, "The Non-Designer's Design Book: Design and Typographic Principles for the Visual Novice." In the opening statement the author, speaking from the perspective of a professional designer, says the book was produced for students who understand that a better-looking paper often means a better grade, the professionals who realize that an attractive presentation garners greater respect, the teachers who have learned that students respond more positively to information that is well laid out, the statisticians who are seeing that numbers and stats can be arranged in a way that invites reading rather than sleeping, and on and on (Williams, 1994, p.11) The point is, the design of a document is an important issue, that it does have an effect on the way information is received, and, at the heart of that, it may combine with personal reluctance to form another barrier to impede effective utilization of technology among post-secondary instructors with limited skills.

Is There Another Way of Looking at This?

Rather than view this refusal to adopt technology as a lack of co-operation, it is more important to see it as an ego-protection device. Highly educated individuals, unaccustomed to feeling inept, are suddenly placed in situations where they have limited, if any, support and little experience. Culbert (1996) argues that the key to motivating individuals to change is understanding the psychological perspective of that person. How do they see what's happening? "Self-interests and personal, work-related effectiveness agendas significantly impact - even wholly determine - how people see events at work, and ultimately how they think to operate given those perceptions" (Culbert, 1996, p. 30). He points out that all people wish to be seen as competent and effective in both their work place and personal settings.

While every institution needs to communicate a vision of where they want their people to be, and the goal they are striving to fulfill, Culbert (1996) reinforces the importance of the individual in this process. Instead of pointing to a mark on the wall and telling someone that's what they're going to have to aim for, he suggests administrators need to look at where the person really is. His advice is to "engage them where they actually are" (Culbert, 1996, p. 33) and facilitate ways of having them incorporate the larger vision into their personal agenda. So, when it comes to getting faculty to use computer technology for everyday tasks, what is the pay-off for them?

The budget cuts that have reduced secretarial support are not likely to be reversed any time soon, so that faculty have no choice but to take personal ownership for much of their work. At the same time, these individuals also want their work to be seen in a positive light; an important aspect of which is a professional look. Practicality suggests that running all faculty through a design course is not feasible. Apart from heavy workloads limiting available time to fit in another workshop or meeting, design is not only a skill; it is a talent. Recognizing that mastery of page layout will be uneven among faculty, how then can institutions facilitate people producing documents that reflect well on the individual and the institution? How can administrators give faculty, especially the reluctant user, the confidence and ability to produce an attractive, credible document their first time?

The answer to the question is far simpler than it appears. Surprisingly, a tremendous number of people using common word processors are not aware of the page layout features built into the software. Even reluctant beginners can produce a newsletter or brochure that compliments their professional selves. People have tended to use the word processor as a typewriter without a carriage return resulting in underutilization of the many features that can make the job easier and the results quite professional-looking.

Recently, a faculty person with very limited computer skills, saw a newsletter this author had produced. Complimenting the final product, the faculty person commented that they would never be able to produce anything like that. Knowing the computer system that had recently come to reside on the individual's desk, the author pointed out that if the faculty person wanted, she, too, could produce a document that was a mirror image of the one she was presently admiring without having to know much more than how to type in the content. The secret is templates.

A Look at the Possibility of Templates

All of the major word processing packages residing on faculty desks have built-in templates. These templates are professionally designed documents covering a variety of tasks, including business letters, brochures, newsletters, signs, and a number of other categories. Most of the latest versions also include the ability to convert certain features to HTML. In addition to those already in the software packages resident in the building, commercial design packages are also available for purchase; many cover a vast array of possible projects.

The only effort required on the part of the end-user is the content. A faculty person can call up the newsletter template (usually there are three or four designs to choose from), follow the on-screen instructions, enter their information, and a while later, they have a beautifully designed document. A complete novice to word processing will need some assistance getting up and going using templates, just as they would regular word processing facing a blank screen; but the end result is what is different in the two scenarios.

The valuable feature about templates is that they can also be generated. Electronic templates of these forms can be easily produced and distributed to faculty, decreasing effort. Another point to consider is that faculty supervising students have a variety of communication tasks, many of which are common to all colleges. Producing a document template for each situation assures administrators that students are all receiving the same core information while, at the same time, allowing faculty opportunities to personalize the letters in a fraction of the time. At the most rudimentary level, templates incorporating the institution's letterhead can be stored in electronic format so there's never the need to hunt for the right stationery again.

Most high-end word processing packages also allow for the incorporation of "macros" into documents. This would allow templates to be produced which would prompt the user for information. Think of it as word-processing with a guide.

Finally, use of templates also serves as a teaching function. Using professionally-designed templates exposes faculty to models of how documents should look. They learn that a Times Roman font is more appealing than a Courier font. They see how professionals would design a page. Inevitably, they will begin to utilize some of those same features when they produce original work.

Templates are nothing amazing; in fact, they're very ordinary. But most faculty are unaware that they have such powerful and flexible assistance only a couple of mouse clicks away. As technology, regardless of its sophistication or complexity, is fundamentally a tool, the critical question for most in higher education is whether a given tool can improve the caliber of their work. As templates address issues of format and layout, instructors can be freed to focus on the clarity of a document's content. If an attractive product that clearly communicates has been produced by leveraging their existing skills rather than demanding that they acquire new ones, faculty may regard the technology as a empowering tool rather than an impending threat. Thus, readily available templates can be valuable tools in reaching faculty who need to master technology skills and don't know where to begin.

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Using Technology to Support Special Education Certification Through Distance Education

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Technology and teamwork are essential components of Utah State University's distance education preservice training of special education teachers. This field-based certification program is designed to increase the number of certified special educators in the Intermountain region by providing access to the same quality of instruction and supervision available to students on campus at Utah State University in Logan. The field-based component features on-site supervision by local cooperating teachers with support through e-mail. Cooperating teachers from the rural areas attend a summer training designed to strengthen supervision skills and provide technology training required during the supervision phase. Didactic courses are designed and delivered to rural locations using two-way interactive video technology. As students and faculty gain experience with distance education and the technology, overall procedures and discussion formats emerge to support learning.

Prior to development of the distance education program, it is critical to maintain ongoing communication and collaboration between the distance education coordinator and the faculty members delivering instruction to the rural sites. Without the expertise and support of faculty members in the special education department, the program would not survive. Dillon and Walsh (1992) examined and analyzed faculty attitudes toward distance teaching. These studies report that faculty who teach at a distance have positive attitudes toward distance teaching. As faculty become more familiar with the technology and logistics of distance teaching, faculty attitudes improve. Faculty members have also expressed an interest in connecting technology used in distance education with on-campus courses.

The distance education coordinator at Utah State University is a member of the special education faculty, has an office in the same area as other faculty members, and is available as a support to faculty members teaching distance education courses. Other responsibilities include contacting students, coordinating sending and receiving materials, and addressing technical problems in delivery.

Technology Uses

E-mail

The distance education program for preservice special education teachers requires frequent and explicit communication between professors, adult students, advisors, cooperating teachers, district administrators, and the program coordinator. Students receive weekly e-mail messages from the program coordinator dealing with needed assignments and/or checking progress. They are encouraged to check in with professors to ask questions, send assignments, and comment on the content and application of the class material. It is also important for faculty members to use e-mail to communicate with each other as they develop skills in distance education.

The following challenges are addressed on an ongoing basis: availability of computers with e-mail networks, teachers needing training on e-mail, and local technical support. Participating school district personnel team with university distance education faculty and staff to address those challenges unique to each student and situation.

Fax

Sending material via fax is the preferred method of delivering material for several of the sites. Fax machines are available, easy to use, and can be used at convenient times to both the sender and the receiver. In several instances the site coordinators at the rural locations have a fax machine in the classroom, but must go to the media center for access to e-mail.

Web Page

Web pages are used as a support for the student, offering opportunities to expand and enrich topics of interest. Several commercial Web page developers are user-friendly and support is available for creating Web pages for faculty members in the technology center on campus. Students can access the extended syllabus, a listing of topics and overheads per class period, as well as connect to related topics made available by the professor.

Hypertext

Future educators are instructed on how to use hypertext technology to adapt regular classroom materials for use by students with special instructional needs. The adult students receive training in how to use hypertext and hypermedia in curriculum adaptation as they work with students who have disabilities and in their university assignments.

University students also receive instruction on methods concerning how to determine the appropriateness of hypertext for scaffolding instruction during curricular modifications. For example, for students with reading comprehension difficulties, hypertext adaptations can be used to add pictures, simple definitions, graphic organizers, or computer-generated speech to support existing knowledge. It is important to make decisions about the use of hypertext in making curricular modifications that support student learning and access materials for students in the schools. Hypertext can be used for students with language difficulties to help point out relationships between words and phrases in the text (Dyck, Pemberton, & Woods, 1996).

Two-way Interactive Video

The primary model for the didactic component of the program is through EDNET, an interactive video network. Instructors deliver courses from an electronic classroom on the USU Logan campus to the rural sites. Instructors receive training and support in the use of video and graphics capabilities, extended syllabi, Web pages, group discussions, and case studies. Several professors model using hypertext to teach certain course objectives.

Remote Supervision

Remote supervision of preservice special education teachers in field practica and student teaching experiences begins with a summer training workshop for cooperating teachers. During the workshop the technology and observational skills required to accomplish the supervision are demonstrated and practiced. Technology mentors for cooperating teachers and students are identified. The distance education program coordinator travels to the various rural sites to offer support, problem solve and encourage students and cooperating teachers dealing with issues of supervision and technology. As areas become more proficient in the use of technology as a means of communicating and teaching, the on-site support will diminish and communication through technology will increase.

As the special education certification program through distance education develops, additional uses of technology are added. Courses are offered on a two-year cycle, with the first cohort group graduating in May, 1997. Additional sites will be added during the 1996-97 school year and a second cohort group will begin taking classes Fall, 1997.

Future Plans

The next step in Utah State University's distance education certification program is to access technology that would support observation and conference opportunities in remote locations. A resource library is located at each site currently housing students, and a database for locating information and a process for checking out materials is in the process of being developed.

In the Department of Special Education in Logan there are three areas in distance education: early childhood, K-12, and rehabilitation. Beginning Fall Quarter, 1996, faculty members and doctoral students interesting in distance education meet monthly to discuss current technology developments and offer support to the various programs. Technology and distance education are ongoing topics, with the challenges of remote supervision drawing special attention.

At Utah State University, students are developing skills in technology while obtaining the special education certification program. Educators working with students with special needs must use teamwork and technology as they work with other professionals and parents to address the needs of all children.

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Technology Use Benefits for Learners With Attention Deficits

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The presence of technology in American classrooms is gradually transforming the image of the ideal learning setting from one in which students sit silently in neat rows, paying close attention to the teacher's every word, to one in which students are productively engaged in investigations, problem solving, and critical thinking. Although the latter depiction suggests a noisy, perhaps chaotic environment, educators with a constructivist perspective are convinced that active learning strategies are far and away the most desirable for building thinking skills. Furthermore, educators who embrace experiential learning models suspect that students who participate in relevant, engaging activities are likely to spend more of their classroom time on task.

Common sense tells us that increasing time on task is likely to increase student achievement. Yet some controversy exists in our ability to measure time on task. While one student staring into oblivion appears to be distracted and off task, another may appear to be in deep thought. Distractibility is considered so onerous for school children that some architects, thinking that they had the learning interests of children at heart, have designed schools without windows in order to reduce the distracting effects of gazing out the window.

At a chronic level, a child's distractibility has come to be diagnosed and labeled as a disability. While Attention Deficit Disorder (ADD) is not restricted in definition to children, its impact on learners has earned it extensive national attention, and is defined within the legal statues of our country (Irland, 1992). A refinement of the classification system added yet another category: Attention Deficit Hyperactivity Disorder (ADHD). Legal definitions notwithstanding, children who appear unable to sit quietly for extended periods, listen attentively, complete complex tasks, or engage in focused discussion are often labelled ADD.

The Council for Exceptional Children estimates that three to five percent of children have ADD or ADHD (1992). While researchers may argue about the finer points of diagnosis and identification, clearly more than one million children exhibit a noticeable level of inattentiveness. It is not the intention of this report to summarize the research on the causes, indicators, and remedial strategies for children with ADD. (For the sake of brevity, this paper will refer to both ADD and ADHD as ADD, as do a number of authors on the subject.) This paper will attempt to examine the potential of technology to provide a highly focused learning environment for children with attention deficits. The design and results of a modest study on the subject will be presented and followed by a discussion of implications for teacher education and classroom application.

A Modest Study

In early 1994, a study of the literature on ADD/ADHD was undertaken in order to establish the applicability of technology in decreasing students' waiting and listening times and increase the time they are actively engaged in new learning. In the education literature, "wait time" refers to the deliberate pause between a teacher's question and students' response. Thus, the term "waiting time" will be used to identify those periods when teachers expect students to pause quietly before they proceed to the next instruction or activity. "Listening time" is meant to identify periods in which teachers expect students to attend to what they and other students are saying, including lecture, discussion, procedural instructions, and questioning, and non-verbal listening to music or other sounds.

The literature review yielded a surprisingly small number of selections in which computers or technology appeared along with studies or discussions of ADD. Some studies focused on the use of computer-based interventions to increase the child's ability to self-monitor, keep calm, and increase concentration. In the special education literature intended for teachers, references concerning the use of technology tended to relegate computer use to reward structures for good behavior or achievement. Conversely, some of the literature on ADD fails to take into account some obvious benefits of technology. For example, a Web page outlining remedial practices for ADD students with poor handwriting suggests reducing standards of acceptable handwriting and avoiding recopying, but omits any suggestion that these students might enjoy gains in both written composition and self esteem by switching their environment to a word processor.

In recent years, a number of textbooks have been written that provide extensive suggestions concerning the use of technology for children with a wide variety of disabilities. The discussion of computer use for children with attention disorders, however, tends to be limited to those generalizations that apply to children with learning disabilities. Some of these textbooks omit the discussion of attention deficits altogether.

The motivation for a study of technology use for children with attention deficits arose from the realization that most children appear to attend to computer-based tasks for countless hours, along with the fear that the use of rapid shooting games might exacerbate hyperactivity in some learners. The task at hand was to test the hypothesis that children's attention span was longer with the use of computers than in a traditional setting of "waiting and listening," and that children with attention deficits benefited from increased periods of attention without complex interventions.

Research Question

The research question that was formulated for this study was, "How does percentage of time on task while using computers compare with time on task in traditional instructional settings for children with and without attention deficits?"

Setting

The setting for this research was an urban junior high school in the Pikes Peak Area of Colorado. This school was selected because a recent grant had provided a new computing facility in the school. The school was typical of many schools acquiring technology: they chose a lab setting for the placement of equipment, and they assigned a paraprofessional to monitor the lab and maintain the equipment. The school served an ethnically diverse population, and teachers assured us that at least 100 students in their school suffered from significant attention deficits. We expected to randomly select 10 to 12 students with ADD and another 10 to 12 students without ADD who were comparable in age, grade, sex, and ethnicity.

Sampling

The reality was shockingly different. First, fewer than ten students in the school had been officially diagnosed with ADD, and all but one were currently on medication to control their condition. Second, the process of obtaining parental permission took more than two months and yielded only four subjects with ADD. Third, the selection of a comparison group was problematic. All of the students diagnosed with ADD were placed in special education classrooms, and their peer group in such classrooms could not be deemed to be representative of the general population of students without attention deficits. Indeed, the teachers who taught these children complained that the study was probably invalid since many of their students were "more ADHD" than the identified subjects. We decided to proceed, assuming that our data would allow us to identify students who had pronounced attention problems, whether or not they had been diagnosed.

The final sample of students was made up of four male students diagnosed with ADD and a comparison group of six male students with similar characteristics. We designed the study so that observations were conducted on an ADD student and a non-ADD peer simultaneously, and we needed at least six comparison subjects to ensure that one comparison group peer would be in the observed class setting at any given time.

Limitations of the Study

Along with the limitations in sampling, sample size, and generalizability, the study was slowed by the difficulty of determining what behaviors might fall into the "inattention" category, as opposed to being distinguishable as "attentive" behaviors. The ADD literature yielded a wealth of discussions about these difficulties, and some instruments exist that measure defined categories of behavior in a variety of settings, but few of them were designed for classroom use.

Design

We decided to use behavior classifications that would lead to the greatest interrater reliability; that is, we kept the categories simple so that the graduate students who performed the observations and coding of behaviors would achieve a high level of agreement between them. An average interrater reliability score of 94% was achieved in 36 observations coded by both assistants.

We employed a momentary time sampling method in which the observer coded a student's behavior as "attentive," "inattentive," and "other." The "attentive" behaviors were those in which students appeared to be appropriately engaged according to the intent of the teacher. For example, the student who is attentive is writing when others are writing, listening when others are speaking, moving about the room when instructed to fetch materials, talking with other students when instructed to engage in a discussion, etc. The "inattentive" behaviors were those in which the student was inappropriately talking, moving around, distracted by objects or other students, or not attending to the book, screen, person, or object intended by the teacher. "Other" behaviors were those in which the student was neither off task nor engaged in a designated task. These included "waiting time," and moving about without specific instruction but without any particular expectation that this behavior was undesirable.

The momentary time sampling allowed the observers to code a student's behavior every ten seconds over a 15-minute interval, alternating between an ADD subject and a comparison group subject. Observers wore headphones attached to portable cassette players. Tapes had been pre-recorded with cues at 10-second intervals. This process yielded 40 to 50 pieces of data for each observation, for each subject. The observer then converted his data to percentage of attentive time, percentage of inattentive time, and percentage of "other" time.

Findings

One hundred observations were conducted; 54 of these were observations of ADD subjects, while 46 were of comparison group subjects. Also, 52 of the observations were conducted in a computer lab setting, and 48 were in classrooms.

Figure 1 displays the data on "attentive" behaviors in the lab and classroom settings for the ADD group and the comparison group. With a group mean of 76.0% attentive behavior in both settings, the data clearly indicate that ADD students significantly increased their attending behaviors in the lab setting.

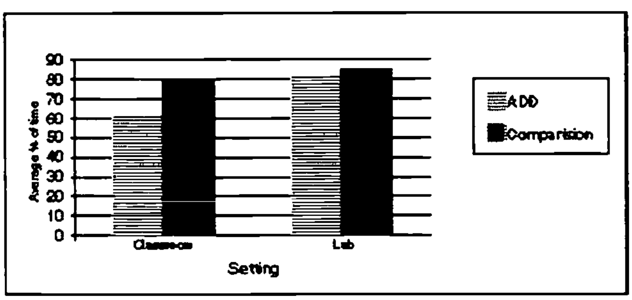

Figure 1. Attentive Behaviors Across Settings by Student Group.

The Analysis of Variance displayed in Table 1 indicates a significant difference in attentive behaviors for the entire group between settings and a significant difference in attentive behaviors by student type.

No conclusion can be drawn about the variance among student types by setting. That is, we cannot specifically conclude that a lab setting generally increases attending behavior for ADD students.

An examination of the results for ADD students, taken separately, helps to reveal why this may be. Figure 2 displays the inattentive behavior data for ADD students only. Clearly, a large proportion of the variance between settings is attributable to the dramatic drop in the inattentive behaviors of Student #3. In fact, two of the ADD students appeared to increased their inattentive behaviors in the lab setting.

Table 1.
Analysis of Variance for Attentive Behaviors

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Setting	1	3086.25	3086.25	8.00	.0057
Student Type	1	4122.38	4122.38	10.68	.0015
Setting*Student Type	1	1460.65	1460.65	3.79	.0546
Residual	96	37047.52	385.91		

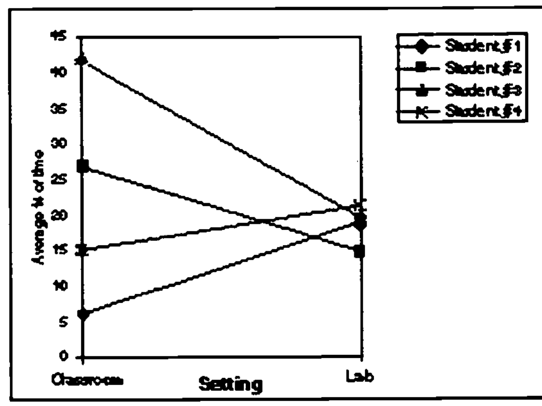

Figure 2. Average Percentage of Inattentive Behavior Among Four ADD Subjects.

Discussion and Implications

The findings of this small study of ten students may at first appear to provide little information, aside from dramatic results for Student #3. For this reason, it seems useful to examine the data on inattentive behaviors of all ten students. These are displayed in Table 2. Students #1 through #4 are the students who were identified with ADD.

Table 2.
Average Percentage of Inattentive Behaviors for All Students

Student No.	Lab Setting	Classroom Setting	# of Observations
1	19	6	10
2	15	27	13
3	20	42	27
4	21	15	4
5	20	6	10
6	4	47	4
7	13	10	4
8	8	11	20
9	9	9	4
10	30	27	4

We can conclude that, at least for some students, whether diagnosed with ADD or not, the use of technology appears to help increase attentive behavior. If only one student in a sample of four with ADD is capable of a large increase in attentive behavior over his classroom rate with no specific intervention, then teachers have reason to deliberately assess technology use and to design interventions that maximize its potential.

Research Implications

The lessons learned in this small study provide some guidelines for the design of future studies on the implications of technology for students with attention deficits. First, a researcher might attempt a district-wide study to ensure a sizable sample of ADD subjects. A reasonably large sample might allow for distinguishing between medicated and non-medicated subjects, ADD and ADHD subjects, male and female subjects, and subjects in regular classrooms as opposed to special classrooms.

Given an opportunity to study a large sample of ADD and ADHD students, the authors would also choose to investigate variables within the computer lab. For example, we would examine teachers' choices of software to determine whether difference occur in applications such as keyboarding practice, word processing, simulations, educational games, etc. We would also seek to examine the effects of pairing and group work, compared with single user settings.

A third variable that would add richness to the study would be teacher behavior. We would formulate hypotheses about the amount of interaction time between teacher and group, teacher and subject, and postures such as "lecturing" and "guiding." We would compare group sizes and whole group versus small group instruction. We are also interested in the effects of interventions for teachers in which they learn strategies for increasing time on task for ADD students in both settings. Finally, we would study the effects of providing a computer for each ADD student within the classroom setting, as opposed to the distant lab setting.

Implications for Teacher Education

Aside from the obvious need to operate a computer with some degree of confidence, the needs of preservice and inservice teachers who are preparing to use technology with children who have attention deficits appear to cluster into three categories: knowledge, classroom management, and assessment. Participants in a class titled "Technology for Learners With Special Needs" articulated these needs in the summer of 1996.

Knowledge Base

In examining technology for learners with attention deficits, students previewed a variety of software types and were able to decide for themselves which were likeliest to captivate and hold students' attention. Some software titles were rejected because they emphasized high speed performance or because the timing of stimulus questions and response time were not designed to be adjusted by the teacher. Students concluded that reward systems for correct responses were particularly important in programs designed to provide drill on facts, since several were suspected to provide excessive distraction to the user. Open-ended environments such as the word processor were examined for their benefit in helping students concentrate on their writing. Participants in the class concluded that some of their students could benefit from increasing the print size and decreasing the window size to avoid overwhelming the writer with a large amount of text on screen or a large area of white space. Participants who had extensive experience with students with attention problems welcomed the opportunity to "chunk" computer experience into small segments—a practice that is often recommended in the literature on ADD.

Classroom Management

Students found that explanations of the various causes of ADD/ADHD and the associated remedial practices were abundant in the traditional research literature and on the World Wide Web. A study of these remedial practices are applicable to the design of educational environments that include computers and other technology. Teachers must design a suitable learning environment for students who experience difficulty in attending to classroom material for reasonable periods of time. They should decide when group work is appropriate; when isolating a student is desirable; when short activities might be scheduled to alternate with longer activities that are easier to sustain; and when students need manipulatives, visuals, open ended environments, interaction, speed, or quiet time.

Assessment

Many educators are overwhelmed by the complexity of technology augmented classrooms. Regular education teachers who include students with disabilities are understandably nervous about dealing with students who might be regularly disruptive. Factoring in some fear of technology, crowded spaces, and unclear expectations, we get a picture of the complexity that might deter a teacher from attempting to use computers with students who have special needs. The single factor that might convince teachers to pursue these solutions is evidence. Teachers must have a repertoire of strategies for ascertaining what effects, if any, computer use might have on their special students. We used some of our class time to discuss ways in which a technology intervention for students with disabilities might be measured for both behavioral and learning effects. For example, a classroom aide or parent volunteer in the classroom might conduct observations similar to those described in the study: momentary time sampling in 15 minute intervals, once a day for two weeks. These can be compared with baseline data on the student's behaviors.

Conclusions

Data from a study comparing ten students' attentive behaviors in a traditional classroom with those in a computer laboratory indicate that, for three of the students, a remarkable increase in attentive behavior occurs when students are engaged in a computer-based activity. Two of the three students were identified and treated for ADD and the third showed a high degree of inattention in regular classrooms. Although not generalizable by any means, these findings do at least suggest that technology should be considered as an option for students with attention problems. Teacher training should include the development of skills in program development, learning environment design, and assessment that teachers will need in order to ascertain whether technology use is, in fact, beneficial to individual students. A large scale study of computer use by students with patterns of inattention is needed to determine the specific applications that enhance or inhibit a student's ability to sustain a learning activity.

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VISUAL LEARNERS AND VISUALLY-BASED LESSONS USING THE INTERNET: MATCHING NEEDS WITH SUPPORTS

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The Internet has many capabilities that make it especially useful with students who benefit from a highly visual presentation of information. These students include those who have auditory learning difficulties or hearing impairments, as well as those who have experienced educational difficulties because they are "at risk" or are second language learners. Because of potentially poor reading and academic achievement, using reading as their primary access to information for these students may be neither efficient nor effective.

The Internet can provide teachers with access to a wide variety of visually-based resources for use in the classroom to enhance textual materials or to provide information in a non-text or text-supported format. These resources include a wide variety of photographs, maps, graphic images, and video. In addition, these resources are archival and currently offering real-time opportunities to participate in events that are still developing as well as to become involved with the narrative, opinions, and personal histories of individuals from the past. This involvement can help stimulate interest and provide primary as well as contextual information that will serve to support other text-based information.

Both the teacher and students can research the Internet and use computer capabilities to identify graphic information for use as primary or supplemental resources. In addition, this information may be easily represented in another conceptual and visual format, such as conceptual maps or semantic webs. Imagery strategies which identify relationships between ideas and chunking of information have been found to be effective in assisting students to process new learning (Dwyer, 1994). Many computer application and word processing packages include spreadsheet and graphic capabilities that can be used to portray information in a visual form.

The combined textual and visual presentation information can assist all students in increasing their conceptual understanding through a more thorough representation and refinement of the concepts to be learned. Some researchers believe that a visual vocabulary precedes a verbal one, such that strengthening the visual vocabulary will assist verbal learning and response capabilities (Hortin, 1994); such an enhanced learning environment ultimately can lead to increased academic achievement (Dwyer, 1994). However, any lessons, regardless of new or unusual formats used, need to be effectively designed and implemented (Hannafin & Peck, 1988).

Effective Planning and Design

Despite the inherent novelty and, therefore, initial motivation in using computers and the Internet, conceptualizing lessons and planning research activities for students need to be based upon principles of instructional design. Based upon recommendations from Hannafin and Peck (1988), effective computer-assisted lessons should:

1. be based on the teacher's instructional objectives;
2. match learner characteristics, such as knowledge and skill levels of students, abilities with various input devices, and type of screens and output used;
3. maximize interaction by asking for meaningful and thoughtful responses;
4. be individualized and adapted to teach topics of interest as well as remedial instruction needed;
5. maintain learner interest through intrinsic merit of the lesson;
6. approach the learner positively, taking advantage of the nonthreatening, patient, and "forgiving" nature of the computer which does not penalize for errors or time taken;
7. provide a variety of feedback: positive when doing well particularly for younger students; and, corrective feedback for older learners and those who desire more efficiency and information about their performance;
8. fit the instructional environment to require minimal teacher involvement, such that lessons can be started and completed without assistance, and will record student performance to be reviewed later when the teacher has sufficient time;

9. evaluate performance appropriately based on meaningful, measurable objectives with accurate assessment of their accomplishment to include the following:
   a. asking the right questions, not just those in the most convenient format;
   b. avoiding ambiguous or poorly worded questions by using the same vocabulary as found in the lesson and that support a correct interpretation by students;
   c. judging answers thoroughly and to include unanticipated responses;
   d. are not confusing an inability to respond with ignorance of the correct answer or procedure;
10. uses the computer's resources wisely with a recognition of the screen's poor resolution in comparison to printed materials, but uses to advantage its capabilities for static and animated graphics, colors, flashing, and sound to amplify ideas and concepts;
11. is based on principles of instructional design to:
    a. motivate the learner;
    b. inform the learner of the lesson objectives;
    c. review prerequisite skills required for lesson success;
    d. present well-organized instruction;
    e. evaluate progress frequently;
    f. provide adequate feedback;
    g. allow for adequate practice; and
    h. evaluate the final performance of both the student and the lesson itself (Gagne & Briggs, 1979);
12. has been evaluated thoroughly and over time, when possible, for instructional quality, affective considerations, cosmetic appeal, curricular relevance, accuracy of the program, and monitors the achievement of the objectives and learners' attitudes toward the lesson.

Internet research lessons and projects are well suited to these principles. A thoughtful and relevant project provides students with a framework for using and expanding their conceptual understanding towards more in-depth learning. In addition, they are allowed to select World Wide Web (Web) sites and resources that portray information in a manner that is most effective for them as individuals. Choice helps to maintain motivation as well as truly individualizing the learning and response format. Group projects allows students also to receive feedback from peers in addition to that provided by the teacher and allows the teacher more time to monitor those that may require some additional assistance.

The quality most often credited as contributing to the effectiveness of computer-based learning is interaction (Hannafin & Peck, 1988). The active exchange of information between student and computer is key, and the ability to individualize is largely responsible for learning efficiency. Use of the Internet for resource searches as well as interactive and multimedia programs provides a forum for high levels of student engagement.

Any project must be carefully designed. With limited access to a computer lab or limited numbers of computers available within the classroom, the logistics of such an activity must be thoughtfully planned. Hannafin and Peck (1988) suggest the following steps in creating a lesson:

a. a needs assessment phase to clearly define and specify the project taking into account the students' needs as well as classroom and scheduling constraints;
b. a design phase to determine the sequence of activities and to select the best, or several potential, solutions as necessary for each instructional objective; and
c. a development and implementation phase which transfers the ideas to a useful format including testing and debugging, formative and summative evaluations, and revision.

Designing a lesson or project using visual materials requires identifying strategies to effectively incorporate visual formats that also address the development and expansion of student concepts and literacy skills; however, not all use of visuals assists with student learning (Dwyer, 1994). Research has found that learners possessing higher intelligence do better with complex visual displays. Yet, by varying the degree of realistic detail within a visual image, a teacher can reduce differences in performance of learners bring different levels of prior knowledge to the learning situation (Dwyer 1987 as cited in Dwyer, 1994). The teacher can suggest certain visuals for certain students, however the variety of resources on the Internet allows individual students to access visuals from which they can choose those which are most meaningful and helpful to them.

Enhanced Learning Using the Internet

Examples of using the Internet effectively include enhanced conceptual development by using (1) topical searches to expand students' knowledge base, (2) to create or expand information presented as graphic organizers (e.g., semantic webs and conceptual maps), and (3) access to video encyclopedias or resources that provide footage of real-world events and their impact on our lives. Topical searches using one of the many search engines can lead students to learn and understand with increasing depth. There are a number of search engines available, some of which may come with your Internet access program. Some of the more common search engines include:

a. Alta Vista (http://altavista.digital.com/): claims to be the largest Web index and is updated daily
b. Excite (http://www.excite.com/): provides a search engine and Web directory by category, with daily news summaries, reviews of Web sites, but does not display URLs;

c. Lycos (http://www.lycos.com/): creates abstracts of pages based mainly on headers, titles, and first words and doesn't do well on complex (Boolean) searches;
d. InfoSeek Guide (http://guide.infoseek.com/): claims to be the fastest index and includes reviews and newsgroups ;
e. World Wide Web Worm (http://wwww.cs.colorado.edu/wwww): is one of the oldest search tools and indexes 3 million sites;
f. WebCrawler (http://www.webcrawler.com/): displays page title and relevancy rankings, works best with simple searches and mainstream information;
g. Internet Search (http://search.internetmci.com/): allows complex searches and restrictions to portions of documents (e.g., header only), provides a list of closest matches and links to document files;
h. Yahoo (http://www.yahoo.com/): is really a Web directory but is the largest and most popular with sites arranged hierarchically by topic, includes a search engine that will search an entire site; and
i. Magellan (http://magellan.mckinley.com/): also is a directory that rates sites on a scale of 1 to 4 stars.

Information from many Web sites and resources can be imported into word processing and other application programs directly, thus facilitating the creation of visual displays within textual material. Access to online and video encyclopedias provide a source of maps, visuals, photographs, in addition to textual material. Graphic representations can be created by using spreadsheet programs (such as Lotus 123, Excel, in addition to those associated with many word processing programs) that make pie charts, line graphs, bar graphs, and other visual images.

Encyclopedias and References

Online news services also provide video segments, photographs, and visual images useful in presenting textual information. A number of these resources are subscription-based but can be a very useful resources for classrooms (*Internet World*, 1996, October; *Technological Horizons in Education Journal*, April 1995, April; 1996, August):

a. Britannica Online subscription service (800-554-9862), 32 volumes with bibliographies, links to related topics within Britannica and to Internet are continually updated by Britannica; http://www.eb.com (librarians and educators can receive free 2-week preview).
b. CNN online (very popular site); http://cnn.com.
c. The Electric Library, K-12 (800-304-3542), free trial version; www.k12.elibrary.com
d. iWORLD Internet news and daily information; links to Internet World, Web Week, and Web Developer magazines; http://www.iworld.com.
e. MSNBC (Microsoft-NBC) 24-hr cable news program, news and high-tech information, audio and video clips for NBC network shows; http://www.msnbc.com
f. National Geographic Online, dramatic photography, original illustrations, maps and interactivity (chats with persons in the field); "visitors" accompany writers, photographers, scientists, and explorers on adventures, receive their images, journals, etc, features rotate weekly, are archived monthly; records people, places, cultures; http://www.nationalgeographic.com.
g. The San Jose Mercury News, the first full-service news site online; http://www.sjmercury.com.
h. Scholastic Online (800-246-2986), K-12 learning organized by curriculum areas: Scientists as Mentors (collaborative), Global Kid Reports (student teams with monthly reports from 7 countries), Animals in the Wild (track and share results daily), Writers Workshops (pair with published authors), Witnesses to History (talk with persons present); daily activities and projects (updated & created by editors, writers, artists, educators); weekly/monthly schedules to integrate into curriculum; professional forums, guides, and mentors for teachers; http://scholastic.com. (variety of purchase options available).

Other resources are video or CD-ROM based but are interactive and multimedia-based:

a. The Heinemann Children's Multimedia Encyclopedia (Reed Technology & Information Services, 800-922-9204), text with video, sound, animations, photos, illustrations, other graphics; articles organized by subject instead of alphabetical listings designed for children 6-12 years old to explore easily; large icons for controls and graphical interface positions.
b. Microsoft's Encarta multimedia encyclopedia (206-882-8080); current affairs, political developments, social and cultural trends, scientific and technological advancements; Pinpointer search tool to find facts, conduct research, browse and create specific lists; academic versions include teacher's activity guide.

Curriculum-based Resources

English literacy skills are supported by (1) text that includes pictorial, graphic, or video footage, (2) student presentations or explanations using both textual and visual information, (3) written communication in participating in bulletin boards, e-mail, and collaborative projects with other classes or Internet users, and (4) communication skills in accessing and researching real-time or information services such as the weather and news. Language arts skills are supported by several specific Web sites and interactive CED-ROM programs, as well as social studies, science, and math-based resources:

Reading and Language Arts

a. Pulpless.Com providing downloadable books (few authors of name yet); $9.95 per book (some special rates); http://www.pulpless.com.
b. Random House horror serial novels, episodes posted twice weekly, setting at fictional Wintervale Univ. with title creature taking over minds of innocent college students and pits against each other; http://www.randomhouse.com/lurkerfiles.
c. Universal Press Syndicate comic strips (Doonesbury, For Better or Worse, Dilbert, etc.); http://www.azcentral.com.
d. "Where the Wild Things Are;" http://www.sau.edu/cwis/Internet/wild/index.htm.
e. On CD-ROM is "Poem Finder '95" (Roth Publishing, 800-899-ROTH) which indexes nearly 500,000 poems from anthologies, single-author collections, and periodicals. It is available on a subscription basis with two discs each year and can be searched by title, first/last line, keyword, date, author's name, pseudonyms, birth/death date, gender, religion, nationality, and profession. It provides definitions of poetic forms and meters.

Science

a. A.D.A.M. Software (800-755-ADAM), shows anatomical features in an interactive manner; http://www.adam.com.
b. Wilson Applied Science & Technology Abstracts (800-367-6770) contains scientific articles on database; http://ww.hwwilson.com.
c. The Biology Place (888-TBP-SITE), focus on inquiry learning; organized around 8 topics: bio-chemistry, cells, genetics, evolution, diversity, plants, animals, ecology; learning activities, research updates, and "The Best of the Web" links (free until 9/13/96); http://www.biology.com.
d. On CD-ROM, "Science Sleuths" (Videodiscovery, 800-548-3472) teaching critical thinking and problem solving skills for middle school students: clues for "Traffic Accident," mystery of "Exploding Lawnmowers," malady at the "Biogene Picnic," mystery of "The Blob."

Social Studies

a. Destination: Time Trip, USA; Destination: Pyramids (Edmark Corp, 800-691-2985), student tools to produce interactive electronic books, movies, and printed works while learning about the program's theme; learning destinations have richly illustrated backgrounds with character "stickers" that animate to create a "movie" including text and sound; individual and group activities in writing, creativity, and communication while creating scenes, choosing and animating characters, planning plots, writing stories, adding music to create interactive adventures; stories can be played back onscreen or printed in color or B&W to share; http://www.edmark.com.
b. On CD-ROM: Canada's Visual History (National Film Board of Canada, 212-596-1770), 2,200 photos, rare paintings, original maps, articles to examine urban growth, conflict, social issues; Keyword Index allows browsing, text in French or English;
c. U. S. Geological Survey CD-ROMs (Geological Survey, Earth Science Information Center, 800-USA-MAPS); structure and composition of locations across the North American continent, photographs of historical mining operations, geological maps; aerial photos arranged by country with applications for vegetation management, habitat analysis, soil erosion assessment; most titles sell for $32.
d. Vietnam, an interactive CD-ROM narrated by photojournalist Drew Pearson who worked for NBC News (Medio Multimedia, 800-788-3866) with 30 minutes of archival footage, original video, hyperlinked text from two books, 200 photos, maps, and timetables; interviews with officials, soldiers, and civilians from U.S. and South Vietnam covering key events 1854 -1982.
e. "Where in the World is Carmen Sandiego?" Junior Detective Version for primary students (Broderbund, 415-382-4400); requires no reading, challenges the students' strategies, memory, and matching skills. It includes full-color photos of international locations, regional maps, animated characters; contains teacher's guide and companion geography book.

Mathematics

a. Paws and Pyramids (GAMCO Education Materials, 800-351-1404), students find a formula to save cats from an evil queen (Egyptian theme). They discover the formula by answering questions about perimeter, area, volume, surface area while using critical thinking skills; includes 22 skill levels and a report of student progress is stored for the teacher.
b. 3001: A Reading & Math Odyssey (702-597-5032), a journey through Greek mythology using painted screens, 3D graphics and animation, and 150MB of speech to teach arithmetic, fractions, decimals, and pre-algebra. Skills are tested on a range of levels, sessions are saved and can be completed in intervals, students may practice math without doing game sequence; online help screens are available.

Several available programs and projects involve e-mail and other communication links between classes and students. The Logo Telecommunications Project (Logo Foundation, 212-765-4918) links students with peers in foreign countries via learning activities. Communication occurs using text, images, and graphics through several Logo-based application programs. Houghton Mifflin Company's School Division, Education Place (617-351-5000) helps teachers K-8 navigate Internet resources and integrate into existing curricula. Activities are divided into reading and language arts, math and social studies, with extensive links and project ideas (http://www.eduplace.com).

In addition to these services, the Internet allows access to topical chat lines and bulletin boards for establishing specific communication and interaction opportunities for students and the teacher. Some news and information services provide on-line "experts" that students can access. Students who have difficulty in communicating through writing will have functional and "live" opportunities during which it is important that they write clearly. Successful experiences will build their confidence and help them learn strategies that can support them through their difficulties, such as asking peers for assistance or reading messages "orally" to themselves prior to sending them.

Summary

Lessons which incorporate a variety of visual information using the Internet can provide current and motivating content for students who otherwise have difficulty learning from text-based information. Classroom presentations and discussions are likely to improve as a result of students having had initial learning experiences accessing materials that are best suited to their learning styles and based upon their personal preferences. Students will be better prepared to participate in sharing and explaining what they have learned resulting in further development both of their own and others' understanding. Simultaneously, they will be increasing their linguistic and communication skills, both in interpreting information for understanding and in expressing it to others.

Both the teacher and students can use the Internet to meet individual and unique requirements in creating projects, lessons, and activities. Learning is flexible and students assist in making resource choices which will best support their own individual learning and conceptual needs. Incorporating the principles of learning and following systematic procedures for lesson design will result in enhanced academic growth through learning opportunities most suitable for each individual student.

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Building an Electronic Community to Serve Children with Special Needs

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Those of us who work in public schools and other human services agencies historically have been separated by time, space, policy, and organizational structure. In many cases, we have duplicated our services in our attempt to serve children and their families. Unfortunately, this practice of services duplication continues today: we ask children and families to visit multiple agencies to get the same service; we ask them to understand and implement multiple service plans; and, we ask them to be passive consumers of professional services.

In our present climate of decreasing federal funding, changing family structure, increasing ethnic and cultural diversity, and a myriad of other changing social conditions, the challenge is before us to create systems of care which integrate the organization, coordination, and delivery of services for children and their parents. At the same time, we must create systems of care in which families are active, equal partners in the organization, coordination, and delivery of services. Such models operating from an ecological perspective can assess relationships between and among children, families, schools, other human services agencies, institutions, and communities to design a single unified family plan.

The PEN-PAL Project: A System Of Care

The Pitt Edgecombe Nash-Public Academic Liaison (PEN-PAL) Project is a community, family, university, and public school partnership to build a community-based system of services for children with special needs and their families. The Project includes three counties (Pitt, Edgecombe, and Nash) in eastern North Carolina along with their school systems, local mental health centers, juvenile justice, health departments, social services, community organizations such as the Boys and Girls Club and ministerial associations, the public schools, community colleges, and East Carolina University. Funding for the project comes from the Center for Mental Health Services (CMHS), Washington, DC. The grant is administered by the North Carolina Division of Mental Health, Developmental Disabilities, Substance Abuse Services, Child and Family Services Section, Raleigh, North Carolina. The long-term goal of the grant is to design a model to provide new and innovative services for children and adolescents with serious emotional disturbances in North Carolina and the nation.

A major assumption underlying the PEN-PAL Project is that integrated, interdisciplinary, interagency services are critical elements of positive, lasting outcomes for children and their families. Through interagency-community-parent collaboration and coordination, services are co-planned and co-delivered, thus reducing or completely eliminating duplication and fragmentation of services.

Goals and Objectives

The primary goals of PEN-PAL at the system-level are:

1. to meet the service needs of children with serious emotional disturbances so that they can remain in their communities,
2. to work as partners with families to plan and provide services that meet their unique needs,
3. to build on strengths of all community groups and local child-serving agencies to develop a seamless local system of services,
4. to provide intensive services in the community to avoid unnecessary separation of children and their families, and
5. to prepare local agency staff and university students in new ways to provide family-centered community services.

Specific objectives for the children being served include:

1. reduction in out-of-home placements,
2. decrease in school suspensions,
3. decrease in referrals to juvenile justice,
4. decrease in school absenteeism,
5. increase in graduation rates, and
6. increase in positive functioning of individuals and families.

The long-term outcomes for the children and their families are to decrease formal service dependency and strengthen naturally occurring community support systems.

Implementation Requirements

The PEN-PAL Project requires in-service teachers, administrators, school social workers, school psychologists, therapists, case workers, and others to have the skills, competencies, and attitudes to work within a collaborative system of care. Such changes in skills, competencies, and attitudes require intensive training as well as on-going technical assistance for those in the field implementing new collaborative ways to work with families and other professionals. The Project also requires an infrastructure to manage and administer the grant requirements. To build this infrastructure and provide training and technical assistance, the PEN-PAL Project proposed the design and creation of a Training and Technical Assistance Resource Center to serve the three counties.

The PEN-PAL Training and Technical Assistance Resource Center

The PEN-PAL Project enlisted the help of East Carolina University to provide personnel, space, and academic computing support. This year faculty from the School of Education and the School of Medicine have worked together to develop the PEN-PAL Training and Technical Assistance Resource Center. The Resource Center's primary goals are to identify training needs, develop a comprehensive training program to meet those needs, develop a core of peer trainers, and provide technical assistance upon request.

Building the Infrastructure to Support Systems Change

The first operational goal of the Resource Center was to create an electronic infrastructure to connect the community agencies in the three counties to area schools, the East Carolina School of Education and the School of Medicine. Using telecommunications, project participants from the three counties could access resources from Web sites, request resources from the Resource center, communicate more effectively and efficiently, and engage in discussions about best practices.

Phase One. A needs assessment for electronic connectivity was conducted through written surveys, interviews, and on-site visits to community agencies. Strategies for providing e-mail and Internet access were developed utilizing existing computer systems as much as possible. An analysis was conducted on the forms, policies, manuals, letters, and data files to determine how these could be shared across the PEN-PAL partners. A Web presence was developed to allow participants to share information, moving to a digital environment.

Phase Two. The second initiative was to provide training in how to use the Internet and technical assistance to install the hardware and software to create the electronic network. The School of Education, as a component of the Microsoft Professional Development Project Program, provided hands-on instruction and practice in using productivity software as well an the initial instruction in using the technologies for distance learning.

Phase Three. The third step was to use distance education to provide training to participants in the three counties. Using e-mail, online conferencing software, video conferences, and the North Carolina Information Highway, a series of staff development opportunities were designed. The East Carolina University School of Medicine, a pioneer in the use of telemedicine as a training and diagnostic tool, extended its delivery to members in the project. In addition, online tutorials are in the development stage. These tutorials, to be available on our Web site, will enable participants to work at their own time and their own speed.

Conclusion

The PEN-PAL Project's electronic network is in its early stages. By June 1997, the expectations are to have installed the hardware and software, to have completed initial staff development for all users, and to have presented our first series of best practices workshops via distance education. The challenge has been to weave together the assorted computer systems, agency software, and personnel skills while also addressing the issues of individual agency policies, confidentiality, and the rights of individual clients. As we move forward during the next three years, the PEN-PAL Project can provide invaluable information about the benefits and the barriers to such electronic multiagency initiatives.

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Assistive Technology and Teacher Education: A Course Design Process

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Recently, the preparation of teacher candidates of students with disabilities included in general education class rooms has received attention from teacher education programs throughout the nation (Behrmann, 1993; Bowser, 1995; LaPlante, 1992). Due to the increasing number of students with disabilities in the general education classroom, many teacher education programs require pre-service teachers to take classes in special education. Similarly, all students who are being prepared for teaching careers at Towson State University are required to successfully complete one course in special education. This introductory special education course addresses the basic issue of including students with special needs in the general education environment. Although students become familiar with the definition, characteristics, and causes of various exceptionalities as well as numerous teaching strategies and modifications necessary for success in the general education classroom, little attention is given to the various adaptive devices students with disabilities may need to use in the classroom in order to access the general education curricula. Moreover, few instructors in higher education are familiar with the wide array of adaptive technology used by students with disabilities and even fewer faculty understand how to prepare teacher candidates to assist students who use those devices (Behrmann, 1993). In response to the need to prepare pre-service teachers for the demands of students with adaptive technologies, a group of faculty members initiated the process of designing a course for pre-service teachers that would address those issues. The purpose of this paper is to present an overview of the course design process and to report on some preliminary data collected and its implications for teacher education programs.

Project Goals and Objectives

The current project is an important component in the design of an undergraduate major in special education at Towson State University. It also represents a collaboration between faculty in the areas of special education and instructional technology and the Baltimore County Public Schools Office of Special Education. This collaboration brings together expertise across disciplines and strengthens the relationship between the teacher education program at the university and the surrounding schools. It is hoped that this collaboration will bridge theoretical and practical issues related to adaptive technologies and classroom practices that will ultimately result in a course of great value to future teachers. There is also a need for an in-service course for those teachers currently teaching who must deal with students with special needs using adaptive devices.

Methods and Activities

During the summer of 1996, faculty members attended the Tri-State Assistive Technology Conference held in Alexandria, Virginia. At that conference, the issue of preparing teachers to assist students with adaptive technologies was discussed in a variety of sessions. Materials were collected regarding the variety of technologies used by students with disabilities as well as programs to educate classroom teachers on the issue. Following that conference, meetings of faculty in instructional technology and special education were held to discuss the feasibility of developing a course in adaptive technology.

In September, a representative from the Office of Special Education of Baltimore County Public Schools met with Towson State University faculty from the respective disciplines in order to discuss the topic of adaptive technology from the perspective of Baltimore County Public Schools. It was decided that a survey of teacher education students should be conducted to determine their familiarity with adaptive devices and their level of comfort in working with students using adaptive technology. The survey form was created and distributed to "core"classes in teacher education (Table 1). The sample included special education, instructional technology, and educational research classes. 211 undergraduate students and 110 graduate students were included in the survey. When completed, the survey forms were analyzed in order to determine the extent to which students were familiar with commonly used adaptive devices, and their degree of comfort in working with students with disabilities requiring adaptive technologies. Results of the survey are reported in Table 2.

Table 1.
Adaptive Technology for Students with Special Needs: A Needs Assessment Survey

Please circle the class in which you are currently enrolled.

SPED 301	SPED 637	EDUC 732
EDUC 605	EDUC 761	ISTC 269
ISTC 541		

Directions: Circle NHO if you have NEVER HEARD OF this device or software OR circle HONU if you have HEARD OF THE DEVICE/SOFTWARE BUT NOT USED. Then circle the # that best describes your level of comfort in assisting a student with special needs in utilizing this device. Very comfortable (1) UNCOMFORTABLE (2), COMFORTABLE (3), OR VERY COMFORTABLE (4).

Types of Hardware	**Experience**		**Comfort**			
Tape Recorder	NHO	HONU	1	2	3	4
Typewriter	NHO	HONU	1	2	3	4
Audio Card Reader	NHO	HONU	1	2	3	4
Keyboard Overlay	NHO	HONU	1	2	3	4
Expanded Keyboard	NHO	HONU	1	2	3	4
Spell Checker	NHO	HONU	1	2	3	4
Grammar Checker	NHO	HONU	1	2	3	4
Talking Calculator	NHO	HONU	1	2	3	4
Touch Window	NHO	HONU	1	2	3	4
Head Pointer	NHO	HONU	1	2	3	4
Mouthstick	NHO	HONU	1	2	3	4
Page Turner	NHO	HONU	1	2	3	4
Keyguard	NHO	HONU	1	2	3	4
Switches	NHO	HONU	1	2	3	4
Speech Synthesis	NHO	HONU	1	2	3	4
Speech Recognition	NHO	HONU	1	2	3	4
Type of Software						
Electronic Books	NHO	HONU	1	2	3	4
Word Processor	NHO	HONU	1	2	3	4
Tutorials	NHO	HONU	1	2	3	4
Drill & Practice	NHO	HONU	1	2	3	4
Simulations	NHO	HONU	1	2	3	4

Table 2.
Adaptive Technology for Students with Special Needs: Results of Needs Assessment

Types of Hardware	**Experience**		**Comfort**			
	NHO	**HONU**	**1**	**2**	**3**	**4**
Tape Recorder	.6	5.6	2.8	1.9	13.1	76
Typewriter	1.2	8.1	4.4	5.0	21.2	60.1
Audio Card Reader	62.3	19.3	3.4	5.0	6.2	3.7*
Keyboard Overlay	47.2	26.6	3.1	5.9	11.3	5.9*
Expanded Keyboard	48.9	25.2	4.4	6.0	8.8	6.6*
Spell Checker	1.3	10.0	2.5	5.3	19.1	61.8
Grammar Checker	5.0	20.9	3.1	8.8	23.1	38.8
Talking Calculator	22.9	37.9	5.0	6.9	11.3	15.7
Touch Window	24.7	21.8	5.7	9.2	17.1	21.5
Head Pointer	56.0	23.0	5.0	4.7	4.7	6.6*
Mouthstick	54.3	32.1	5.1	5.1	1.6	1.9*
Page Turner	42.5	40.0	5.4	4.8	4.1	3.2
Keyguard	70.7	18.5	3.8	3.5	2.2	1.3
Switches	79.6	11.1	4.1	2.2	2.5	.3
Speech Synthesis	56.1	31.0	4.0	4.3	3.3	1.3*
Speech Recognition	62.9	27.1	3.5	2.6	3.2	.6
Type of Software						
Electronic Books	21.1	32.6	6.1	7.3	15.7	17.3*
Word Processor	.3	11.5	3.5	5.4	25.0	54.2
Tutorials	16.0	27.2	5.1	11.8	16.3	23.6*
Drill & Practice	26.0	20.2	5.1	7.4	19.2	22.1*
Simulations	28.6	25.1	4.8	10.3	15.8	15.4

**Chi-square analysis showed a significant difference (p.<.05) between graduate and undergraduate students for these items. The numbers in the table represent percentages for each level of experience and comfort.*

Outcomes and Impact

There were several important outcomes of this project. First, it was apparent that few pre-service teacher education students were familiar with most of the commonly used adaptive technologies. Second, it was clear that even fewer students considered themselves to be comfortable in working with students with disabilities who might require their assistance in the classroom while using these technologies. Specific information from the survey will be used to design the course "Adaptive Technology and Special Needs Students." Based upon the survey results, a case can be made to include such a course in the new special education major at Towson State University. It also indicates that there are differences in the needs of graduate and undergraduate students, suggesting that a graduate course should also be developed.

Timeline and Completion Dates

Data analysis were completed in November of 1996. Based upon that analysis, the proposed new course will be submitted to the curriculum committee of the Department of Reading, Special Education and Instructional Technology at a department meeting in February. If approved, the course will then move through the curriculum approval process of the university. That process involves approval by the College of Education Curriculum Committee and by the University Curriculum Committee. Pending the approval process, the course could be scheduled to be taught in the fall semester of 1997.

Evaluation Plans

Quantitative data were collected which indicated the need for such a course in the preparation of teachers at Towson State University. In addition, collaboration with the surrounding school system indicated the need for in-service work by classroom teachers. Based upon this collaboration, the preliminary course will be evaluated by Baltimore County Public Schools, Office of Special Education, and comments from that office will be considered in the design of the course. Once developed the course will be evaluated by students and faculty at the end of each semester, and modifications will be made as needed.

Current dissemination plans include sharing of the course contents with the surrounding school systems of Baltimore City, Anne Arundel County, Howard County, Harford County, and others where appropriate. In addition, presentations at the Eastern Educational Research Association and the Maryland Association of Teacher Educators are planned.

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Technology Diffusion

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Webster's New World Dictionary defines diffusion as the "dissemination of news, cultures, etc." This definition offers a good perspective for this section of the *Technology and Teacher Education Annual.* Too often onlookers think about the diffusion of technology only in terms of the spread of hardware and software. But the *news* of technology integration often involves complex issues of how we do business—how we think about teaching and learning and how we relate to the procedures and *cultures* of our educational institutions. A second definition from *Webster's* characterizes diffusion as a "scattering of light rays." In a metaphorical sense, this definition is also apropos as this section documents numerous examples of innovative projects and insights that *illuminate new* methods and directions.

The first group of papers documents various aspects of integrating technology into teacher education programs. Cooper, Browne and Maeers describe a four-year plan to infuse instructional technology into their elementary teacher education curriculum. The authors examine obstacles that they have encountered and critique their attempts to solve them. Paccione, McWhorter and Richburg tell about the Project Promise model for coaching preservice teachers in technology use. The program, which has evolved at Colorado State University over the past eight years, is in its second year of infusing a rigorous technology component. The model includes three main "chunks" of direct instruction followed by lengthy and diverse field experiences.

Sanche, Haines and Robertson describe an innovative project in which special education faculty have integrated a software system specifically designed for collaborative teams working with special needs students. The *CoPlanner* software has built-in features that help teams explore the needs of students, create a personal program plan, implement the plan, monitor the student's progress, and communicate with other team members.

Dirksen and Tharp document their use of the Concerns-Based Adoption Model (CBAM) to determine preservice teachers' concerns about technology use and their ability to integrate technology into their teaching. Results of the stages of concern questionnaires, which were administered on three separate occasions throughout the study, are presented.

The next two papers focus on university/school district collaboration. LeBlanc and Oates describe a project, funded by the U.S. Department of Education's Funds for Innovation in Education, to develop, implement, and evaluate a model for providing district-wide teacher training employing a "train the trainer" model. Evaluation data show substantial change of teaching behaviors for project participants. Hoskisson and Stammen describe a collaborative effort of university and school district personnel to create training materials for inservice and preservice teachers in the area of computer-based multimedia. The authors document their efforts to transform print-based training materials into interactive, CD-ROM-based modules.

K-12 planning and inservice efforts are addressed in the next two papers. Dexter reports on a two-year case study that examines technology planning in a large suburban school district. The author uses symbolic interactionism as a lens to examine the planning process and analyze how various stakeholders and administrative structures shape implementation. Garcia, Johnson and Dallman detail an elaborate and structured inservice program designed to expand the use of technology for meeting curricular goals at the elementary level. Their model includes expectations of active leadership by the school principal to motivate, support, and reward teachers to help overcome resistance to change.

K-12 issues are further explored in two papers that report on surveys of current technology use by teachers. McKenzie, Kirby, Clay and Davidson surveyed all the technology trainers and media specialists in two school districts to determine what hardware and software teachers are using and what problems they encounter. Isaac and

Ganske surveyed teachers in Alberta to find out how teachers are using "low-tech" media (i.e., media that are "pre-microcomputer") and how the push for "high-tech" media is influencing patterns of usage of the older tools. The authors found that traditional media are still commonly used in K-12 classrooms and conclude that more attention to "low-tech" media should be given in teacher education programs.

The papers in the final group address various aspects of technology integration. Twining offers an analysis of the literature on educational change designed to help readers evaluate if pursuing a particular technology-based project is the worth the effort. He suggests a three-question decision tree and discusses details involved in each of the questions posed. Bowers, Rodriquez, Budd and Campbell examine the reflections of four educators as they consider their experiences in learning to use technology in an educational setting. In this paper, a special education teacher, classroom teacher, principal, and university inservice provider present their thoughts on the often intimidating process of technology integration.

Tykwinski, Thompson and Grooters describe the use of notebook computers at one university. The authors provide information on hardware and software as well as improvements to classrooms, networking capabilities, and training. Meyer and Schranz describe an informal group of computer-users at one university who voluntarily meet weekly to address computing problems on campus. While holding no official responsibility, the university has come to recognize the group as a valuable resource and calls upon them for advice regarding funding priorities, etc. The authors suggest that this model could work in other university and secondary school settings.

Finally, Broughton provides guidelines for incorporating the use of the Internet in secondary schools. She presents issues for determining which lesson plans might include an Internet component, suggestions for implementing an Internet project, and resources for teachers that can be accessed directly from the World Wide Web.

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60 IN A 20 ZONE: TECHNOLOGY AND TEACHER EDUCATION

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Let us imagine a school. It is on the edge of a city. The streets around it are residential. A school zone, with a speed limit of 20 mph regulates traffic flow around it. Down at City Hall a group of forward thinking officials decide the city needs a freeway to keep the city safe and prosperous, to bring tourists and new business. The best route for the freeway goes right by the school. After much debate it is built, but there are no access ramps near the school. The school and the freeway seem to exist in separate worlds.

This is very like the situation in which teacher educators find themselves when they begin to use computer-related technologies (CRT) in teacher education. The authors work in an elementary teacher education program. This paper describes our experiences as we began to try to integrate CRT into our work in an existing program. The problems which we faced are described, some attempts to solve them are outlined and critiqued.

The Problem

Whether we like it or not, technology is changing what teachers do. The public expects teachers to know how to work with children using new tools of CRT. Many children are technologically sophisticated. Often, preservice teachers are less so. Teachers are asking teacher educators (and our newly-trained preservice teachers) to provide in-service in the use of technology in schools.

When we at the university try to respond to these demands we become aware that we are located in an institution where change is always carefully examined and gradual (Kapuscinski, Browne, Krentz, Cooper & Goulet, 1995; Lanier & Little, 1986). To make a program or course change one must navigate several levels of committees. Moreover, the pragmatic need to realign the contents of the teacher education program to include advanced technologies is not as important to our institutions as publications in established refereed (hard copy) journals. We may be in a time of rapid change and realignment, but the requirements for promotion and tenure in the university are the same as they have been for 20 years. Expectations have increased and resources have not.

Attempting to provide teacher education which will enable teachers to work well with CRT in this institutional environment is like trying to drive at freeway speed in a school zone.

Our Story

This story began when we decided to include the Internet, e-mail and some presentation software in the classes we teach. Naively, we thought we could just begin. We asked students to reflect, in electronic journals, on what they had learned in our classes. But there weren't enough computers in the computer lab. The computers and the mainframe were often down. We had no one to teach the students how to use e-mail and the e-mail programs available were not user friendly. Problems multiplied.

We began to use the Internet as a source of teaching materials. We tried to use software packages such as Powerpoint with our students and in our own teaching. We tried to learn to use everything at once. We began to recognize gaps in our knowledge and even more gaps in our technical support. There was no one to teach us to use the technologies, so we spent many unproductive hours teaching ourselves. We needed immediate access to computers with large memory and these were jealously guarded by the lab technicians. We couldn't get them moved to offices or classrooms. Hours were spent ordering free materials and demonstration hardware and software in an attempt to solve our problem outside of budgetary restraints. The new programs we ordered were complex and required hours of learning time. In our busy lives this meant that many of them sat on the shelves unused.

We approached our superiors and outlined the problems. They responded in the usual way. Committees were set up. One of the authors of this paper was on six technology related committees. There were sub-committees of standing committees, ad hoc committees, and a standing committee that was advisory, but no committee which had any control over budget.

Some faculty were resistant to the use of CRT. Their eyes glazed as we talked about computers in teacher education. They couldn't understand where we found the time to "play" with our computers while they were busy writing papers for publication. We were "wasting our time," "nuts," or "not thinking about our pensions."

In addition to all this, teaching and learning using computer-related technologies required us to think about knowledge in unconventional ways. Recent research clearly documents the importance of knowing "how, where and why", not simply knowing "what" or knowing "about" (Skemp, 1989). This research is particularly relevant to problems of teaching and learning using CRT in teacher education. We wanted to model what we were expecting students to do. One of us developed a personal web site to post ideas, readings for weekly classes. She tried to develop and use new materials with multimedia programs, only to be tripped by details such as: "Which cable should I use to make the data projector work with the Mac?"; "How can the server machine for the web site and the CPU connected to the data projector be on at the same time?" and "I need to teach myself Power Point this weekend so that I can use it for my class presentation."

We spent time with each other and our students, teaching each other, trouble-shooting, talking, and solving problems. We were not simply giving the students autonomy to be part of the decision-making in learning—we were, in many cases learning from them. They made decisions and in some cases we were their assistants; they facilitated our learning, by what they knew and how they worked with us to enable us to learn, or by virtue of the fact that we were learning together. The student teachers saw their professors in various roles, as learners, as confused learners and as frustrated and angry learners. The workplace had changed dramatically for us all. In the end, we found no solutions, but we have learned so much. Having acquired a taste for the fun and excitement of "playing" with CRT we are determined to continue.

The Four-Year Plan

In an attempt to solve some of the technical problems and develop a reasonable sequence for teaching student teachers to use CRT, a faculty committee (on which one of us served) developed the following proposal.

In the first year students would use e-mail to communicate with school students to enable them to learn HOW to do e-mail. They would learn basic key-boarding skills, basic word processing and basic spreadsheet applications. Progression into year two of the program would be possible when students could illustrate proficiency in the above areas. Students would also explore the Internet using URL and various search engines. They would find and explore kid links and teacher links, and compile a report on these activities.

In the second year students would continue to build facility in skills from year one. They would do an assignment using a multi-media program such as Hyperstudio. In the second semester, when students move into subject specific methods courses, they could be introduced to subject-specific software, web sites, CD-ROM material, etc.

In the third year students would continue use of subject-specific software, web sites, etc. in subject area classes. They would use e-mail, computer, and Internet skills to locate resources and make pedagogical decisions about those resources and begin to use this information in their lesson planning and teaching. They would also learn the basics of designing a home page, and create a personal/professional home page.

In the fourth year, which has one semester of practicum and one of coursework, students would propose and complete a project using advanced multi-media and/or Internet. They would mentor a first or second year student in instructional technology.

The plan is a valiant attempt to address all aspects of the problem while concentrating on preparing teachers who can use the tools of CRT to educate children. The proposal, which was created by one sub-committee, is now in between committees.

The Critique

School zones can be frustrating places. They make us drive slowly but they exist for good reason. They protect. In this they are analogous to the bureaucratic structure in a University faculty. Procedures and committee structures frustrate. They make change very difficult. They also protect. Without their gatekeeping function, many ill-considered changes, program and practices might become part of the faculty. So it is with the time honored administrative structures of our faculty.

The freeway brings new products, new possibilities to us. But it also has no speed limits, or speed limits far too fast for those who live and work in the school zone. It encourages the development of faster and faster cars. It encourages the development of wider, better freeways. These eat land and resources. Everything begins to move so fast it is very difficult to make careful decisions. As we need to learn special driving techniques to safely navigate the freeway, we need to learn to think about many problems in unconventional ways if CRT is to become a useful tool for teachers.

Our story demonstrates the practical problems which face those who are beginning to use CRT in teacher education. Underlying these practical problems are several problematic assumptions. Beginners, institutions and individuals mistakenly assume that existing organizational principles and structures will be capable of constructing solutions in this new problem environment. Committees, for example, are valuable gatekeepers, it is true, but CRT problems change so rapidly (you just learn gopher and it's gone) that committee decisions are often obsolete before they're made.

This is closely related to another problematic assumption, the assumption that the Internet is analogous to a library and software programs to books. They are not. They grow, change, mutate faster than decisions about their use can be made. The problem is that teacher educators are used to making careful choices which will govern action for a considerable time. This view of change is challenged by the speed of the development of CRT.

Finally, in the midst of such speed and uncertainly, it is easy to confuse learning about a tool such as Hyperstudio with learning how to use this tool to teach children. This error is wasteful of an already critically scarce resource, time. It is so difficult to direct one's attention away from the glamour and glitz of the technology and towards the uses we might sensibly make of it.

To begin to understand how we might solve some of our problems with CRT, we must look differently at the goal of faculty procedures for decision making about technology acquisition and curriculum change. We must learn not to ask first "How will we teach our students to use CRT and how will we get the resources to do so?" Our first question must be "What must our students understand about teaching and learning using CRT?" The answer to this question can be used to guide a constantly changing process of decision making which will be able to match the constantly changing state of CRT available to teacher educators. It will help us to avoid the seduction of the technology until we understand more clearly the purpose for which it is best used in schools.

Technology is changing the way we teach and learn and is changing our concept of how a faculty should enable students to become teachers. The classroom of tomorrow, tomorrow's teacher and tomorrow's learner will be quite different from what most of us have experienced. If faculties of education continue to promote and propagate instructional notions of the traditional academy, they cannot ethically be preparing teachers to cope with and excel in the classroom of tomorrow.

Knowledge and Knowledge Acquisition

Our views of knowledge and knowledge acquisition must change. Some of our faculty and preservice students believe knowledge can be packaged in "containers" to be "transmitted." They hold the traditional view of teachers as authorities who have knowledge and know precisely what to do. Computer-related technologies challenge this belief.

We must ask how a novice becomes an expert in CRT? What does it mean to be an expert in technology? What does it mean to be a teacher in this kind of situation? What does it mean to be a teacher educator working with tomorrow's teachers? We think it means a complete reconceptualization of what constitutes knowledge, and how this new concept of knowledge should be "delivered." We can begin this reconceptualizing by thinking about knowledge and its uses.

We should ask ourselves how can Elementary Preservice Teachers learn CRT with understanding, in a relational and connected way, not in a rule bound, instrumental manner? (Skemp, 1989) Pirie and Kieren (1991) provide help in this. They developed a model which depicts mathematical understanding as an evolving process of organizing one's knowledge structures. In relation to CRT, this view of coming to know is developed into the following model.

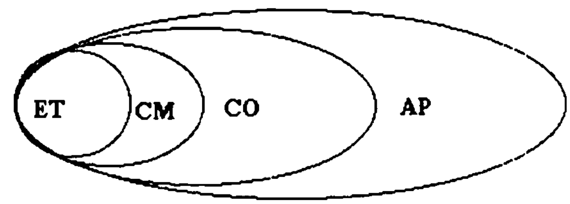

Figure 1: Phases for Coming to Understanding Informational Technology.

Ethnotechnological Knowledge (ET)

This is a starting place for growth in any IT component. People know a great deal about technology from how they have lived, from popular culture. "I know this is something new and something I should know how to do, but I don't." ET is the starting place for learning CRT and may be different for every person. It is defined by the culture they have grown up in, the culture of their peers, the familial, social, and historical experiences that have disposed them to learning CRT.

Concept Making (CM)

When faced with a new technology, learners build concepts through specific doing. They need specific instructions. Without specific instructions these learners randomly explore. They cannot make a personal plan of action, but are dependent on support—either a manual, a guide, or a more able learner (Wertsch, 1981). A concept maker would be seen surfing the web erratically, entering a specific URL, finding sites by chance or trail and error, with no plan to retrace steps to such a route.

Concept Organization (CO)

At this level learners have had several experiences on the web. Separate concept making activities are related to each other. Learners may have a mental image of where they're going and be able to plan a route to get there. It's not always an efficient route, but they understand what the technology can do and they can figure out a way to do it. A person in the concept organization phase recognizes increasing sophistication in his or her understanding of the sub-components of CRT.

Analytic Processing (AP)

This phase is characterized by sophisticated analysis. Learners evaluate tools and select the most appropriate. They can explain their procedure for web usage or for word processing documents. This is where we want our teacher educators to be.

Student teachers and teacher educators seem to need to reach the analytic processing stage in their understanding of computer-related technologies before they are able to begin to understand the difference between learning about an exciting tool (a specific CRT) and planning to use it in ways which will foster student learning about all of the concepts and skills which make up an educational curriculum.

If this is true, then faculties of education must spend money to ensure that a majority of faculty members have reached this level of understanding. Until they do we have the blind leading the blind, unaware of the distinctions between the freeway and the school zone, unable to plan a productive relationship between them. In this sad case many teachers and children will be hurt, not helped by the existence of the CRT freeway near their schools.

Conclusion

The school must take advantage of the freeway without being blinded by its speed and glittering promises. The school must build a footpath over the freeway on which children may safely pass its dangers while their teachers help them to learn the things they will need to use it productively. This footpath will be constructed of a new view of change and of coming to know. In the Elementary Program of our Faculty of Education those of us who have been exploring the use of CRT believe that preservice teachers need more than a basic skills approach to informational technology. It simply is not sufficient for students to have technological expertise. They need to understand these technologies as pedagogies. They need to know how to determine appropriateness and usefulness. They need to explore and become familiar with the new technologies. Their knowing about CRT precedes discriminate and critical use of CRT. Knowing about CRT precedes integration of these new technologies into effective teaching and learning.

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COACHING PRESERVICE TEACHERS IN TECHNOLOGY: THE PROJECT PROMISE MODEL

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In 1994, schools across the U.S. collectively spent about $3 billion on technology related to networks and computers. President Clinton and Vice President Gore spent a weekend installing telecommunications cables in California schools. The general populous has become infatuated with the internet. However the question remains, to what degree are Schools of Education equipping future teachers to use this technology for effective instruction?

Between the years 1983-1995, the number of students per computer in U.S. public schools shrank from 125 to nine (Glennon and Melmed, 1996). Despite this rapid growth microcomputers have yet to spark a broad revolution in teaching and learning. While personal computers and networking may have revolutionized the business world and captivated the imagination of the general population, they have yet to revolutionize the field of education. It is our contention that until teachers master the use of technology in the classroom, the revolution will continue to bypass education.

In this paper we will describe how Project Promise, an experimental teacher training program at Colorado State University is training its preservice teachers for a future of technology. Project Promise is a Colorado Commission on Higher Education (CCHE) designated "Program of Excellence" in teacher training (Richburg, Knox, Carson, & McWhorter, 1996). The purpose of the project is to use "best practices" in the training of future teachers. Within the Project Promise Model the training and subsequent mastery of technology occurs gradually over the ten and a half month program. This gradual process produces mastery and accommodates the varying degrees of technological knowledge each student brings to the class. Inservice teachers who have mastered the use of computers in education report that they have done so through a gradual process with the support of others along the way (Sheingold and Hadley, 1990). The cohort of 20 Project Promise students provides the requisite support and encouragement for preservice teachers to become proficient in the use of technology. The Project Promise staff works diligently to bring all of the preservice teachers up to the level of mastery.

Whole-Part-Whole Strategy

Project Promise is attempting to train a new generation of teachers who are at ease in front of a computer terminal. Our approach includes a whole-part-whole strategy often found in the arena of athletic coaching. To achieve optimal results, coaches examine the **whole** performance and then scrutinize and remediate the component **parts.** Coaches understand that the success of the finished product is dependent upon the precision and mastery of the component parts. Therefore, if they can recruit their athletes, coaches will select those who have demonstrated command over the details of the sport. Once the athletes have mastered those components, a coach will reassemble the parts into a more effective and more productive **whole.** This step requires creativity and a vision for what will be successful. For the final product to be successful, it must accomplish precisely what the coach has envisioned. This whole-part-whole strategy is repeated until the desired outcome is achieved. Project Promise attempts to replicate this model.

In technology training the **whole** is a fundamental shift in the pedagogical environment towards promoting student achievement rather than simply the acquisition of new skills. Glennen and Melmed (1996) found that educational technology has significant potential for improving student learning. In the Project Promise Model, preservice teachers are continually encouraged to be facilitators of students' success. One way this is accomplished is by using technology in tailoring educational experiences to meet the needs of the learners. Kulik (1994) found that students usually learn more in classes in which computer-based instruction is used. Therefore, Project Promise students are trained to use technology as an instructional tool to enhance the potential for learning of all students. In addition, research indicates that students enjoy classes more, appear more motivated, and are more attentive in classes which use technology (Kulik, 1994; Schofield, 1995).

The **parts** of the training include technological skill attainment and development using particular hardware and software. Students are instructed in the use of devices from printers to scanners to digital photography. While a number of school districts across the country report that they will be requiring 1-10 hours of technology training for their teachers (Barron and Orwig, 1995), Project Promise students will receive 25-30 hours of direct instruction and hands-on practice. In addition they are expected to infuse technology into their lesson plans. As students achieve mastery of the technological **parts** they progress toward a new **whole**. As coaches, the Project Promise staff has the ability to work with preservice teachers on an individual basis to assist them in developing their best performance.

Preservice teachers who have mastered the component **parts** of technology, and understand the purpose and benefits for using technology in the classroom, can begin to incorporate it as a tool in their classroom. The teacher can more readily adopt a "guide on the side" pedagogical stance and devote more time to individualized instruction. The instructional focus becomes more student-centered, with students often assuming the role of expert (Schofield, Eurich-Fulcer, & Britt, 1994; Sandholtz, Ringstaff, & Dwyer, 1990). This frequently leads to collaboration between students as they help one another succeed in using technology (Means and Olson, 1995).

Teacher-to-Teacher

The Project Promise teacher training model is designed so that students receive three main "chunks" of direct instruction followed by lengthy and diverse field experiences. During the fall instructional session, students are introduced to technology on the first day of registration. All students, even those with no computer experience, are instructed in a mini-lesson on how to access a site on the World Wide Web. This particular site has an online version of the Kersey Temperament Sorter, which Project Promise students are required to complete. The School of Education at Colorado State University houses a computer lab with 20 Macintosh and more than 30 IBM computers. Our 20 students can complete their first assignment with relative ease. This initial success often assuages the fears of those students with no computer experience.

During this early fall session, Project Promise students will engage in eight hours of technology training. Included is instruction in the basics of internet usage: e-mail, newsgroups, listservs, and accessing the World Wide Web. This initial training is intended to enable students to locate and retrieve resources to supplement pedagogical and content area knowledge. This is primarily a **Teacher to Teacher** phase of the instruction. Students learn how the internet can be beneficial to professional development and content area enrichment.

In a four-part process, Project Promise students are introduced to ways in which they can access information from around the world. First, they set up an e-mail account at the University. This allows them to communicate with one another and with the staff more conveniently. Next, students are introduced to newsgroups where teachers share ideas and concerns. As preservice teachers, they have more questions than they have answers. The newsgroups become an additional source of information about the complexities and realities of teaching. Then students learn about listservs which specialize in K-12 teaching. Here, they can delve into a deeper conversation about particular issues. Finally, students discover the wonders of the Web. The number of web sites which are devoted to education has seen a steady growth. To reduce the time spent following hypertext links, students learn how to use search engines for locating specific information. In addition, a Project Promise resource page has been created for their use (http://promise.cahs.colostate.edu/Project/Promise.html)

This entire fall session of technology instruction is designed to heighten awareness of the immensity of resources available to teachers. This allows preservice teachers to streamline schedules. Preservice teachers' concerns about content knowledge and classroom management seem to take priority over reflective practice and creative lesson designing. In addition to instruction and practice using information technology, students learn how to use software for managing the classroom. This includes software for keeping track of grades, attendance, seating assignments, and lesson plans. We have found that when preservice teachers learn to take advantage of the resources available through technology they have more time to devote to their pedagogical development.

Teacher-to-Student

After the first instructional session, which lasts for seven weeks, the Project Promise students begin an 11-week field experience. During that time they meet one evening a week for seminars. Technology is taught in four of the seminar sessions which lasts for two hours each. The technology seminars consist of instruction and practice in the basics of computer and peripheral device usage. This includes: word processing, spreadsheets, HyperCard®, and the use of scanners, digital photo equipment, video/audio capture, computer-to-TV hookup as well as LCD projection panels.

During this phase, preservice teachers implement the use of technology (parts) into their lesson plans as they continue their student teaching assignment (whole). This creates a **Teacher to Student** paradigm. At this developmental juncture, preservice teachers use technology as elements of their lessons; particularly for mini-presentations or for content enhancement. Their students are introduced to the integrated use of technology to supplement classroom instruction. In addition, preservice teachers begin to introduce their students to the internet. Some secondary schools with which Project Promise works have computer labs with direct internet access. Our teachers can then set their students up with e-mail accounts. They can use the training they have received as a model for introducing their students to the Web.

Student-to-Student

Upon completing 11 weeks of student teaching, Project Promise students return to the classroom for a three-week January inter-session. During this time they participate in an intensive, six-hour weekend workshop to learn the mechanics of presentation software. Students learn how to design and format slides in PowerPoint ® and cards in HyperStudio ®. They spend time learning how to import video, clip-art and sound from web sites to use in their presentations. This lets the teacher model the use of presentation software as they instruct. The primary purpose for this instruction is so that Project Promise teachers will be able to guide their students in developing individual or group presentations. This orientation is **Student to Student**. The secondary student will organize and construct a presentation for an assignment in class. The teacher, who has now achieved proficiency with the software, can effectively guide the students in the development of their projects.

After the January inter-session, the students embark on another field experience. Upon the completion of nine weeks of student teaching, the Project Promise students return for their final instructional session. During this time they will receive an additional four hours of training in technology. This final training consists of Web site development and HTML instruction. Students author their own home pages and post them on the Project Promise file server. Students' technological proficiency is assessed authentically through student-designed projects. They are required to demonstrate evidence of their competency, including the direct observation of a lesson in which they implement technology.

Looking to the Future

The Project Promise Program has been training teachers for eight years with an experimental model. The model remains fluid and continually strives to incorporate best practices in preparing teachers. This is the second year that Project Promise has included a rigorous and comprehensive technology training component in its preparation of teachers. To date, the **whole-part-whole** model for training in technology has been highly successful. Project Promise students are career change professionals with an average age of 29. Many come to the program with little computer experience. As a result of the training they receive, Project Promise preservice teachers often are more knowledgeable in technology than their cooperating teachers in the field experience. Former students report that this training enhanced their marketability in the job search process (20 of our 21 graduates of the class of 1996 have teaching positions, one has opted to pursue graduate school). While we have only recently begun this practice we believe it has the potential to become a model for training teachers for a technological future.

Acknowledgement

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CoPlanner: Integrating Computer Technology into Preservice Resource Teacher Education

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Today teachers are beginning their careers in a highly technological world. Computers have become necessary tools in every aspect of their lives, including teaching and learning. School boards expect computer competency as an entry skill for new teachers, and still teacher educators have been slow to recognize their responsibilities in the preservice preparation of these teachers (Harrington, 1993; Hunt, 1995; Resta, 1993). The present paper describes an innovative project in which special education faculty integrated computer technology into a preservice resource teacher education program.

While there is a growing body of literature on the issue of infusing technology into preservice teacher education, papers by Fulton (1993), Norvack & Berger (1991) and Resta (1993) are particularly germane. In her keynote address at the STATE conference in California, Fulton (1993) provided both a retrospective and a perspective on the increasing role of computer technology in education. From her experience in the Office of Technology Assessment, Congress of the United States, she summarized a number of studies which showed that while most teachers wanted to use the technology, they were either not using it very much, or were using it in relatively narrow applications. Above all, she noted that new teachers coming from schools and colleges of education were not entering new teaching jobs ready to teach with technology. In concluding her paper she noted that the next major issue on the educational agenda was how to bring about "a marriage between teachers and technology", that is, how to prepare teachers to integrate computer technology into their teaching.

The state of Michigan had earlier established a task force to study ways of integrating computer technology into the preservice preparation of teachers (Norvack & Berger, 1991). State education officials and school boards were also concerned that new teachers were not well prepared to use computer technology. The Michigan Task Force suggested that much more be done to integrate technology into teacher education during initial preservice preparation. Specifically, the Task Force recommended that teacher educators: a) model teaching with computers, b) make sure that teachers-in-training are taught to use the computer in teaching, and c) that teachers-in-training be able to show proficiency in the use of computers during field practica.

Resta (1993) reviewed some of the barriers colleges of education experience in trying to infuse computer technology into preservice teacher preparation. He then listed the 13 computer competencies which the International Society for Technology in Education said newly graduated teachers should have. These competencies include some associated with using the computer as an aid to instruction and others related to using the computer as a personal planning and productivity tool. Finally, he reviewed new and emerging models for infusing computer technology into teacher preparation programs.

These three papers supported the ways in which special education faculty at the University of Saskatchewan responded to student requests for the inclusion of more course content on the use of computers in resource teacher preparation. Since we prepare our resource teachers in a collaborative model, faculty reviewed published computer programs in search of software to support the collaborative roles of resource teachers. We were particularly interested in a software package which could be used—according to the Michigan Task Force recommendations—in preservice teacher education and subsequently as a long-term tool for practicing resource teachers. Not having found any such software, we obtained an innovative project grant and, over a five year period, conceptualized, programmed, and field-tested "CoPlanner". CoPlanner is an open software system, which can be readily adapted to any local resource teacher education program. Its strength is in the fact that it is equally effective in preservice resource teacher education and in subsequent use as a support for collaborative teamwork in schools. After three years of using CoPlanner in our own program, we have found that our students do indeed learn to use the computer effectively through preservice education, as the Michigan Task Force had predicted (Haines, Sanche & Robertson, 1993; Sanche, Haines & Robertson, 1994).

What is CoPlanner?

CoPlanner is the first software system specifically designed to mediate the efforts of collaborative teams working with students with special needs. These teams— which today frequently include the students with special needs and their parents, as well as classroom teachers, resource teachers, and other support staff— strive to maintain effective, on-going communication as they plan with the students. Also, they try to be thorough and systematic as they create a single, shared, accessible plan for each student. CoPlanner has built-in features to help the team: (a) achieve consensus on the needs of the student, (b) create a detailed personal program plan, (c) implement the plan and monitor the student's progress, (d) maintain confidentiality of student information while providing ready access for all team members, (e) facilitate effective on-going communication among all team members, and (f) save team members time and energy in planning, record keeping, and reporting.

There is usually a team of two or more support staff, including the resource teacher, serving most students with special needs. CoPlanner empowers these teams to work collaboratively and to communicate effectively as they collaborate. Team members can use CoPlanner to send e-mail messages, they can share documents from the student's file, or indeed they can transfer the student's complete file confidentially and instantly. An initial collection of useful assessment and teaching tools is provided with CoPlanner. Teams can add their favorite tools to the initial collection.

The following are the CoPlanner features which support collaborative planning and service delivery:

- **Program Planning Worksheets.** At the core of CoPlanner are preformatted, two-dimensional, electronic worksheets which facilitate collaborative team planning for a student with special needs. These worksheets are configured according to a generic intervention model, with guiding questions to focus the support team on relevant information for planning.
- **Forms Tool.** An integrated Forms Tool allows a team to place frequently used forms on-line, as templates, which can be copied and used in hard copy or on computer. This CoPlanner feature allows a team to create its own forms, or to use existing preformatted forms.
- **A Communications Tool.** A user-friendly co-mail system allows all team members to maintain on-going communication, share information, or send a student's whole file to other team members.
- **A Security System.** A two-level password system provides both document and file security. Even though a file might be accessible to a team, some documents in the file can be retained as confidential.

Resource Teacher Preparation in Saskatchewan

Resource teacher preparation at the University of Saskatchewan is completed as a 30 semester hour post graduate diploma in special education. To be accepted into the program, students must have completed a four-year general B. Ed. program, have been certified as regular classroom teachers, and have successfully taught in regular classrooms for at least a year. Eight of the ten three-semester hour courses are mandatory, while the remaining two courses can be used to obtain more depth in specific areas of exceptionality. The required courses are built around a computer-based core of four three-credit unit courses on assessment, resource teaching, and service delivery. The fourth course is an integrated field practicum.

During the Fall term, when the first three courses are taught, the students are introduced to CoPlanner, and become proficient in its use in assessment, instructional planning and service delivery. Pairs of students are assigned to established resource teaching programs, where they work collaboratively with the resource teacher(s) and regular staff. In these field practica settings, preservice resource teachers do their work collaboratively using CoPlanner as a support. Faculty can critique instructional plans in advance, review student reflective statements after teaching, receive and mark reports, and submit comments and grades to students confidentially. When they have completed their preservice preparation programs, these teachers can then take CoPlanner with them into their first resource teaching positions, where they can use it effectively as a collaborative and personal productivity tool.

Integrating CoPlanner into Resource Teacher Preparation

Every resource teacher-in-training has a unique learning curve with CoPlanner. Some are introduced to the program having had limited prior computer use, while others are already quite proficient in using the computer for word processing and for student games, drill, and practice. According to the Michigan Task Force, however, teachers in training should see computer use modeled by their professors, and these students should also be required to use the computer in their field practica.

During the first month of teaching, at the beginning of the resource teacher education program, faculty introduce the concept of CoPlanner and model the software. Students then have opportunities to "explore" the software in the dedicated computer laboratory. From the very beginning, students are encouraged to do their class assignments on

CoPlanner and to submit them electronically or on diskette for grading. For example, students are asked to review current literature on some aspect of assessment or teaching of students with specific disabilities. They then use CoPlanner to create assessment or teaching tools, based on the literature. There are many benefits from this assignment; students must do research in the current literature, and they do create relevant and useful tools. What is more important is that in the process they learn a great deal about specific features of CoPlanner, and about the use of the computer in instructional planning. By the end of the Fall university term, the resource teachers-in-training have logged many hours on the computer. They have also used most of the other features of CoPlanner for assignments during the term.

When these students go out to do their integrated field practica, they are already quite proficient at using CoPlanner. Their experience with the software intensifies, because now they use CoPlanner as it was intended—for collaborative planning with a fellow student, an experienced resource teacher and any others involved with the students with disabilities in the schools. During the field practicum, a student will establish a number of case files on CoPlanner, create or use assessment and teaching tools, prepare and submit progress reports, collaborate with university faculty by sharing intervention plans, and submit field work for evaluation. By the time the term is over, most students are quite competent in using CoPlanner as a teacher tool.

Conclusion

The original impetus to integrate computer technology into the preservice preparation of resource teachers at the University of Saskatchewan came from our students. Faculty are grateful for the student initiative which began the development process for CoPlanner. We suspect our resource teachers-in-training were focused on learning to use the computer as a means of teaching rather than as a teacher productivity tool. Serendipity and innovation led to the conceptualization and creation of CoPlanner, a more powerful tool than they had contemplated. Indeed, CoPlanner empowers teams to collaborate in ways not possible in the past. It has the potential to greatly enhance the ways we plan with and serve students with special needs.

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Utilizing the Concerns-Based Adoption Model to Facilitate Systemic Change

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Technology plays an integral role in American life. Technological tools have become essential for the effective operation of businesses and as a primary means for people to acquire information. The technological age has increased the demand for well trained, highly educated personnel. Education has long been attracted to technology's promise and potential. The hope is that computing and instructional technologies will yield new levels of educational productivity and excitement for the learner.

The American educational system has a responsibility to prepare students to live and work in this technological age. As K-12 instructional technologies expenditures rise over $2 billion (Green & Eastman, 1994), some worry that training teachers may be an afterthought. For technology to have an impact on education, more than access to equipment is required. Educators need to learn to effectively use these new instructional tools. The integration of technology needs to be a systemic change effort.

There are significant pressures to prepare new teachers to effectively use technology (National Council for Accreditation of Teacher Education, 1993). Some have called for systemic restructuring of our educational system so that it can better meet current and future educational needs. The ultimate goal for many educators is to seamlessly integrate technology in the classrooms so it becomes an integral part of the educational environment.

To prepare preservice teachers to work in a technologically rich environment and become part of a systemic change effort, ways to infuse effective uses of instructional technologies into teacher preparation programs must be developed. However, little evidence exists to show that computers and information technologies have become an integral part of the classroom (Denk, Martin & Sarangarm, 1993). The promise that technology would aid student learning, nurture professionalism and allow teachers to become facilitators of learning, instead of providers of knowledge, has yet to be realized in most educational settings.

LeBaron and Bragg (1994) state that current preservice teachers graduate with skills similar to those of teachers who graduated thirty years ago. With few exceptions, instructional technologies are typically presented to preservice teachers in a manner which fails to model the seamless integration of technology into the classroom (Lampert & Ball, 1990; LeBaron & Bragg, 1994). For instructional technology to truly become integrated within the school classroom and achieve a systemic restructuring of education, appropriate integration of these technologies must be defined, modeled, and mentored for the preservice teacher. The systemic integration of technology requires time and carefully planned strategies to facilitate the adoption process.

Systemic Change

Systemic change can be facilitated by promoting a mindset that includes strategies or methods that are used to understand education (Jenlink, Reigeluth, Carr, & Nelson, 1996). Systemic change 'recognizes the interrelationships and interdependencies among the parts of the educational system, with a consequence that desired changes in one part of the system are accompanied by changes in other parts that are necessary to support those desired changes" (Jenlink, et al., 1996, p. 22). The premise presented in this paper is that preservice teacher education, by following these guidelines, promote and support systemic change efforts.

The purpose of this study was to use the Concerns-Based Adoption Model (CBAM) to evaluate a systemic change effort which promotes the integration of technology abilities of entry level teachers (teachers moving from the preservice learning environment to positions as first-year teachers). This study involved identifying preservice teachers concems about integrating technology into the classroom and their ability to integrate technology with their instruction.

Methodology

Subjects

Subjects were 27 preservice teachers in urban public schools along the Colorado Front Range. The student teaching program is designed to mentor the development of effective teaching strategies and the use of technology in the classroom by preservice teachers. The program utilizes an on-site cooperating teacher and a consultant from the university to mentor the student teacher. The mentor's work is supplemented by bi-monthly seminars which the student teachers attended during the semester. Further, the university consultant visits the student teacher a minimum of six times during the semester and evaluates the student's teaching during a minimum of four of those visits. A standardized form is used to evaluate the student's performance and is designed to provide the student with constructive feedback, both positive and negative.

Concerns-Based Adoption Model (CBAM)

The Concerns-Based Adoption Model (CBAM) was used to evaluate the participants' concerns and level of use of technology within the classroom. CBAM was developed by the staff members of the Research and Development Center for Teacher Education at the University of Texas. They recognized that educators involved with change were having the same types of concerns about innovations that Fuller (1970) had identified in her studies relevant to teaching. The concerns that arose were not limited solely to teaching but related to concerns which developed during the adoption of any educational innovation (Hall & Hord, 1987).

CBAM sets forth several assumptions and assertions based upon the implementation of innovations in colleges and school settings. They established the following perspective for observing the change process (Hall & Hord, 1987):

1. Change is a process, not an event, and it takes time to institute change;
2. Individuals must be the focus if change is to be facilitated and institutions will not change until their members change;
3. The change process is an extremely personal experience and how it is perceived by the individual will strongly influence the outcome;
4. Individuals progress through various stages regarding their emotions and capabilities relating to the innovation;
5. The availability of a client-centered diagnostic/prescriptive model can enhance the individual's facilitation during staff development; and
6. People responsible for the change process must work in an adaptive and systematic way where progress needs to be monitored constantly.

CBAM addresses three assumptions: the individual's concerns about the innovation, the particular manner in which the innovation is delivered or implemented, and the adaptation of the innovation to the individual through three diagnostic dimensions. The Stages of Concern (SoC) measure addresses the intensity of the feelings and perceptions that the individual adopting the technology is expressing. The Levels of Use (LoU) measure addresses behaviors related to how the individual uses the technology. Finally, Innovation Configuration Maps (ICMs) require the development of word maps that describe the operational components of an innovation and how each can be adapted, re-invented, or in some cases mutated (Dirksen & Tharp, 1996). In the following sections, the SoC and LoU dimensions of the diagnostic measures will be described in greater detail. The ICM dimension was not used in the present study.

Stages of Concern. According to Hall and Hord (1987) the process of change can be more successful if the 'concerns' of the individual, as identified in CBAM, are considered. The concept of concerns is defined as: "The composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall, George, & Rutherford, 1979, p. 5). The SoC Questionnaire provides a quantitative measure of the intensities of the seven Stages of Concern dimensions (Hall & Hord, 1987):

0. Awareness—concern or involvement with the innovation.
1. Informational—gaining more information about the innovation such as general characteristics, effects, and requirements for use.
2. Personal—how the innovation relates to the individual (i.e., role, decision making, consideration of potential conflicts).
3. Management—the mechanics of using or integrating the innovation.
4. Consequence—the effect of the innovation on students.
5. Collaboration—coordinating efforts in using the innovation with others.
6. Refocusing— the exploration of other ways to utilize the innovation or improve upon the innovation.

The SoC Questionnaire contains 35 items representing the seven stages. Respondents are asked to rate each item on a scale of zero (not true of me now) through seven (very true of me now). Peak or predominant Stages of Concern, and the relative intensity of the other concern stages, are plotted from the percentile scores (Hall & Hord, 1987).

A Stages of Concern profile graphically represents the relative intensities of each concern toward an innovation in each of the seven Stages of Concern. The profile pattern, taking note of the highest peaks, characterizes the concerns of a nonuser, inexperienced user, experienced user, or a renewing user. The shape of the concerns profile typically changes as the user moves through the change process, shifting from on emphasis on self concerns to task to impact concerns.

During the course of this study, SoC Questionnaires were administered to participating student teachers on three separate occasions. The questionnaires focused on the student teacher's concerns about integrating technology in the classroom. Questionnaires were administered during the student teacher's regularly scheduled seminars. The first questionnaire was used to establish a set of baseline data; the remaining two questionnaires were used to determine how their concerns changed during the course of their student teaching experience.

Levels of Use. Levels of Use provides a key ingredient for understanding and describing the implementation process of an innovation. Data collected from LoU interviews can provide useful insights about staff development, evaluation, planning and facilitation for leaders and change facilitators. According to Hall and Hord (1987), Levels of Use focuses on the behaviors that are or are not taking place in relation to the innovation. The Levels of Use include three nonuser descriptions:

0. Nonuse—little or no knowledge of the innovation.
I. Orientation—acquiring information about the innovation.
II. Preparation—preparing to use the innovation and five user descriptions (Hall & Loucks, 1976):
III. Mechanical—focused on the mechanical day-to-day aspects of using the innovation.
IVA. Routine—comfortable with the innovation with little preparation and not planning to change how the innovation is used.
IVB. Refinement—working to improve their personal use of the innovation.
V. Integration—is working with colleagues in a collaborative effort to use the innovation.
VI. Renewal— reevaluating the innovation seeking to make major modifications to the innovation.

Typically a person will move in sequence from Level of Use 0, Nonuse, to Level of Use IVA, Routine; assuming that the innovation is appropriate, the leader and other change facilitators fulfill their roles, and time is provided.

In this study, an LoU Interview was conducted with each student teacher at the conclusion of their student teaching experience to determine their Level of Use upon exit from the program. The student teacher's Level of Use will, in part, determine their ability to integrate technology within the classroom as part of a greater systemic change.

Data Analysis

A percentile score was determined for each of the seven stages in the SoC questionnaire. Participant's scores formed a profile that was examined qualitatively. The LoU Interviews were scored using a rubric created by Hall and his associates at the University of Texas. The rubric provides a behavioral description of each LoU relevant to: (a) knowledge, (b) acquiring information, (c) sharing, (d) assessing, (e) planning, (f) status reporting, and (g) performing. The data obtained from individual student teachers were compiled and comparisons made between student scores. Trends were identified and outliers explored in greater depth.

Results

Stages of Concern

For students entering the student teaching experience, their Self concerns (awareness, informational, and personal) were high. Task and Impact concerns were less evident. Previous research, indicates that this should be expected. "Concerns at this point have to do with feelings of potential inadequacy, self-doubts about the knowledge required, or uncertainty about the situation they are about to face. Typical statements reflecting these types of concerns are: 'I wonder if I know enough to teach them.' 'Will I be able to control them?'" (Hall & Hord, 1987, p. 57).

The results of the second SoC indicated higher Task concerns (management). This instrument was administered midway through the semester. As student teachers transition into the role of teacher, concerns regarding: logistics, classroom management, and preparation are expected to increase (Hall & Hord, 1987). As students begin to observe the new role of the student teacher, they place added demands on the student teacher's time and on their ability to manage the classroom.

As the student teachers progressed through their student teaching experience, Impact concerns (consequence, collaboration and refocusing) increased in intensity. "Ultimately, teachers can become predominately concerned about how their teaching is affecting students and about how they can improve themselves as teachers" (Hall & Hord, 1987, p. 57). At the conclusion of the experience their overall concerns regarding instructional technology were intensified.

Levels of Use

Upon exiting their student teaching experience, the student teachers' LoUs ranged from Level I through Level IVA. The percentage of nonusers was 20%, while the users were 80%. However, the heaviest grouping of users were Level III, Mechanical, at 54%. The remaining student teachers were at Routine LoU. Only 26% of the entry level teachers are prepared to integrate technology within the classroom.

Discussion

The first use of an innovation tends to be disjointed and erratic. Most new users cling to the user's guide and concentrate on the day-to-day uses more than considering long term uses. Hall and Hord (1987) indicate that individuals typically remain at the mechanical level for an extended period of time. As the user becomes experienced, they move into Level of Use IVA, Routine. Once a user reaches a Routine Level of Use, they typically fall into a comfortable pattern for using the innovation. As users move toward the higher Levels of Use (IVB Refinement, V Integration, and VI Renewal), adaptations are intended to improve the effectiveness and positive outcomes of using the innovation (Hall & Hord, 1987). The user's focus is on increasing effects with students.

Systemic integration of technology depends upon the faculty and staff receiving training and guidance if the vision is to become reality. This is a process that should begin with student teaching and extend through the first few years of actual teaching. Many preservice teachers leave college using the skills they have learned at a mechanical level of use. This level of use is easily deteriorated (Hall & Hord, 1987). Mechanical level users fall back on their most comfortable methods which are not always productive. To ensure that novices progress beyond a mechanical level of use so that they can participate in a systemic change effort involving the integration of technology within the classroom, a procedure for mentoring them in the continued use of instructional technologies should be instituted. In this program, student teachers progressed through the Stages of Concern as expected. During the mentoring process the concerns of the student teacher must be addressed to help them adopt the innovation.

Teacher preparation programs must model the integration of instructional technologies within effective instructional practices that will prepare preservice teachers to facilitate classrooms which are rich, informational, computer-mediated environments (Bandura, 1986; Fullan, 1993). Research on educational change strongly supports the notion that innovations will not be implemented in schools simply because the change makes sense and meets specified needs (Fullan, 1991). Modeling promotes adoption by socially instructing people about new ways of thinking and behaving as they demonstrate the innovation.

Summary

The adoption of instructional technologies and the movement through the change process requires time and appropriate intervention strategies to be successful. This study has presented a perspective for the integration of technology within the classroom through a systemic change process. One means of achieving this is through modeling and mentoring technology integration within the teacher preparation program. The components of CBAM can be used to bring about systemic change in education by evaluating progress in the change process. The concerns-based approach requires the understanding that a school does not change until each individual changes throughout the whole system (Hall & Hord, 1987). Concerns and use data, along with the mentoring of preservice educators, can provide a foundation for a ground-up approach to effect systemic change in education.

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Project Infusion: Lessons Learned

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Project Infusion, funded by the U.S. Department of Education's Fund for Innovation in Education, sought to address the teacher training needs created by Hurricane Andrew in 1992 and proposed a training model that had the capability of directly influencing the training of personnel in instructional technology at the elementary school level across the entire school district.

Submission of the grant application was made by the Educational Computing and Technology department of the Adrian Dominican School of Education at Barry University, in collaboration with Dade County Public Schools (DCPS) in Miami, Florida.

The purpose of this project was to develop, implement, and evaluate a model for providing district-wide teacher training in the use and integration of instructional technology to achieve curricular goals that are competency based and designed to be world class standards.

Barry University proposed a training-of-trainers model to conduct system-wide teacher training to help teachers utilize and integrate available state-of-the-art technology in the teaching of math, science, social studies, language arts and English as a second language. The seminal works by Joyce (1990) and Joyce and Showers on effective inservice education (1983, 1988) and Joyce, Showers, and Rolheiser-Bennett (1987) served to guide the development of the Infusion training model.

The key components of the Infusion model included:

- best practice in teacher training/professional development;
- levels of training: university, school based, and parent;
- competitive recruitment of teachers to be trained;
- intensive, graduate level training of project teachers;
- administrative involvement at all levels of project;
- mentoring and follow-up of trained teachers responsible for training personnel at their school sites.

Each project year, a team of two elementary school teachers per school were competitively selected from applications from Dade County Public Schools and interested private schools. Using grant monies, selected teachers received tuition remission at Barry University for 6 graduate credit hours in Educational Computing and Technology which they could apply toward 1) state recertification requirements and/or 2) a master's, specialist, or doctoral degree in Educational Computing and Technology at Barry.

The first course was ECT 680, Integrating Technology in the Elementary Classroom, a three-credit course that included a comprehensive examination of instructional technology, learning theory and research in the field, competency-based curriculum and technology, models of teaching and learning with technology, and integration of instructional technology across the elementary curriculum. Instruction for each of the sessions was provided by the project director, who is a faculty member from the Educational Computing and Technology department at Barry University, and the teacher on special assignment from Dade County Public Schools.

The second three-credit course, ECT 690 Teachers, Training, and Technology, was designed to be a practicum during which project teachers 1) developed, with their principals and/or school management teams, teacher inservices at their school sites; 2) carried out training with Level II teachers at their schools in collaboration with Barry University staff; 3) implemented their personal technology infusion plan and evaluated its effectiveness; and 4) collaborated with teachers at their school sites to develop classroom infusion plans and parent training activities.

The Project Infusion trainers were supervised and mentored by project staff during the practicum course in a type of "clinical" follow-up as they conducted inservice training at their respective schools for their colleagues.

Project Infusion's design and implementation has been described in previous articles (LeBlanc, 1995, 1996) and in the final evaluation report, all of which can be accessed from the Infusion web site (www.barry.edu/adsoe/infusion.html). The purpose of this paper will be to describe the results of the project and to discuss the lessons learned from a teacher trainers' perspective that could translate into best practice in teacher education in technology.

Project Results

During the three year period, 248 teachers representing 125 elementary schools completed both courses in Project Infusion. Ninety-six public schools, 1 Indian School, and 28 private schools were involved in the project. Fifty-seven percent of these schools were Chapter I schools. Two hundred eighteen (87%) of the Infusion teachers were female, and 32 (13%) were males. Most of the participants were classroom teachers, and 12 were administrators. Participants came from a variety of teaching assignments, including self-contained elementary teachers, middle school sixth grade teachers, teachers from special programs such as exceptional student education and alternative education, computer lab teachers and coordinators, bilingual/ESOL teachers, and resource teachers.

A total of 1,905 Level II teachers were trained by Infusion teachers at their schools with an average of 14 teachers at each school site and a range of 1 to 88 teachers. Infusion teachers provided a total of 1,542 contact hours of training, with the average being 11 hours and the range being 1 to 75. (The numbers of hours at school sites is reported as only the hours for completion of 690. In most cases, additional training, mentoring, and follow up at the schools were provided by the Infusion teachers, but were not included in the summary of total hours.)

Because of its documented impact, Project Infusion was one of nine projects statewide identified as an *Exemplary Initiative in Math, Science, and Technology Related Education in Florida's College and Universities* by the Florida Department of Education's Post Secondary Education Planning Commission during the second year of the grant.

At the end of the third year of the project, a survey was developed by the project director and project evaluator and sent to all but 40 of the most recent Infusion participants. This survey was designed to 1) obtain a measure of instructional technology usage by Level I teachers before and after participation in Project Infusion, and 2) probe the impact of the project on the individual, the teachers, and on students. The range of time that had passed after participation in the first course for Project Infusion was from 6 months to 2 years. The return rate for the survey was 64% (134 respondents out of 208 sent).

T tests of dependent samples were used to compare the numbers of Infusion teachers using various technologies at least once a month prior to and after participation in Project Infusion. The results of these comparisons are displayed in the table which follows.

These results point to increased use over time of a variety of technologies to which the teachers were exposed during Project Infusion. Impact of the project was measured by the survey in the areas of impact on the individual participant's teaching, on the teachers at each school, and on the students at the school. The results of this portion of the survey are presented in Table 2.

Table 1
Numbers of Infusion Teachers Using Technologies Before and After Participation (n=134)

Technology	*N* Pre	*N* Post
Audio components	55	88*
Barcodes	27	57*
Calculator	79	95
Camcorder	42	52
Computer images	8	43*
CD ROM	65	111*
Color Printer	63	107*
Computer	110	122
Computer Animation	18	39*
Networks	30	67*
Databases	42	74*
Email	34	77*
FIRN	22	55*
Laser discs	30	59*
LCD Panel	16	38*
Modem	38	81*
Overhead Projector	71	91
Printer	93	111
Scanner	13	53*
Spreadsheets	22	54*
Teacher Tools	33	71*
Telecommunications	23	64*
VCR	87	107
Word Processor	99	118

*$p < .05$

Table 2 Results of Survey on Project infusion's Impact on a Scale of 0-3 (n=134)

Mean	No impact	Minimal impact	Moderate impact	Great impact	
My teaching					
comfort	2%	0%	13%	85%	2.82
use	1%	2%	1%	81%	2.78
integration	1%	4%	28%	67%	2.60
Level II teachers					
classroom use	4%	5%	40%	51%	2.38
comfort	3%	5%	33%	59%	2.48
increased use	3%	5%	40%	52%	2.41
integration	5%	12%	48%	36%	2.14
Students					
learning	16%	5%	28%	52%	2.14
comfort	5%	4%	30%	62%	2.49
increased use	5%	4%	33%	59%	2.46
writing	7%	7%	31%	55%	2.35
mathematics	7%	10%	36%	47%	2.23
science	13%	10%	41%	37%	2.01
social studies	19%	11%	37%	33%	1.82

The results of the analyses of the survey can be summarized as follows:

1) there were significant increases in the use of and in the variety of technologies used by teachers after participation in Project Infusion;
2) Infusion teachers reported the project as having a great impact on their comfort level using technology, the use of technology in their classrooms, and their ability to integrate technology in their instruction;
3) Infusion teachers reported that the project had a moderate impact on the teachers at their schools in terms of comfort, classroom use, and integration of technology;
4) teachers reported moderate impact on student learning in all subject areas except social studies, which showed minimal impact.

We believe that the project's impact will continue to grow as access to technology increases at the schools and as teachers' personal and instructional use of technology continues to develop over time. Other documented measures of Project Infusion's impact include:

- 19% reported that they moved to a different school or took a new job assignment as a direct result of participation in Project Infusion.
- 17% received honors and awards directly related to the infusion of technology including 4 nominations and 1 award for the district's Technology Teacher of the Year.
- 30% joined the Dade County Chapter of Florida Association for Computer Educators (FACE) and currently, three of the officers of that organization are Project Infusion participants.
- 30% indicated that they had participated in additional technology-related training since completing Project Infusion, not including those who entered degree-seeking programs at Barry
- 14% authored articles about technology integration, presented at professional conferences, and served on technology advisory committees.
- 37 Infusion teachers participated in grant writing for technology, with a total of $2,301,731 awarded from state or private monies
- 20% entered the Masters, Specialist's, or doctoral programs in instructional technology at Barry as a direct result of their positive experiences in Infusion.

In short, we believe that Project Infusion has been very successful in achieving its goals of district-wide infusion of technology across the elementary curriculum and in building the district's capacity to support instructional technology.

Critical Success Factors

The following factors have been identified by the project director and the project evaluator as being critical to the successful implementation of this staff development model.

At the university level:

- outstanding, hard working project staff and excellent managerial processes;
- appropriate training facilities, equipment, courseware, and technical support;
- administrative and academic computing support at the university;
- competitive recruitment of teachers;
- team teaching;
- telementoring;
- school site observations;
- curriculum and delivery that models the sorts of behaviors expected from the trainers when they integrate technology in their classrooms;
- robust, challenging curriculum which emphasized the reasons for integrating technology vs. how to integrate technology;
- reflection on the day's activities via journal writing.

At the school sites:

- access to technology;
- administrative support;
- training incentives: money, time, equipment, courseware;
- voluntary participation;
- careful needs assessment and analysis of the school's capacity to fill those needs;
- careful planning of workshops;
- enthusiastic and patient trainers who can think quickly;
- workshop content which acted as great "hooks" to technology;
- hands on learning;
- partnerships, both trainers and trainees;
- strong trouble-shooting skills;
- time for reflection/closure;
- realistic and fun tasks;
- involvement of Infusion staff;
- inclusion of parents, students, and administrators in workshops;
- employment of strategies to create a critical mass of trained teachers at schools.

At the district level:

- cooperative employment of teacher on special assignment;
- free access to DCPS school mail in order to provide consistent communication between Infusion teachers and project staff;
- announcements of opportunities for additional funding of technology-based projects through state-funded technology incentive grants, Chapter 6 funds, and other funding sources.

Although the majority of Infusion training sessions were overwhelmingly successful, the project director observed some common problems at school sites worth mentioning:

- need for technical support and/or trouble shooting capabilities;
- trainers tried to cover too much in too short a period of time;
- trainers provided too much lecture/talking before hands-on time;
- teachers ran out of time, leaving no time for closure;
- lack of articulation of training with overall technology plan;
- too many people in the session;
- assuming the people knew more or less than they did and not allowing for individual differences during instruction;
- inappropriate beginnings and endings of sessions;
- lack of alternative plans b and c.

Replication Issues

The Infusion model for teacher development in the use of instructional technology can be replicated at other universities fairly easily with a few important caveats which follow.

At the University level:

- the university and department must recognize the value of this type of model and support it by means of course load reductions, especially for mentoring and school based observations, both of which are very time consuming;
- the university should have a level of computer-based technologies and courseware sufficient to support instruction which is innovative and enlightening. However, these technologies need not be available for each student in order to be effective. Students can rotate through technology learning stations just as they might in their own schools;
- the university's academic computing division must support the program, particularly in the areas of email/telecommunications, help desk response, and technical support in the teaching labs;
- the registrar's office must cooperate with the program to ensure the smooth operation of a program like this one where teachers are finishing their practica at times which do not coincide with regular grading periods.

At the School level:

- access to instructional technology is imperative, even if the access is not optimal in terms of numbers and types of technologies available;
- administrative support for teachers who want to integrate technology in their teaching is vital;
- incentives and continuing professional development activities should be provided for teachers who actively infuse technology into their instruction;
- appropriate technical support is vital to the success of any school based technology integration plan
- teachers must have a vision of where their school might go with technology and be willing to seek means of supporting that vision.

Dissemination Plans

The results of Project Infusion will be disseminated in a variety of ways. Currently the project has its own WWW server which anyone can use to access teacher-developed training materials, school action plans, course syllabi, and other materials developed by project staff. A group of Infusion "tech-perts" are linked to the web site and are available for advice and support to other teachers via email. In addition, ECT 680 and 690 will be offered by the project director as distance education courses in the spring of 1997 to any interested teachers in order to further broaden the impact of the Infusion model. Video footage of several project teachers using technology has been edited by the project director and will be used as part of a weekly instructional TV program called "Techie Tuesdays" in order to model and share with a district-wide audience the exciting things teachers are doing with technology as a teaching and learning tool.

Conclusions

Using the training of trainers model, 68% of all of the public and private elementary schools in Dade County were trained during a three-year period, with two people at each school having had graduate course work in the integration of instructional technology across the elementary curriculum. These teachers have already directly impacted more than 5,900 students. In addition, 1,905 teachers and administrators were trained at the school sites by Infusion teachers. These teachers will in turn affect approximately 45,000 students each year. We believe that this model has proven to be a highly cost effective method of providing high quality teacher training in state-of-the-art instructional technology and that the benefits of this infusion of technology training will continue for many years to come.

We also conclude that university based teacher development is the most cost effective means of promoting professional development and growth in instructional technology for a number of reasons:

- university courses provide more long-term instruction and follow up than typical school-based inservices using existing faculty or consultants;
- university courses tend to last longer than most teacher inservice courses, providing more time for practical application and assimilation of information into the teacher's existing instructional paradigm;

- graduate instructional technology course work tends to focus on the *reasons* for using technology—the "*why*?" questions—rather than focusing on the "*how*?" questions most often seen at school based teacher inservices;
- exposure to new and emerging technologies along with innovative strategies for integrating those technologies at the university tends to "raise the sights" of teachers to see what is possible and desirable, while school based inservice tends to emphasize what exists and how to use it;
- bringing teachers together from different schools generates enthusiasm and motivates teachers to try new things at their schools, rather than to focus on the barriers to the integration of technology at their particular school.

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Collaborative University/K-12 Multimedia: Problems, Solutions and Lessons Learned.

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With the advent of multimedia technologies, today's teachers have opportunities that were hardly dreamed of 20 years ago. The ability to easily access video, sound, animation, still pictures, and text from one single control and to quickly choose between them or even to use more than one at a time, allows the teacher and the students to bring greater drama and reality into the classroom.

Just as with any powerful tool, it is only as good as the skill of the artisan directing its power. In order for any tool to be useful in the classroom, the teacher must know how to wield it appropriately. Multimedia is no different. It will only affect the quality of learning in any class to the degree that the teacher can use it effectively. Merely showing a movie to students will not ensure that they have learned anything. The teacher must know how to prepare the students so they know what they are watching, why they are watching it, and how it will affect their lives.

In the Spring of 1995, US West awarded a grant to a consortium of North Dakota State University (NDSU) and Valley City State University (VCSU), Center for Innovation in Instruction (C.I.I.), and 46 public school districts. The grant provided funding to produce training and called for a collaborative effort between the universities, the C.I.I. and the school districts. The purpose of the grant was to help teachers bring the power of multimedia into their classrooms and to build collaborative relationships between universities, K/12 schools and technology experts.

That summer a development team was brought together to begin the process. The team consisted of members from the universities, the C.I.I., and several of the school districts. The development tool chosen was Systematic Curriculum Instructional Development (SCID) from the Center on Education and Training for Employment, The Ohio State University (Hoskisson, Stammen, Nelson, 1996).

In the Spring of 1996, with the skills of public school teachers, district technology directors, computer scientists, instructional designers, and university methods teachers the first phase of the grant was finished (Nelson & Sologuk, 1996; Stammen, 1996). The team had produced the paper version of the training that would then be turned into a multimedia CD-ROM and be made available on the World Wide Web (WWW).

From Paper to CD-ROM: Making the Transition

Because the grant called for a collaborative effort, the team chosen to make the transition from print to CD-ROM retained the same diverse character as the original development team. The members included a professor of computer science, a director of a campus multimedia center, a sixth grade teacher, a school district technology coordinator/ elementary teacher, an instructional designer, the assistant director and a training coordinator from the C.I.I., a graduate assistant, the assistant superintendent of a parochial school, and a campus web master.

Problems

The transition team leaders met early in May of 1996 to review the existing material and plan for the first full team meeting. The leaders quickly discovered that no one had a good overall picture of the materials developed. Up to that time, no one had taken all the material and checked it for thoroughness and completeness. Therefore, a review of all of the modules was conducted. One review looked for redundancy among the seven modules. Another review checked the thoroughness of the treatment in each module. The seven original modules, referred to as guides, were: (a) Acquire Basic Computer Skills, (b) Improve Curriculum with Multimedia, (c) Deliver Instruction with Multimedia, (d) Utilize Support Services, (e) Enhance Teacher Communication with Multimedia, (f) Promote Multimedia in the Classroom, and (g) Pursue Professional Development Related to Multimedia.

As the team leaders examined the print version and pursued their planning, it became apparent that there were several problems that needed to be solved in order to make a successful transition from print to CD-ROM. The problems were inherent in the process of turning a linear print project into an interactive CD-ROM and coordinating the work of a geographically dispersed team with varied backgrounds and experience.

The reviews pointed out several areas that needed work. The concerns could be grouped into two main categories: concerns about the design of the material itself and problems in coordinating and working with such a diverse team.

Concerns about Design. There was considerable overlap between some of the modules. Much of the material was extraneous or even unnecessary. Some of it was nice to know but was not appropriate for the main body of instruction.

The reviews also showed that there was not much interactivity. Because of the nature of the planning tool used in the first phase, the modules were well-designed for print but not for interactive media like CD-ROM and the WWW. Most of the development team members had little or no experience in developing a dynamic medium like multimedia. It was difficult for them to go beyond the design tool and think in terms of interaction between learner and learning material.

Problems in Working with a Diverse Team. Geographically there were difficulties, also. Initially four of the ten team members lived and worked up to 60 miles away from the rest of the members. Before the transition was over a fifth member had moved to North Carolina.

Along with geographical dispersion, team members had other jobs and responsibilities. Four were taking graduate courses as well as working. Finding time when people could meet and then getting everyone there proved to be a tremendous task.

The Final Dilemma. The final dilemma was the choice of authoring system for producing the CD-ROM. The tools that were considered were HyperStudio, HTML, and Director. The main consideration in selecting the possibilities was cross-platform compatibility. Only a few members of the team had any experience with multimedia authoring systems. One member of the team had written and produced a CD-ROM using Director. One other member had experience with Director. Two other members had some experience with authoring tools. Choosing a tool that was cross-platform capable and that all the team members could learn quickly was the task.

Solutions

The transition team met together for the first time on May 28, 1996. For the next two days they worked on defining the process that they would use to produce the CD-ROM and WWW versions.

Design. During this meeting the team coordinator proposed that the original seven guides be changed to: (a) Preparing, (b) Planning, (c) Producing, (d) Presenting, and (e) Promoting.

He then showed how all the original guides could be rearranged to fit into these five new guides and at the same time eliminate the redundancy in the originals. This proposal was based on the planning discussions of the team leaders prior to the full team meeting. The new arrangement was accepted by the full team. With only five guides and the redundancy reduced, it was much easier to maintain an overall picture of the material. It was also easier to check for thoroughness because the various concept treatments were consolidated.

Initially, it seemed that the lack of interactivity would be more difficult to solve. However, as the transition team proceeded they found that, though there were checklists and some questions in the paper form, the learner was actively involved in many hands-on projects. For example, in the Preparing guide aimed at computer novices, the learner was not just reading material and answering questions, but was busily engaged in physically setting up a computer and learning how to turn it on and run it. Later, in the Producing guide, the learner actually produces a multimedia project.

What the team did discover was that the guides did not take advantage of multimedia in the learning process. The whole project could be printed and used without any technology. Therefore the team decided to collect samples of multimedia projects created by classroom teachers. In addition, they embedded an example into the guides that would be developed as the learner progressed through the material. This would enable the guides to actually model what they are teaching. There is still a year of development time left and the team will continue to look for ways to improve the learning experience using multimedia.

The nice-to-know material was placed in an appendix. The team felt it was too good to just throw out, and, while not needed for the instruction, it was helpful and related material.

Diversity. As the team discussed the problems of working together with such great diversity, they realized that they would be more successful if they:

- organized smaller specialized teams that could meet together more easily than a large team could;
- prepared a timeline to follow;
- took advantage of the Higher Education Computer Network (HECN, the North Dakota University System computer network) and SENDIT (the North Dakota public school computer network) for communicating between meetings and sending in work; and
- agreed on a set of design protocols to ensure a more consistent construction and appearance of the material.

Although these decisions did not solve all the problems of coordinating the team, they provided enough of a solution that the work was able to proceed relatively smoothly that summer. Most of the work followed the time line closely. Everything went well until it was time to put everything on the web site. Despite our design protocols and frequent communication, the final guides were quite inconsistent in some areas and many small problems surfaced. It took the web master two months to clean every thing up and get it ready for review by the grant administrator and the final editing phase.

Dilemma

In retrospect, choosing a development tool was perhaps one of the easier decisions that was made. Since the intent was to not only have a CD-ROM available for schools to use but to make all the guides accessible on the WWW, HTML was selected. Director, though capable of producing for the web, was too difficult for the team to learn in the time allowed. HyperStudio would be easier to learn than Director, but the team decided to go directly to HTML and save any "middle men." The transition team was not familiar with HTML so two training sessions were held to give them enough knowledge to get started. They used an HTML editor and Claris Home Page for creating the pages.

The Project's Value and Lessons Learned

Despite the pitfalls and the arduous efforts to negotiate all the twists, turns, hills and blind curves of such a collaborative project, all those involved felt that it was worth the sweat and pain. Why was it worthwhile and what was gained that couldn't have been achieved using a smaller and more experienced design team? The answer is simple: relationships and commitment.

One of the most important results of the grant is that there now exists an active, working K-12/university relationship that is much broader than anything that existed before. The members of the various teams represented more than five different districts, two universities, and a statewide public school technology support center. Add to these the remaining 41 school districts and the extent of the relationship begins to spread across the state.

Another valuable outcome of the collaboration is that there is now a commitment from 46 school districts to train their teachers in the use of multimedia. The superintendents all wrote letters of commitment saying that they would support the grant efforts. Selected teachers will be trained using the material and equipment provided by the grant. These teachers, in turn, will train other teachers in their respective schools. If all goes well, the effect will ripple out from these initial trainers throughout the entire school district until all the teachers who so choose will be trained to integrate multimedia into their classrooms.

The commitment from the superintendents was shown from the beginning of the project. Those members of the development team and transition team who worked in the public schools were given time and encouragement from their principals and superintendents to participate in the project. Their principals found substitutes for them as needed to work on the grant.

Conclusion

One purpose of the teacher guides is to help inservice and preservice teachers learn to use one of the most powerful tools that teachers have ever had. Perhaps the only influence in the classroom that is more powerful is the teacher herself. A quality teacher with a dynamic and versatile tool like computer-driven multimedia can work wonders in a child's life. It is the hope of those involved in the grant that the guides will help make the power of multimedia a reality in the classroom.

The second purpose, building a collaborative relationship, has been accomplished as witnessed by the number of different entities involved in the work and which will benefit from the guides. The relationship has been made. It remains to be seen how well it can be maintained.

Acknowledgement

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Taxonomies and Myths: A Case Study of Technology Planning and Implementation

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A school district's technology planning, often done by committees with members representing different interests, combines a variety of stockholders' views. Through discourse, the committee constructs a meaning for technology. The result, for the planners, is a paradigmatic truth which is credible, authoritative, evokes a loyalty to that vision, and is complete with roles, values, assumptions, and logic. In this way, school district technology plans serve as symbolic discourse, representing official ideology about technology and, in so doing, about teachers' and students' roles. However, if all implementers of technology did not participate in constructing the plan, or if it is not explained completely, they may not have the same values, assumptions and logic regarding why technology is needed and the role it is to play in the classroom. While planning committee members consult the technology plan to make meaning, to prioritize implementation activities and to judge proper and improper uses of technology, others who did not write the plan, but who are involved in technology implementation may use other (often unstated) criteria to make decisions. This differential interpretation can result in a "collision of visions" with all sides convinced of the sanctity of their actions.

This practitioner-researched, two-year case study of one large, suburban school district utilizes Bruce Lincoln's conceptualization of taxonomy and myth (1989) to analyze the district's technology planning and implementation efforts. The findings illustrate how the official discourse of the technology plan was used to promote one pole of the technology taxonomy that evolved during these two years. Opposition to this view came both from the other pole in the taxonomy—a vision of technology use that was nearly opposite the vision expressed in the official plan. The subsequent struggle by planners to establish the official vision for technology as dominant in this organization illuminates the struggles and confusion many school districts face as they attempt to realize the promise behind educational technology visionaries' rhetoric.

Methodology

This case study explored various district stockholders' views of the use of technology in education. I utilized a case study design to study the technology planning and implementation in context. Data was collected over a two year period through multiple sources: observations, informal interviews, and on-site documents.

Participant observation was my data-gathering mode throughout the study. Sometimes I served more as a participant, such as when a member of technology advisory committee and fulfilling the role of the technology staff developer for the district; this allowed me "insider" access to both technology talk and critical site documents. Insider technology talk I was privy to included informal technology strategy discussions and meetings, and the thoughts and musings of the administrators charged to plan and implement technology. Insider access to site documents included technology committee minutes, and other internal documents such as focus group data and drafts and revisions of documents that would become the official district rhetoric on technology.

At other times I was more of an observer to decision making regarding technology planning and implementation. This included when I acted as a consultant to technology teams from individual school sites and when technology planning and implementation decisions were made by district administrators "above" me in the hierarchy and without my input.

Data was coded for themes and analyzed at several points throughout the two years. *Symbolic Interactionism* informed my data collection and analysis. In Symbolic Interactionism Blumer describes interpretation as a "process of handling meanings" (1969, p. 5). Thinking of interpretation as an active, mental engagement with the surroundings underlies the Symbolic Interactionism premise that what people do is related to what they think they're doing, what others think they're doing, and what they think of other's opinion of what they're doing. In Symbolic Interactionism, to understand the behavior of people in the presence of an object, we must understand the symbolic meaning they give to it and how they created that meaning. This underscores the importance of how the technology plan's official discourse reads and which pole of the technology taxonomy is dominant as influential on how computers are encountered and used by teachers in this school district.

The Evolution of a Technology Taxonomy

In order to coordinate and make more efficient technology purchases for the district's 27 schools, the Superintendent started a technology planning committee in the spring of 1993. The committee, with membership representative of the various district stakeholder groups, met twice a month during the 1993-94 school year and arranged district staff and community member focus groups on technology, conducted site visits to school districts with recent technology implementations, reviewed technology literature such as other district's technology plans, and then wrote the district's plan.

Analysis of the technology plan and focus group data, yielded two quite different ways of thinking about why to place technology in schools and the role it should play there. I have named the two categories "Technology, *Then* Uses" and "Uses, *Then* Technology" to emphasize their contrasting objectives, values, and logic. During technology planning in this district these two categories gradually evolved into a taxonomy, a binary arrangement the poles or categories of which express hierarchically the ways of thinking about a subject. In *Discourse and the Construction of Society*, Lincoln (1989) describes taxonomies as epistemological instruments: "a means of gathering, sorting, and processing knowledge about the external world" (p.136). He goes on to explain that taxonomies allow us to organize the experiences and ideas of our world, as we put concepts into our taxonomy categories, it allows us to categorize not only our experiences and information but ourselves, others, and their ideas and views.

Interestingly, both categories have similar assumptions about technology underpinning their categories' objectives. One assumption is that schools should have technology and teachers and students must learn how to use it. There is nearly universal agreement among community members and educators in this district that students and their teachers must become technologically literate. A second assumption is that technology should serve as a helpful tool for educators and students in doing their work. Again, nearly universally, all parties agree that technology would help students and teachers do their work. However, even though all parties worked from these assumptions, two major categories of thought developed with different objectives. These objectives are the basis for the binary oppositions of the technology taxonomy.

Technology, *Then* Uses

This category represents the majority of opinions expressed during the focus groups. These views were expressed by the group members who represented students, licensed and non-licensed staff, and community, as well as the district's administrative cabinet (the Superintendent and his five directors). In this category getting equipment, getting trained in its use and having technical support for the equipment's use is the main concern. Uses for the equipment focused on day-to-day work including accessing, handling, and coordinating data so that records and communication could be transmitted easily all over the district.

For the Technology, *Then* Uses category, technology is a tool that helps teachers do their work. Technology allows faster access to data and provides a tool for working with the data more easily and with greater sophistication. The value of networking a school and providing teacher workstations and grading software is that it allows teachers the opportunity to automatically calculate students scores, send them to a main server, and allow the office to compile report cards, all without paper.

The focus group responses indicated that the members of the Technology, *Then* Uses pole valued the equipment as most important, getting connected to data as their next most important value, and training in computer uses as third. Responses indicated that with the technology in place, administrators and staff would *then* determine uses for it by themselves and their students. The logical basis of this category is that software and hardware can be a time-saver for doing work and clearly, administrators, teachers and learners have a considerable amount of work to do. In addition, there is recognition that beyond school, everyone has computers and students need to know how to use them to survive.

Uses, *Then* Technology

The other category, or pole, of the technology taxonomy sums up appropriate uses of technology identified in the official district technology plan. This official document represents what I call the Uses, *Then* Technology category. The technology plan mentions the hardware and technical support that the focus groups addressed and added to nearly every statement "for curriculum and instruction" or "for teaching and learning." These added phrases about why equipment would be purchased and what training would be needed creates a rationale for the technology plan that members of the focus group did not articulate. The Uses, *Then* Technology category members recommended placement of technology in classrooms only after a school site had defined specific educational objectives that made use of the technological capabilities.

For the Uses, *Then* Technology category, technology helps teachers, students, and administrators do their work, but it is new and different educational work—work that without technology would be impossible to do. For example students can: use the Intemet to conduct research and publish their findings on Web pages, construct databases and use Boolean logic to search for relationships in the data and test hypotheses, and use e-mail to share and compare knowledge with students in other countries. The technology should provide the necessary tools to assist teachers to teach in an interdisciplinary manner, transform students into compilers and users of information, aid more authentic assessments, encourage higher levels of thought and creativity, and allow individualization of instruction.

The Uses, *Then* Technology category promotes technology as a tool with capabilities that will help achieve instructional outcomes beyond what schools currently are doing. Changing current educational practice is a primary concern. Another critical factor in this category is training staff in the use of technology. If technology use is not internalized, it can not be a part of a teacher's instructional thought. The logical basis of the Uses, *Then* Technology category is that educators will first redefine what their work is, and *then* technology will allow initiatives that, before access to technology, seemed impossible to implement. For this category, technology use only makes sense when it is directed by specific curricular and instructional goals.

Lincoln's work points out that it is the dominant group that can claim they are the "good" side of the taxonomy and that the other side (its binary opposite) is "bad." In so doing the dominant group can appear as if it is classifying along innate lines and make it difficult for the other group to gain a hearing. In this way taxonomies can construct social order. But which pole of this taxonomy is dominant? Clearly, the Technology, *Then* Uses category had number-dominance, the focus groups provided a view that expressed the conventional wisdom in the district about technology. The Uses, *Then* Technology category had voice-dominance in that the official technology plan for the district reflected their ideology. However, this dominance existed mainly on paper. As the technology planning efforts of this district turned towards developing a budget for the technology plan and implementing it, the struggle began.

The Struggle for Ideological Dominance

When the school board unanimously endorsed the plan in the Fall of 1994, funding the plan became the next step in the process. Because of their emphasis on access to information and communicating knowledge, the technology planning committee ranked infrastructure wiring, local area networks and a wide area network as top priorities and recommended funding in these areas to the Cabinet. However, the Cabinet (the superintendent and his five directors) created the budget that was actually presented to the school board. The authority to set the agenda for funding, in effect, gave them gave them control over technology implementation. Cabinet members who did not identify with the constructivist orientation of the plan used other criteria regarding what technology should do and be for in the classroom and thus had different implementation priorities.

For example, the director of elementary education supported the use of technology for learning skills and factual information through individualized learning systems. Consequently, her top priority for funding was to purchase this software and equipment for computer labs in all of the elementary schools. This view was in opposition to the constructivist orientation of the official plan but the district in which she had previously worked had utilized individualized learning systems and she wanted to replicate their use in this district. She actively opposed the installation of networks which she deemed unnecessary because they would direct money away from purchases of computers for in her schools. She pressured the technology committee to reconsider their prioritization, demanded an ad hoc "brainstorming" committee be formed to offer opinions on priorities for implementation, and indicated to the chair of the technology committee that she felt the committee had been "brainwashed" into supporting networks.

To other cabinet members what really mattered was the technology itself, acquiring hardware was the main goal. They focused on the hardware and network configurations in the plan. Technical issues like processor speeds, megabytes of RAM and hard drive space, video cards, network connections, hubs, routers, LCD display panels, scanners, and overall numbers of computers was the focus for these cabinet members as they talked about implementing technology.

After addressing funding issues for two months, the cabinet revealed their three-year budgeting plan at a school board meeting—where it was approved. Their budget was expressed strictly in terms of dollar amounts to be spent and the type of hardware allowed for purchase. Infrastructure wiring was funded and there was a per pupil dollar amount for computers (referred to as learning/work stations for instructional access by both students and staff). The secondary Director also funded the local area networks whereas the elementary Director divided the local area network installation in elementary schools into a three year project, finishing one third of the schools each year for three years.

While this budget did reflect the letter of the technology plan by funding wiring, networks, and computers, it did not reflect the spirit of the plan—the district technology plan's rationale was not referenced. Furthermore, secondary and elementary Directors allocated money directly to building principals who were only required to present their building's plan to the relevant director to receive approval for expenditures. This resulted in a wide variety of site-based plans. Some school level plans had a rationale for technology use similar to the district technology plan, others merely listed the hardware they wished to purchase, and others planned for the use of individualized learning systems.

Following the release of the budget, the Superintendent created a technology advisory committee to advise district administrators and develop guidelines and plans for various aspects of technology implementation. According to the committees charge, this was to include monitoring implementation of the plan, creating selection criteria for hardware and software, reviewing all district technology purchases and tracking all planning components. The chair for this committee was the top administrator for technology services in the district. She had been Chair of the technology committee and all of the personnel with technology duties as part of their job description reported to her (i.e., repair, technical support, network management, staff development). She was also responsible for setting the standards for hardware purchases and coordinating the network installations, and received the phone calls when technology coordination or implementation problems occurred. However, she did not have any budgetary control for implementation.

Technology Plans as Official Discourse

Educational technology visionaries agree that a common view of the educational purpose of technology is the most important requisite for successful implementation. (Collins, 1991, Means, Olson & Singh, 1995, Newman, 1992, Sheingold, 1991) Although originally charged with effective and efficient coordination of technology purchases, the advisory committee's emphasis clearly shifted to address issues of curriculum and focus that accentuated a constructivist view of learning. This view developed over the course of a year by committee members who developed a clear vision for the role of technology in the classroom. They returned to the vision expressed in the original technology plan, to "Empower learners through technology by providing all students and staff with access to information through voice, video, and data technologies for the purpose of processing and communicating information and ideas, and constructing knowledge." This group went beyond including an educational rationale to justify all purchases and suggested that technology be used to support instructional reform.

In this way the committee created a paradigmatic truth about the role technology should play in schools. It should create increased access to information, allow teachers to serve as facilitators for students to use information to construct knowledge, and serve as the tool with which students communicate their findings and insights. The technology plan represented the official story of how to use technology. This vision for technology is not unique to these planners. Most visionary technology rhetoric, including the literature that the technology committee read while planning, promotes using technology as a tool in a constructivist learning environment (Metropolitan Educational Research Consortium, 1993).

The Making of a Myth

Lincoln (1989) describes such narratives as myths. His definition of myths demands that the stories possess both authority and credibility. In this way his definition of myth is more akin to what others might call a model, blueprint, or charter rather than the fairy-tale-like connotation of the word myth. He explains that by evoking a paradigmatic understanding of the way things ought to be, a myth can serve as a "coding device in which important information is conveyed, on the basis of which actors *can then* construct society. It is also a discursive act through which actors evoke the sentiments out of which society is actively constructed" (1989, p. 25, emphasis in the original). The technology plan served as an official myth that the technology advisory committee referenced as the "correct" way to use technology; the plan directed the educators of the district to consider specific uses of technology first, then the technology.

Lincoln also explains how politics can form around different myths. Which myths are told, by whom, and with which groups they are received and evoke a response makes visible the social borders present in organizations such as school districts. In this way the telling of myths create feelings of affinity and estrangement between individuals and groups as the myths evoke or rebut sentiments. Lincoln goes on to describe that the ability of a new myth to influence an organization and its power distributions is in the degree to which it can gain a hearing, be persuasive, and evoke sentiment.

Implications for Implementation

In this district the official discourse/myth of technology use represented one pole of the technology taxonomy that evolved. The analysis of this pole's struggle for dominance provides insight into directing technology implementation—a high priority for many school districts across the nation. The district utilized their standard protocol of creating a committee with representative membership and charging it with several roles including developing a vision, planning, guiding, and implementing. However, the budget for technology implementation was held at a higher level of the district hierarchy and allocated directly to the building level. This influenced which pole of the taxonomy was able to gain a hearing and as a result there have been goals funded which deviated from the official technology plan.

At the end of the first year of implementation there are aspects of both technology visions in. The infrastructure wiring for the networks is done, local area networks are complete in the buildings scheduled for them and the wide area network, which will bring Internet access, is in progress (Technology, *Then* Uses category members are eager for a direct Internet connection). Individualized learning systems are in the district schools with Title I allocations as the Title I Coordinator was pressured to fund the hardware, software, and technical support for this project. The secondary subject areas worked with the curriculum and media specialists during the curriculum planning cycle to select software. In the elementary schools, the software is chosen by individuals or grade level teams in an individual school. As implementation continues, it appears that implementations of technology depend on which of the competing taxonomy poles an individual references.

Conclusion

The words on the paper of a technology plan matter far less that the imagining, constructing, and myth and meaning-making that occurs between those involved in creating the plan. Technology planning treated as myth-making can create a set of values and logic for technology use that has the potential to transform education. The impact of such a myth, Lincoln cautions, is limited to the ability of the myth to gain a hearing and evoke sentiment. If there are other conflicting accounts of how technology ought to be used circulating, including the ubiquitous Technology *Then* Uses account, a technology taxonomy forms. If the creators of this myth are not the implementers of the technology plan, or are subordinate to the controllers of funds and decision-making, a "collision of visions" is likely to result. Which pole gains dominance is likely to determine technology use. When a particular goal is desired, the technology myth, the authoritative, credible, paradigmatic understanding of the way technology will be used in the district, must be repeated often throughout the implementation.

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The Role of the Principal in Technology Integration

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In the past decade, the number of computers in schools across the nation has increased dramatically. By 1994, 98% of American schools had one or more computers for instructional use in contrast to fewer than 20% of the nation's schools with at least one computer in 1981. This increase equates to approximately 5.5 million computers in schools across the country. (Mehlinger, 1996). The infusion of computers into educational settings has an enormous potential to impact the teaching and learning process when this technology become an integral part of classroom instruction. Unfortunately, the existence of larger numbers of computers on the nation's school campuses does not mean that students have daily (and as needed) access to these computers nor does it ensure that classroom teachers are comfortable and competent in integrating computers into the daily instructional process. The most common pattern of computer location is in laboratory settings with 20 or more computers which serve each classroom on a once weekly basis. Computers in elementary schools and in increasing numbers of secondary schools are used to teach basic skills and for remedial instruction. (Center for Excellence in Education, 1995).

Campuses which have computers distributed in classrooms, whether as stand-alone or networked units, tend to differ widely in the extent to which teachers and their students use computers as tools for instruction and personal productivity. This difference has been obvious to university, community, and school district personnel who have been in regular contact with the four campuses that are public school partners in the Lower Valley Center for Professional Development and Technology (LVCPDT). Funds awarded to the LVCPDT were used to provide computers for 12 classroom teachers at each of the four campuses when the program was initiated in 1994. From this even start, site-based-decision committees recommended use of additional campus funds for the purchase of more computers and other hardware to provide more teachers and students with classroom computers.

Each campus also had the services of a technology facilitator paid by grant funds who provided twice-monthly training in the use of technology and on-site assistance to teachers in response to their requests. By the end of the second year of funding, teachers and students at one campus demonstrated substantially greater, and more sophisticated, utilization and integration of technology across all grade levels. These observations led us to question what elements had contributed to create the obvious level of technological literacy among these teachers and students. Our questioning led us to a review of the literature and an analysis of the contributing factors that fostered the varied ways in which teachers and students used computers in the teaching/learning process.

Critical Leadership Attributes

Knowledge about technology and leadership attributes are critical components in ensuring the integration of technology across the grades. Campus administrators are the key to encouraging and supporting faculty in the development of computer literacy and the use of technology as a tool for instruction and student learning. By the late 1980s the importance of administrator knowledge and support was identified as a key variable in implementing educational technologies in the classroom (Mecklenburger, 1989). The role of the principal as an instructional leader and role model is critical for any campus desiring to change paradigms of instruction to embrace technology in formats other than computer-assisted instruction in isolated laboratory settings. Components of facilitative administrator behavior include acquiring a basic knowledge of hardware, software, and telecommunications; promoting site-based involvement in the development and implementation of technology plans; identifying and overcoming the human, fiscal and technical barriers to successful implementation programs; and providing on-going leadership for campus technology-related activities.

Campus Process and Outcomes

At the campus level, a deliberate process was adopted by the school administrative team (principal and instructional facilitator) to encourage teachers to transform traditional instructional programs into technology-enriched programs with the seamless integration of technology across the curriculum.

In order to meet the technology needs of all students and teachers, the campus administrators felt that there should be a system of checks and balances to assure that all computer hardware and software were being used effectively. Accordingly, the campus established a protocol for weekly technology "checks." This was based on the belief that "what is important gets monitored (or checked) and what gets monitored gets done." Major components of the monitoring plan put into place included: ongoing needs/satisfaction assessment, collaborative policy-making and goal-setting, training and support, administrative involvement and "modeling," fiscal commitment, recognition and sharing, and accountability.

Ongoing Needs/Satisfaction Assessment

Faculty, professional staff, and paraprofessionals responded to technology surveys at the beginning, midyear and the end of year to adjust training to their requests for technology training and additional equipment and software needs. Staff members also are encouraged to make recommendations that are used to make necessary adjustments during the year. By responding to teachers' needs and desires, training is tailor-made to fit the priorities of its recipients. The majority of the training is done by the CPDT technology coordinator, campus-administrators, campus computer lab managers, and district technology specialists. However, administrators and faculty frequently attend special training sessions or conferences where they receive additional specialized training. This specialized training is then shared with the rest of the campus so that all staff have the benefit of the new knowledge and skills.

Collaborative Policy-Making and Goal-Setting

The Campus Improvement Plan developed by the Campus Performance Objectives Committee (CPOC) and approved by all of the staff, gave technology implementation high priority. Thus, all technology integration activities have campus-wide support. The CPOC recommended that teachers submit technology samples on a weekly basis and that lesson plans reflect the integration of technology into instruction and student projects. The committee also set guidelines for when samples were due, what to include, and how they were to be shared with other teachers.

Training and Support

Every staff member (including paraprofessionals and office staff) is required to attend at least 10 hours of in-house or outside training in the area of technology. Training includes computer hardware, file management, the electronic gradebook, and grade/position appropriate software. All teachers have Texas Educational Network Telecommunications (TENET) accounts that allows them access to both the state information network and to Internet. Teachers have all received TENET training and are currently receiving training in using Netscape and the World Wide Web. All teachers also participated in training in using ClarisWorks, MS PowerPoint, Kids Desk, KidPix2, Grolier's/Compton's CD-ROM encyclopedia, and equipment such as scanners and Quicktake cameras.

Training for teachers at specific grade levels has also included software utilization such as Wiggleworks, Kidworks, Hyperstudio, Using a Spreadsheet, Thinkin' Things, and Inspiration. Finally, a core team of teachers has been trained in using the compressed digital interactive video equipment available on the campus. Teachers and their students regularly conduct video conferences with teachers and students in other schools to share information and learn from and about each other. Last spring, kindergarten students prepared and presented a video conference to eighth grade students in San Benito in which they described their science experiments and explained their findings.

Administrative Involvement and "Modeling"

The principal and instructional facilitator take advantage of every opportunity to become more familiar with, and knowledgeable about computer hardware, software, distance learning equipment, software, computer applications in instruction and emerging trends. This means that they can serve as "resident experts" for their staff. Certainly, their knowledge helps to give them credibility among the members of the school community. However, the critical element that makes all of the difference is that they don't just know about technology, they are competent users of technology. The principal developed a very professional PowerPoint presentation last fall to show parents the campus performance profile at a district-required "campus report card night." Using a notebook computer and an LCD panel in the school cafeteria, the principal and a team of teachers presented a series of 25 PowerPoint slides to more than 200 parents.

The principal and instructional facilitator as well as the computer lab managers are all willing, and able, to troubleshoot when a teacher has a problem with hardware or software. Teachers do not need to wait for an outside technician to come in to help them or demonstrate how technology works. All communications with the school community and central office is done using various computer software. In fact, technology is so integrated into campus administrative and instructional activities that its use has become nearly effortless.

Fiscal Commitment

Every classroom has from one to three computers accessible to teachers and students with a wide variety of software that enables children to use the computer as a tool for expressing their ideas, for creating meaningful products and for developing personal portfolios. Money is budgeted each year to meet the growing demands for upgrading hardware and adding needed software. Through flexible scheduling, teachers and paraprofessionals are able to participate in technology training during the school day several times a year. Funds are also budgeted to ensure that campus educators can attend technology conferences to learn more about effective use of computers in classroom settings.

Recognition and Sharing

Teachers and students are encouraged to share their technology knowledge and products with each other. Two very effective, and nearly effortless, vehicles for sharing are the Samples of Success (SOS) Wall and the bi-weekly newsletter for parents. The centrally located SOS Wall offers a new display each week of technology samples from each grade level in the various subject areas. Not only do teachers display computer-generated examples of effective lessons or materials, but students are also involved in the selection of the technology samples that will represent their room. They choose their best samples to be displayed on the SOS Wall.

Another means for giving recognition for the use of technology is in the scanned pictures and samples of student work that are included in the parents' newsletter. These newsletters reflect children's activities and often also include scanned pictures of students at work, or pictures taken with the Quicktake Camera. Teachers and administrators also have been asked to give inservice training to educators at other campuses or have had papers accepted for presentations at regional, state, or national conferences. This recognition serves to encourage teachers to keep learning and growing.

Accountability

The very obvious expectation that all teachers will develop competence in using technology is no doubt an important factor that has contributed to the extent of technology integration that is evident on campus. Each staff member keeps a verification form outlining the training they have completed throughout the school year. These data become important indicators when the principal completes the statewide Texas Teacher Appraisal System evaluation forms for each teacher. Technology training and classroom technology utilization are reflected in both the classroom instruction and professional development sections of the appraisal instrument.

Summary

The effective integration of technology into schools depends on the vision and leadership of the campus principal. Successful programs are those in which the principal has put into place expectations, motivators, rewards, and support components. Teacher reluctance and apprehension over the everyday use of computers and the resultant changes in classroom organization, management and instruction can be allayed when there is a climate of support from the top.

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REDESIGNING TECHNOLOGY TRAINING PROGRAMS: WHAT IS AND WHAT COULD BE

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Teacher education faculty are continually challenged to keep up with the latest technological developments and applications in the schools as well as to design and implement training programs that prepare undergraduate and graduate level students to be effective technology users (Niederhauser, 1996; Mc Kenzie & Clay, 1995; Strudler, Quinn, McKinney, & Jones, 1995; West, 1994). To succeed in this undertaking information is needed on the current status of technology in K-12 schools in order to adequately prepare pre and inservice teachers at the college and university levels.

Undergraduate and graduate instructional technology course revision decisions often are based on formal and informal data generated by students enrolled in technology classes and/or the collective opinions of teacher trainers in the technology area. Relatively little interaction appears to be taking place between technology educators in higher education institutions and technology personnel in the schools, who daily see teachers and students more or less effectively utilizing technology.

This exploratory technology study focused on collecting technology related data from selected technology leaders in the schools to add to the existing technology revision database. It was believed that the additional information would be more representative of the current technology training needs of practitioners and their students.

Methodology

The research team collected exploratory technology data through the design and distribution of a questionnaire to all the technology trainers and media specialists in two selected school systems (one city system, one county system) in northwest Georgia (N=19). A second step, currently underway, involves the use of follow-up interviews with the same group of respondents to collect additional and more in-depth data.

Survey recipients were asked to provide demographic data on themselves and to respond to eleven research questions dealing with current technology use in the schools and technology-related problems.

The specific questions were:

1. What are the top three types of technology equipment most frequently used in your school by teachers?
2. What are the top three types of technology equipment most frequently used in your school by students?
3. What are the top three types of technology software programs most frequently used in your school by teachers?
4. What are the top three types of technology software programs most frequently used in your school by students?
5. What types of computer programs are the most frequently used in the teaching/ learning process?
6. What types of CD-ROM programs are the most frequently used in the teaching/learning process?
7. What types of technology skills do your incoming teachers need to be better trained in upon entry into your school system to be better prepared to meet the students' technology needs?
8. What types of software programs do your incoming teachers need to be familiarized with to better integrate the programs into the curriculum?
9. What are the most commonly occurring types of technology problems in the school that you must deal with?
10. What types of technology training do you need to better deal with your school technology problems? and
11. How do you update yourself to stay abreast of the latest technological developments?

Analysis

Frequency counts were compiled for the demographic data and the results were rank ordered from the highest to lowest frequencies. A content analysis was performed by two of the researchers on the responses to the eleven open-ended technology research questions.

Findings

Twelve of the nineteen surveys were returned, a 63.2% return rate. The majority of the respondents were female (66.6%), from the high school level (66.6%), had 1-5 years actual teaching experience in their position (33.3%), served as a media specialist (50%), and had either a M.Ed. (25%) or Ed.S. degree (25%).

The types of technology hardware used most frequently by teachers in rank order were computers (N=9), videotape recorders (N=8), overhead projectors (N=6), and televisions (N=3). Student use of technology was found to be similar to that used by instructors. The types of technology hardware students were reported to use included computers (N=11), videotape recorders (N=4), and videodisc players (N=2). Other types of technology used by students which were cited once included the Georgia Statewide Academic and Medical System (GSAMS), television, scanner, and Dukane filmstrip projectors.

The technology software programs that respondents reported teachers used most frequently were WordPerfect (N=4), Microsoft Works (N=4), Lotus 1-2-3 (N=3), Grolier's Encyclopedia (N=2), and PrintShop Deluxe (N=2). Other software products that were mentioned by single respondents were Learning Logic, Edunetics, Infotrac CD-ROM, Proquest CD-ROM, ClarisWorks, Gradebook, Newsbank, Electronic Card Catalog, and Microsoft Word.

Student utilization of software programs was reported to be relatively similar to that used by teachers. The top programs used by students were WordPerfect (N=4), Lotus 1-2-3 (N=4), keyboarding programs (N=3), Microsoft Works (N=3), Children's Writing Center (N=3), Mental Edge (N=2), Georgia Career Information Systems (N=2), and Grolier's Encyclopedia (N=2). Other software that was mentioned once included dBase, Printshop Deluxe, Writing to Write, SAT software, Linkway, Math Blaster, Surpass, and Tom Jr.

When respondents were asked to identify the types of computer programs used most frequently in the teaching/learning process, five responses received two or more mentions: various word processing programs (N=8, Word Perfect being mentioned specifically), databases (N=5, specifically dBase), keyboarding (N=3), spreadsheets (N=2, specifically Lotus 1-2-3), and electronic periodical indexes (N=2, specifically Infotrac and Proquest). Other programs that were mentioned once included integrated software programs (Microsoft Works), graphics software (Printshop Deluxe), desktop publishing, Edunetics, multimedia, and various CD-ROMs.

The CD-ROM programs that were found to be used most frequently were Grolier's Encyclopedia (N=6), Newsbank (N=3), Broderbund Living Books (N=2), World Book Encyclopedia (N=2), and Proquest (N=2). Other CD-ROMs that were cited once included the Ebsco Magazine Index, Microsoft Dinosaurs, Putt-Putt, Sing-a-long Songs, Discovering Authors, Animals, Infotrac, Time magazine, and Tom Jr.

When asked to indicate the types of technology skills in which incoming novice teachers need better training, three responses emerged. These included basic computer skills, Internet skills, and keyboarding skills (N=3).

Specific software programs that respondents indicated incoming teachers should be familiar with included Microsoft Works (N=5), presentation software such as PowerPoint (N=3), Microsoft Word (N=2), Children's Writing Center (N=2), Printshop Deluxe (N=2), and multimedia such as Hyperstudio (N=2). Other software applications mentioned once included networking, desktop publishing, Internet, web page development, Writing to Write, Math Blaster, Carmen San Diego, Caryold Art, Excel, and touch typing for beginners.

A variety of technology problems were reported to occur in the selected schools. The most commonly cited difficulties involved hardware malfunctions. These included computer downtime that resulted from network crashes (N=4) and individual computer problems such as disappearing icons and printer errors (N=4). Other technology problems encountered by multiple respondents included obsolete computer hardware (N=2), insufficient computer support (N=2), school personnel with inadequate computer skills (N=2), and student apathy (N=2). Singularly reported problems were school failure to upgrade CD-Rom programs and insufficient funds to purchase memory upgrades and ancillary computer equipment such as cables and replacement mice.

The types of technology training that respondents stated they needed to better handle their school's technology related problems were diverse. The most frequently reported needs included computer networking (N=3), more familiarity with the IBM platform (N=3), how to install new software (N=2), and technology grant writing (N=2). General information on the use of ICLAS, CNA, Web page development, and exposure to new software were needs mentioned by singular respondents.

Media and technology personnel reported a myriad of ways in which they updated their skills. The top two practices cited were attending workshops and/or instructional classes dealing with new and emerging types of technology (N=11), and reading technology and media magazines (N=8). Other training strategies that were identified included networking with other technology people (N=4), taking the necessary time to learn and practice new programs (N=3), reading selected technology manuals (N=2), and watching television when technology information was presented (N=2).

Conclusions and Future Directions

This exploratory research was effective in finding out some of the technology practices and problems of practitioners and students. It confirmed that computers are the most frequently used technology in the targeted school systems by both teachers and students. It also suggested that productivity tools such as word processing, databases, and spreadsheets are still the predominant applications used by teachers and students. In addition, the study reinforced the importance of adequate computer training in basic skills and advanced applications for new and veteran teachers, and indicated that sufficient funding and personnel support for computer maintenance is still a problem for some.

However, several new needs and problems for computer users and technology managers were identified. Specifically, the need for Internet training for novice and veteran teachers surfaced, and the impact of computer networking in schools was introduced. The study indicates that some school personnel need network training to be able to solve problems schools experience due to network failures. It also pointed to the importance of having advanced training and workshops available for media and technology personnel, since the overwhelming majority of the respondents indicated this was how they kept up with new developments in the field.

The current research effort is being augmented by follow-up interviews with the technology/media personnel who participated in the study. Future plans include expanding the research to include surveys and interviews with additional P-12 schools throughout the state, as well as with media and technology faculty and trainers in the College of Education, particularly those working in Early Childhood, Middle Grades and Secondary Education. Broadening the research to include these populations will help identify gaps between needs in the field and existing technology training (both credit courses and staff development workshops) provided to pre and inservice teachers enrolled in College of Education technology offerings.

The dynamic state of technology in the nineties necessitates a constant review and redesign of instructional technology education and training. The results of this study, and follow-up studies, will be used to help restructure the technology experiences offered to undergraduate and graduate students in the College of Education. This will insure that pre and inservice teachers, media specialists, and technology trainers will gain the skills and knowledge required to work effectively in today's technology-rich classrooms.

In addition, the research findings will be used to design technology staff development offerings for all faculty in the College of Education. Basic technology training sessions have been offered to College faculty for several years. However, as technology is infused into the College of Education curriculum, appropriate use of contemporary technology must be modeled by the entire faculty. This means that staff development must provide College faculty the broad range of skills required to enable them to use current technology effectively in their own classrooms — and to assure that their classrooms provide the kinds of technology experiences that students can expect to encounter in the field.

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THE HIGH-TECH BACKWASH: THE TRANSITION FROM LOW TECH TO HIGH TECH

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Universities across North America are hurriedly adopting high technology. The push is to develop competent and confident high technology users and the fear that pushes this movement is the fear of being left behind other institutions who similarly seek to be on the cutting edge of these new and promising technologies. Political machines similarly urge educational institutions under their jurisdiction to 'get with the program' — to innovate and hence to remain relevant to a fast paced, changing technological society. This paper is an attempt to look at one aspect of the much larger technological phenomenon sweeping the world. We look at what is happening to technologies in the public schools. For purposes of comparison we will look at two forms of technology: Low technology consisting of all forms prior to the introduction of microcomputers; and high technology consisting of microcomputer-augmented support in any form.

Related Literature

The Japan Audio-Visual Association conducts surveys regularly at three year intervals. Their latest national survey was completed in 1992 (Japan Audio-Visual Association, 1993). This is one of the only efforts found in the literature to keep track of what is happening to audiovisual resources. Elsewhere the interest seems to have been almost completely extinguished. Seidman (1986) surveyed Fort Worth classroom teachers about their use of media. He found that teachers as a whole seldom use media but the simpler the medium is to use the more likely it will be used by teachers. Similarly, Carter and Wedman (1984) reported that teachers were more likely to use media if they were easy to use or alternatively simple and inexpensive to produce. Aside from these surveys there has been very limited formal attention to the status of audiovisual media in the post-computer era.

The Survey

The core of this paper is based on an original survey entitled *Technology in Alberta Schools* designed to find out what was happening to the older technologies, herein addressed as low technologies, as a result of the diffusion of microcomputer technologies in the school. The survey was sent out to schools in Spring 1995 and the results were compiled in June 1995. This survey was based on a 1993 Alberta government survey entitled *Microcomputers in Alberta Schools—1993 Survey*. The 1993 survey looked exclusively at the microcomputer presence in the schools so the survey addressed in this paper sought to fill the gap by finding out about the current status of the other forms of technology present in the schools.

The survey consisted of five parts. Part I identified the responding school's enrollment, grade levels taught, staff data, and other statistics. Part II looked at the existing inventory of low technology, its location in the school or school district and the expectations about acquiring new inventory over the next budget year. Part III looked at the usage patterns by school staff and asked for estimates of use compared to two years ago. Part IV asked respondents to compare the extent of use of low-tech media with high-tech media. Finally, Part V asked about teachers' perceived needs in professional development in relation to both hi-tech and low-tech resources. Comment sections were included for each subcategory of questions. These comment boxes were used to express clarification of the answers given or to add information not addressed by the questions.

A stratified random sampling technique was used to send surveys to a sample of 500 Alberta schools out of a possible 1664 of the province's tax supported schools. The surveys were sent out to the three categories of schools (K-6 Elementary Schools; Grades 7-9 Junior High Schools; and Grades10-12 Secondary Schools). Of the 500 surveys sent out 203 were returned making a return rate of 40.6%.

In order to collect the opinion from a school a single representative spokesperson was sought. An earlier American survey, the National Survey and Assessment of Instructional Materials conducted in 1974 recommended that the best respondent for this type of survey would be the school principal or the school librarian. Therefore, the survey was addressed to the school principal and in the accompanying letter the principal was asked to complete the form or to give it to the person who would most likely be able to respond to questions about the use of resources on a day-to-day basis in the school such as the school librarian. Each school, however, had only one spokesperson who answered the questions on the survey on behalf of all the teachers in that school.

Since the statistics from each of the three categories of schools were quite similar the data were collapsed for the purposes of analysis. The reporting, therefore, is representative of Alberta schools, generally, and not from a single level of school in the system. The basic question being addressed is "What was happening to the older technologies in the school?" Implicit in this question was a series of other questions: "How were older technologies affected by the introduction of new technologies?" "Was there evidence of a transition from low tech to high tech in the public school system?" and even "Were the audiovisual media dead?"

Survey Findings

The data generated from the eleven-page questionnaire were extensive but with respect to the central question there are three generalizations coming out of the survey.

1. Low-tech media are still used as teaching resources on a regular basis by large numbers of teachers.
2. Teachers perceive low tech educational media to be in a state of declining use over what it was two years ago in the schools.
3. The influx of high-tech media is perceived as a separate issue from the perceived decline of low-tech media use in the schools.

The first two of these generalizations are not a surprise to people who are in touch with teachers in schools. The third generalization, however, deviates from what would be expected at least on the surface. Let us look at each of these generalizations in turn.

Teachers Still use Low-Tech Media Regularly. Figure 1 represents the perceived usage patterns for six of the more common low-tech media formats. Of course there are media-specific differences in evidence but the general trend shows regular use of these media in teaching and learning. Looking further into the data we see that teachers who have been regular users of the low-tech media continue to be regular users. Video as a resource continues to be a very popular choice by teachers. There are indications in the survey data that video is gaining popularity in teaching as a production tool even though many schools do not have adequate video equipment for locally produced videotapes. The use of overhead transparencies, similarly, enjoys a fairly strong position as a teaching resource. The place of slides, filmstrips, and films is much weaker than the newer media of audiotapes, overhead transparencies, and videos.

When comparing the usage of low-tech media and high-tech media, the similarity is remarkable. Findings indicate that both forms of technology are used either frequently or regularly in the implementation of the school program.

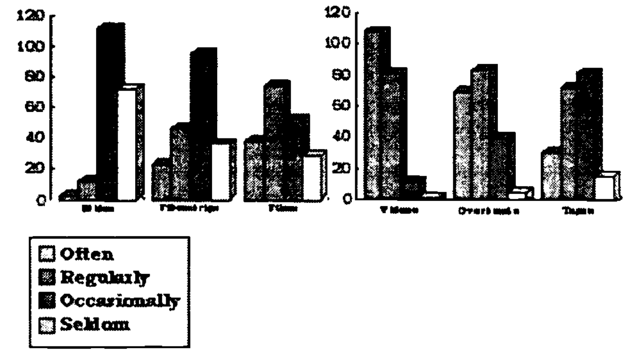

Figure 1. Perceived Frequency of Media

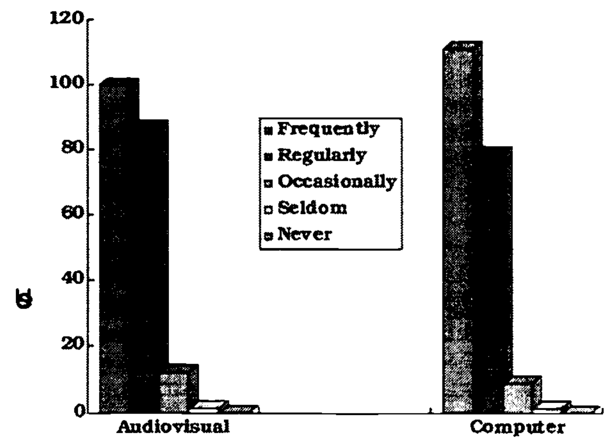

Figure 2. Comparison of New and Old Technologies.

There are also some differences in this comparison chart. The frequency of use of computer technology is perceived to be somewhat higher than for the traditional technologies and the division lines between the different categories of use are much sharper for the high-tech media than for low-tech media; but on the whole, it must be admitted that both forms of technology are recognized as respectable players on the resource team.

These same findings were corroborated by different questions in the survey. The usage patterns for both forms of technology are correspondingly similar. Not evident in Figure 2, but coming from other sources, there is a larger complement of teachers who do not use or very seldom use computer technology than there is for teachers who fit in the equivalent category for the low-tech media.

Teachers Perceive Low-Tech Media to be in a State of Decline. As shown in Figure 3, the older media of slides, filmstrips and films are perceived to be in a state of declining use by about 60% to 70% of the schools responding to the survey. The opaque projector, however, still holds its own as a tracing tool in the school's resource repertoire.

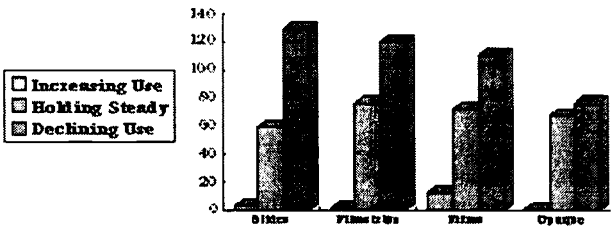

Figure 3. Perceived 'Declining Use' Patterns.

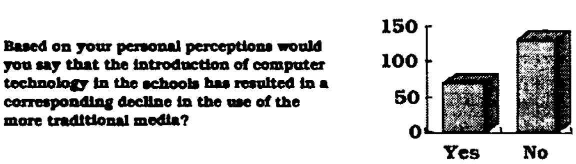

Figure 4. Perceived Effect of New Technology on Old Technology.

Influx of High-Tech Media is Perceived as a Separate Issue from the Decline. The most direct evidence lending support to this generalization is in the response to the question in Figure 4. This is a surprise over what one would expect upon reflection about what is happening in the schools with respect to the technologies. However, if you consider the fact that many teachers have not used low-tech media or have used them in only a very limited way throughout their teaching careers the finding is less surprising. Teachers who have not been media users for whatever reason may be receptive to the use of computer technology in teaching. This would help to account for the perception that the two issues are seen as separate from one another. The influx of computer technology in the school is one issue and the decreased use of the older media is another one. More needs to be done in teasing out the meaning from this somewhat puzzling response.

Discussion

Change without transition is not characteristic of change in the schools. The schools are conservative and tend to resist sudden or dramatic change. Elements in today's schools remain very similar to the way they were in schools in the 1800s. In many ways this is a positive comment. It represents a form of stability or even security. Essentially the purpose of the school has not changed. The school still exists to enable our youth to be able to cope effectively with society: with work; with relationships; with leisure; and with life. In examining the change that is occurring with respect to the new technologies we need to be reminded of the basic purposes that our educational system has. Admittedly, these purposes differ somewhat depending upon your philosophical orientation whether that is essentialist, progressivist, or constructivist or some combination of these three. However, in general terms they share a commonality of preparing our children for adulthood and to achieve fulfillment in their expression of humanity.

The new technology has a sense of urgency attached to it. As well there is the implicit mandate that not to endorse it without reservation means the person is *out of touch*, *out of date*, or simply *not with the program*. There is a bandwagon effect in the adoption of the new technologies which accelerates its penetration and closes down an attitude of critical inquiry. Along with the new technologies we need to accept enormous costs and the fact that much of the technology is out of date before it is mass produced. Everyone at every level needs to be involved in the development stage of the technology.

Based on the results of the survey and our observations as low-tech specialists in education we want to make one strong point. We believe that educational technologists need to respect the heritage in the technologies. There is much to be learned from the work of people in the older technologies. If the two technologies are viewed as unrelated to one another then we cannot use the experience of earlier research and study to inform the direction and contribution of the new technologies to learning. The pattern of research in high tech appears to be concerned with defining the unique and facilitating characteristics of microcomputer-augmented instruction or with comparative studies of computer instruction versus traditional instruction (Ryan, 1991; Wang, 1993; Snowman, 1995). This type of research characterized the early developments in audiovisual technology but research strategies became more specific as the field realized that the questions asked were too general to contribute in a meaningful way to any useful theory about how learning outcomes were affected.

We need to encourage a "true transition" from older media to newer media. A true transition would involve activity in the middle zone between the two technologies:

overhead transparencies prepared using computer software; analog video footage incorporated into desktop video presentations or used in conjunction with computer presentations. Teacher training institutions need to take the stance of proceeding more deliberately in the diffusion of high-tech media into their programs. There is a level of high-tech functioning that could be classified as staple including the use of word processing, spreadsheets and record keeping software, and presentation software. At the staple level development of the software is largely completed. New versions bring refinements but they are incorporated within a fairly well defined and stable structure.

There is a second level of application which has strong relevance but standards, if they exist, are more loosely defined and changes from one version to another in the software are often giant leaps by comparison to similar activity in the staple area. This level includes Internee production, and much of the activity in the manipulation of graphic images and sound. A considerable investment in development needs to occur for applications at this level to be ready for use as classroom resources. Activity in this arena needs to be more selective than at Level One. Level Two needs to be thought of as exploratory and experimental and not everyone needs to do it immediately. Finally, there are applications on the horizon which go beyond many of the applications currently conceived by educators. This Level Three activity is the type of activity that many technologists should read about.

Of extreme importance is for technologists to get in touch with their roots. This not only means looking at the value and need for resources in the first place, but also to look at what has happened with older forms of technology. We need to look at where we are going from the shoulders of giants and consider high tech to be part of the evolving educational technology rather than as a quantum leap away from previous technologies.

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IT INTO EDUCATION: A CHANGE EFFORT WORTH PURSUING?

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It is almost a cliche to say that the only constant thing in the world is change; but like most cliches it is predominantly true. Certainly within the world of education change is the norm. Fullan (1996, p. 420) points out that one of the main problems in education at the present time is overload due to "the continuous stream of planned and unplanned changes that affects schools." Elsewhere Fullan and Stiegelbauer (1991) point out that it is not possible to pursue all the available change efforts and suggests that it would be more productive to "work at fewer innovations, but do them better" (p. 104). Thus we need to be able to decide which of the range of competing changes are worth pursuing.

Three key questions which should help this decision process are:
Q1. Is the quality of the change high?
Q2. How great are the costs involved?
Q3. Is the change effort likely to be successful?

In considering these questions it must be remembered that any change effort involves not only the substance of the change (the innovation) but also the process of change (how the innovation will be implemented and institutionalized); to paraphrase Gilbert (1996), you need a vision (the substance) and a path to reach your vision (the process).

Question 1: Is The Quality Of The Change High?

There is, implicit within much of current thinking, an assumption that change is 'a good thing'; change is progress. This seems to stem from the belief that not changing is a bad thing (which may well be the case in many contexts). However the two statements do not follow on from each other in a logical sequence; just because a lack of change is bad does not mean that all change is good. The quality of a change will depend on your values and perspectives on the purposes of education, but it is important to remember that "change is not necessarily improvement." (Cuban, 1988, p. 341).

In order to identify the quality of a possible change one needs to be clear about what it entails; one needs to have a clear vision of what the change will mean. This is problematic; even if you think you are clear in your own mind about the change effort there is a great deal of evidence that suggests that the very process of implementation leads to modification of the intended change (Berman, 1981; Miles, 1993). For example one might start out with the intention of enhancing children's use of IT by increasing the number of computers available and providing staff training in how to operate the equipment. During the process of implementation it may become clear that the training need is not in how to operate the software but in how to manage children's use of IT in the normal classroom context. In addition the 'real meaning' of the change often does not become clear until it has been operationalized (Fullan & Stiegelbauer, 1991, p. 92). In other words, it is often difficult to see the true impact that a change will have until you start to implement it. For example the most significant impact of increasing the number of computers in classrooms may be to alter power relationships between staff and children, but this may well not become apparent until the equipment is in use.

As can be seen from the examples above the criteria for judging the quality of a change should include consideration of the intended outcomes as well as possible side-effects. Clark, Lotto and Astuto (1984) have identified that a focus on learning is one of the attributes which characterizes excellence in America's best run schools and given that learning should be the key function of education it should be a major factor in any educational change. In the context of enhancing education through the use of IT, this needs to be emphasized given that "there is no automatic educational value in mere exposure to computers" (Maddux, 1993, p. 14).

Question 2: What Costs Are Involved?

When thinking about the costs of a change one needs to consider not only the costs of pursuing the change but also the costs of not pursuing it. For example if legislation were passed which stated that every child was entitled to benefit from using IT and must be taught how to do so then the costs of not incorporating IT into your teaching would be high; not to do so would entail breaking the law with all the associated consequences.

At least three different types of costs need to be considered: (a) resource costs, (b) people costs, and (c) opportunity costs. Resource costs include such things as salaries and the cost of staff development as well as the cost of equipment and the like. People costs refer to the costs individuals have to pay in terms of stress, change of status, emotional upheaval and so forth. Opportunity costs are the costs which one incurs as a result of not being able to pursue other activities because you have committed yourself to this one.

Question 3: Is The Change Effort Likely To Be Successful?

In order to determine whether or not a change effort is likely to be successful you need to: (a) Define success; (b) work out how complex the changed is (the number of obstacles to overcome); and (c) determine the forces operating on the change

Defining Success

Huberman (1973) identified one key criteria as durability, the continued survival of the innovation. This presupposes that you know what the change was going to look like in advance which, as has already been stated, is often not the case.

Even if we accept that the process of change will modify the originally intended change, each change must have characteristics which have to be preserved if that change is to be thought of as successful; those characteristics will vary from change effort to change effort but (none the less) should be identifiable. If, for example, one were considering introducing Integrated Learning Systems (ILS) then one criterion might be the extent to which children's mathematical skills increased. The reason for the increase might be unexpected, such as the teacher being able to target teaching more accurately as a result of the feedback from the ILS, but this would not detract from the success of the change if an increase had occurred.

Many authors view one key criterion for success as the degree to which the change effort has increased the systems (individual's, school's, etc.) ability to change in the future e.g. (Huberman, 1973; Miles, 1993). Indeed Fullan & Stiegelbauer (1991) suggest that "changing the culture of institutions is the real agenda, not implementing single innovations." (p. 107)

Thus, though it may be the case "that different definitions of success are necessary under different circumstances," (Berman, 1981, p. 264) every definition of success should include criteria relating to the enhancement of the culture for change and the institutionalization of identifiable key aspects of the change itself.

The Complexity Of The Change Effort

The complexity of a change depends upon its scope, degree and divisibility.

Scope. The scope of a change effort refers to the number of people that it will involve. Thus the scope is small if only a small number of people are involved. As the scope increases so does the complexity, not only because of the increasing number of different perspectives on the change effort, but also because of the increasing complexity of the interactions of those people.

Degree. The degree of change refers to the extent to which individuals (and the systems which they make up) have to change. Huberman (1973) identified two dimensions that make up the degree of change, the first relating to how much change is required and the second to the kind of change. Fullan (1986) identified three aspects which contribute to the degree of change which effectively combine Huberman's two dimensions. Fullan's three aspects of change are: (a) use of new or revised materials; (b) use of new skills; and behavior; (c) changes in beliefs and understanding.

His view that significant educational change must include the latter two fits well with Cuban's (1988) definitions of degrees of change:

> First-order changes, then, try to make what already exists more efficient and more effective, without disturbing the basic organizational features, without substantially altering the ways in which adults and children perform their roles. ...Second-order changes seek to alter the fundamental ways in which organizations are put together... Second-order changes introduce new goals, structures, and roles that transform familiar ways of doing things into new ways of solving persistent problems. (p. 342)

As the degree of change alters from first to second order the complexity increases. Indeed Cuban (1988) identifies that to bring about second order change "basic social and political changes would need to occur outside of schools" (p. 344); the degree of change thus affects the scope of the change as well as impacting on its complexity directly.

Divisibility. The extent to which a change effort is divisible also affects its complexity. Divisibility can be applied to both the scope and degree of change: the greater the degree to which a change effort can be broken down into components which can be implemented progressively, the less complex it is to implement. In effect it becomes a cumulative series of less complex changes. Similarly the greater the possibility of increasing the change effort's scope progressively over time, the less complex it is. Davis, Kirkman, Tearle, Taylor, and Wright (1996) suggests that "an appropriate strategy is to focus effort and resources on one area or department, thus establishing local expertise which will sustain the innovations when the focus moves on to another department" (p. 14).

Common sense tells us that the more complex the change the less likely it is to succeed, but the research evidence suggests that the situation is not so clear cut. Fullan and Stiegelbauer (1991, p. 71) point out that more complex innovations result in greater change but also have a greater danger of failure; Miles (1993) goes further than this and states that "it's been repeatedly found that more substantial change efforts addressing multiple problems are more likely to succeed than small-scale, easily trivialized innovations" (p. 215).

The Balance Of Forces

Fullan and Stiegelbauer (1991) state that you need both pressure and support in order to bring about planned change; "Pressure without support leads to resistance and alienation; support without pressure leads to drift or waste of resources." (p. 91). The implication here is that pressure and support are different kinds of things; pressure is portrayed as directional and ephemeral whilst support is undirected and concrete. This analysis seems flawed because pressure and support can both be ephemeral and/or concrete. For example, providing a teacher with 'training' (concrete) in the use of computers in her classroom or with encouragement (ephemeral) to use computers in her classroom may both be seen as pressure or support depending upon that teacher's views about computer use.

Thus pressure and support are in fact different perceptions of the same thing; each can be thought of as being a 'force' which 'pushes' you in a particular direction. Something is perceived as pressure when it is 'pushing' you in a direction which you are not actively moving in yourself or may be moving away from. Something is perceived as support when it 'pushes' or facilitates you moving a direction that you want to move in. As with forces in physics pressure and support can vary in strength, direction, duration and in the ways in which they manifest themselves.

In any change effort there are a large number of such 'forces' (pressures and supports), some of which are directed towards the change effort and some against. Pressures and supports that are directed towards the change effort I shall call 'enablers.' Those that are against the change effort I shall call 'resistors.' The 'net force' is the strength of pressures and supports (in the direction of the change effort) remaining after the resistors have been neutralized by the enablers. (Enablers - Resistors = 'Net force')

For a change effort to succeed the 'net force' must be of a sufficient strength to fulfill the needs created by the complexity of the change effort; i.e., it must be sufficient to overcome the 'resistance'. Having a strong enough 'net force' is a necessary but not sufficient condition; adequate duration of the 'net force' and appropriate manifestation (observable conditions) are also needed.

Change takes a long time; significant first order changes take a minimum 2 to 3 years and second order changes take much longer (Fullan & Stiegelbauer, 1991, p. 106). Thus, while the strength of the net force that is required will not be the same at each point in time, it is necessary for there to be a sufficient 'net force' in favor of the change until it has succeeded.

The ways in which the forces manifest themselves are also crucial. These can include concrete forms (e.g., resources which may include time, access to training and/or expertise, equipment) and ephemeral forms (e.g., expectations such as group norms; directives which include orders, mandates and legislation; encouragement or advice). Different manifestations of forces perform different roles and are necessary at different points in the change process.

In order to determine the likely net force, its duration and manifestation you need to consider where each of the different enablers and resisters are emanating from, their level of commitment, degree of influence and style.

For each individual force the level of commitment can be determined by exploring why the force is operating: a form of cost/benefit analysis. A clear focus here should be on whether the 'motivations' of the force are internal or external: internal motivations (e.g., beliefs and convictions) tend to be more durable than external ones (e.g., political pressure).

The degree of influence a force has depends on where it emanates from. For example a teacher in her classroom has a high degree of influence over how her classroom operates but a low degree of influence over government legislation on education. The idea of leadership, which is identified in the literature as being a crucial aspect of any change effort (Blumenfeld, Hirschbul & Rubaiy, 1979; Clark, Lotto & Astuto, 1984; Fullan & Stiegelbauer, 1991; OFSTED, 1995; Rhodes & Cox, 1990), is important at least in part because of the degree of influence that leaders can exert. The greater the degree of influence that an individual has, the greater the strength of force that they can bring to bear. Likewise the greater the degree of influence, the greater the ability to increase the effectiveness of the manifestation of the force. For example a Government minister has a greater ability to affect the level of funding of a scheme than does a classroom teacher.

The style of the source of the force is also crucial because it determines how the force is manifested. A key component here is the ability of the source of the force to determine the most appropriate manifestations of that force at any point in time. This is dependent on their sensitivity to the needs and subjective realities of others as well as to their models of the change process. These models determine the strategies that are likely to be employed in implementing the change effort.

Chin and Benne (1976) identified that the change strategies which prevail in the literature can be placed into three categories. These categories are: (a) Empirical-rational, (b) Normative-re-educative, and (c) Power-Coercive.

Empirical-rational change is seen as a rational process in which the innovation will be adopted once those involved are shown that it is rationally justified and that they will gain from it.

Normative-re-educative change is seen as a learning (reeducative) process involving altering sociocultural norms which entails "changes in attitudes, values, skills, and significant relationships, not just changes in knowledge, information, or intellectual rationales for action and practice." (p. 23) Normative-re-educative change strategies "emphasize norms of openness of communication, trust between persons, lowering of status barriers between parts of the system, and mutuality between parts as necessary conditions of the reeducative process" (p. 37).

Power-Coercive involves a process of compliance of those with less power to the plans, directions, and leadership of those with greater power" (p. 23). Any change effort which ignores the normative-reeducative strategies is unlikely to succeed because effective implementation "seems to be characterized by mutual adaptation at the user level and by the staff's clarification of the innovation's goals and required role behaviors" (Berman, 1981, p. 273) or to phrase it more succinctly: "any significant innovation, if it is to result in change, requires individual implementers to work out their own meaning" (Fullan & Stiegelbauer, 1991, p. 105).

Conclusion

The answers to the three key questions which are presented above will tend to be fuzzy as opposed to a clear-cut. This is because they depend on knowledge of a vast range of factors and this knowledge is often subjective (i.e. depends on one's perspective), unavailable and/or too multitudinous and complex to comprehend (Fullan & Stiegelbauer, 1991). Considering these questions does help to clarify whether a particular change effort is worth pursuing.

Whether an individual decides a particular change effort is worth pursuing will depend not only on the answers to these three key questions but also on the degree to which they are prepared to take risks. Figure 1 below provides a decision tree which suggests how a cautious person might respond to a particular change on the basis of their answers.

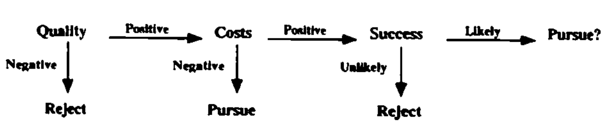

Figure 1. A Decision Tree Showing How One Might React to a Potential Change Effort on the Basis of the Answers to the Three Key Questions.

Ultimately the selection of which change(s) to pursue is a complex decision, but "in the final analysis, either we have to give up and admit that effective educational change is impossible, or we have to take our best knowledge and attempt to improve our efforts" (Fullan & Stiegelbauer, 1991, p. 102). The questions presented here provide a starting point for doing just that.

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Four Journeys with Technology: Getting Something We Didn't Plan For

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Change theory proposes many models for successful development and implementation of new educational practices (Fullen & Steigelbauer, 1991). While acknowledgment is given to involving teachers as active participants for successful innovation and planning (Fullen & Steigelbauer, 1991; van den Akker & Plomp, 1992) we have also come to realize that changes can cultivate new ways of seeing ourselves as teachers and learners. We as teachers may implement and/or affect changes, but, how do these changes alter our personal/professional landscape? Moving into new territories with technology has offered us an opening for enrichment of this landscape.

Recent work at our school in opening up possibilities for our children has launched a philosophical conversation. Technology has become not only a tool by which our students may pursue new learning possibilities but also a vehicle by which we, as educators, are alerted to our basic personal beliefs and fears about our work. It is also a means by which we pursue new ways of seeing ourselves as learners/teachers and compose new stories of collaboration with each other and our students. Each staff member has followed his or her own path, yet many shared dreams have emerged. Anderson (1995), Kazlauskas (1995), and Schuttloffel (1995) have offered possibilities and models for successful implementation of technology. We would like to offer these stories of implementation of technology at our school as portraits of personal and professional growth within a collaborative learning environment.

This paper includes highlights of the history of technology implementation at our school. In particular, four of us have met to discuss our own journeys: one as a special education support teacher (Kathy), another as a grade two teacher (Kathleen), a third as an instructional design consultant with the University of Alberta (Katy), and, finally, a school administrator (Laurie). Each of us has a different story of how technology has become part of our professional lives. Our current school context is the thread that connects us. Through our stories, we hope to share insight into the complexities of life in schools, particularly as it relates to our personal/professional growth with technology.

Kathy's Story

In the past decade it seems that we have been bombarded with new technology tools and programs. The media hype and the excitement that technology innovations have caused in the outside world have made us very anxious to get involved and try out these ideas with our students. While I can see the usefulness of these tools, I continue to ask questions about the change in my pedagogy that technology demands.

Do computers save us time and effort at school? Definitely not—at least at the beginning stages of implementation. In fact, quite the opposite is true. I have spent hours learning, experimenting, failing, and trying different programs and tools. However, once I have successfully used a program and integrated it into my planning and my students' days, it is hard to imagine teaching without it.

The most significant change in my job has come from my own use of technology. It seems that the computer has crept into every aspect of my teaching from test management and student records to worksheets and activities. I have learned to use a very limited amount of what we have available and keep looking for time to learn, practice and experiment with other tools.

I think that using computers depends largely on your comfort level around the machine. The only way to increase that comfort level is to use it and the only way to use it is to find the time to try. Yet, unless we trust that this will someday make life easier or that technology is important to our students' learning and to our teaching, we will not allow ourselves the time to be the learner.

When I first started using computers I thought this would be the answer to the massive amount of record keeping that goes with my job. I started to painfully record, on floppy disk, all of my objectives and units from my special education curriculum. Needless to say, this was like the never ending story. Long before I ever found the time to finish my project, the technology had changed to the point that I could no longer use the disks that I had created. Although this was a time consuming endeavor, it was also a wonderful learning experience and greatly increased my comfort level with computers. However, it makes me very cautious about what we are spending our time and money on at our school. I also spend more time thinking and debating the value of programs or new innovations.

Kathleen's Story

I grew up in a home where the rapid growth of technology was not very apparent. It wasn't until I entered university in 1975 that my mother finally put away her old wringer washing machine and bought an automatic washer. A microwave followed in the late 1980s, and only in the last few years has a VCR invaded my mother's home. There are still no signs of a dishwasher, and computers and computer language is as foreign in her home as an exotic language would be.

As a child growing up in this setting, I, mistakenly, determined that technology must be quite dangerous, and something to be avoided. After all, my mother was a teacher, and if it was a good thing, I felt sure that she would be making use of it. Only years later, looking back, have I come to the realization that finances were the real reason that technology was so slow in entering our home. I took this misconception with me as I began my teacher training at the university. While some technology was available to students in the library, I never made use of it.

Eight years ago, technology was introduced into the school where I teach. Classrooms received computers and heavy inservice training followed. The computer was to be used mainly as a way to strengthen students' skills through games. I dislike educational games, and so I now had two aversions to technology. I saw it as a danger based on my early experiences and as another medium for playing games. This use of computers at the school has since changed. Computers are now used primarily as tools for writing stories and reports, and more recently, for conducting research.

Luck was with me, I thought, as I was in a position teaching music and physical education and neither course involved computers. I hoped that no one would notice my absence from the inservice activities. On those nights I ran from the school as quickly as possible, trying to mingle with parents who had come to pick up their children.

Shortly after this year of computer introduction, I was assigned a grade two classroom complete with a computer, and a stack of disks. For a few months, the computer sat shrouded in the corner. Then, finally, I decided that the students should be able to use it for drill and review, and I learned the basics from other staff members. To anyone looking in, I would have appeared comfortable with technology. However, other than turning the computer on and off, I still had no connection with it.

In terms of my use of technology, those were difficult years. I had come to realize that I had incorrectly assessed technology as a child. However, it still frightened me. At the same time, I felt like the rest of the staff had climbed on to a locomotive, and I had elected to stay behind at the train station. I began to doubt my abilities and felt that I had very little to offer the teaching profession. I was not connected to my more technologically sophisticated peers.

A year ago, Katy, an instructional design consultant from the University of Alberta came to our school to provide inservice for us in technology. At the beginning of the day, I felt as if we had been transported to another planet. While the new technology that Katy showed us overwhelmed many teachers who were comfortable with the technology in place at our school, it left me speechless.

Katy showed us how to use the Internet and e-mail. Even though we had some problems using the Internet that day, I became intrigued with the communication possibilities. As we are situated in a small rural area, it is often impossible to make connections with people who can broaden and intensify our learning. Katy was offering us a door to the entire world. Within weeks, I was closeting myself daily with the Internet. Teaching became alive as my grade two class and I researched animals and countries for classroom projects. I used e-mail with a passion.

I began to take my students to the lab for very basic keyboarding. As they absorbed my enthusiasm, they became relaxed and comfortable with technology. Some of the weakest students have flourished, finding great success in our lab, where we are all on a fascinating journey of discovery.

For myself and my students, technology is building a bridge across the distance of rural living to people all over the world. Like chefs creating new meals, we are creating new connections, becoming open to new ways of learning. Our circle of communication grows daily. Personally, I feel recharged as I once again assume the role of both teacher and learner, moving toward the next century with enthusiasm and anticipation.

Katy's Story

I was invited to enter the process of school-based technology planning in the way that I have always come to the practice of educational technology - through personal relationships. Relationships are the social context in which I design and in which I am able to best explore, and share the experience of technology in my work. I do this through conversation.

I had first worked with Laurie, the principal of Rocky Elementary, on a videodisc project in teacher education. The project was run by a professor in Elementary Education and Laurie was his graduate student assistant. I was the instructional designer. Through the conversation-based process of design Laurie and I created a social space in which the design process became a process of sharing teaching and personal experience. We became friends and, through that relationship, colleagues and design partners. Laurie knew, and had helped me write, my story of becoming a multimedia instructional designer.

Like so many of us who call ourselves Instructional Designers, I have an experiential base to my practice which only later (and only sometimes) seeks validation through formal training and credentials. Personally, I seek authorization to do what I do - to be, in effect, the expert - through the tacit agreement of my work partners. I enter into their worlds and make my own understanding of technology accessible through discussions about experiences with teaching and technology. I chose a technology model because I had an instructional need best solved by technology-enabled instructional strategies. I did not fall in love with technology as an entity, that came later. I know that teachers, and university professors, will only use technology when they need it to solve a problem.

I was invited to an inservice at Rocky Elementary as an Internet expert. Far from being impatient with the resistance to embrace a mostly ubiquitous technology because "what if the network goes down in the middle of the lesson", or becoming defensive about the reliability of 1996 technology, I told the story of my own confrontations, as the technology expert, with constantly failing technology. I entered into the world of the classroom teacher who cannot afford to problem-solve a failed Internet connection for even five minutes with a class of restless 7-year-olds, and worked with the assumption that technology will fail, and how we can recover from that. In the afternoon, I was invited to model my practiced serenity in the face of technological havoc as the school network went down and stayed down all during my hands-on workshop. And I'm told that in so doing I brought the teachers, feeling immensely relieved, into my world of sometimes uneasy alliance with technology for teaching.

Laurie's Story

In 1994, I thought I knew about technology, or, at least some of the possibilities that technology could offer our students. I had embraced it as part of my own classroom teaching since 1980 and had been very active in professional development related to technology. My journey at Rocky Elementary since 1994 has taken me to places I could never have imagined. I have been a privileged observer and participant in a wonderful journey of discovery as I have watched new relationships evolve through dialogue and debate about technology. These relationships have been the foundation for support as teachers have wrestled with the frustration and excitement that technology can bring. Conversations continue spontaneously in the hallways during and after school, at inservices, in our meetings for our technology plan (involving para-professional staff and parents), and now in our writing about our experiences. For us, planning for, and utilizing technology has become another starting point for reflection.

When I came to the school as the principal in 1994, I arrived at a place where many teachers were using computers in exciting ways in their classrooms. For others, computers remained under covers, unused in a corner of the classroom. How could these teachers begin to see themselves as part of the dialogue about teaching and learning with technological tools? In their resistance, I sensed their feeling of being left out and apprehensive about the time that technology could demand of them while at the same time being reluctant to open the doors to new possibilities. Computers had been a mandated part of life for grades four and five teachers for several years with support provided by a teacher (Karen) who was given release time (20%) for technology. I looked for cracks in the doors and tried to provide as many places and spaces as possible for dialogue about changes.

Many doors opened through the broadening of our technology planning process. Whereas Karen had done the majority of the planning until 1995, an increase in the decision making authority of teachers through site-based decision making enlarged the circle. Our staff realized that having the authority to determine where and how our budget would be spent also required careful thought and planning. Our first meeting of the "Step-Forward" committee, held in the fall of 1995, had 17 volunteers in attendance (professional staff, support staff, and a parent representative). This committee was originally formed to address changes that we wanted to see in our library, however, we soon realized that it would become our school plan as it related to technology. I found myself as an observer rather than an active participant. A synergy evolved that allowed me to step back and enjoy watching the direction that the group was heading in. The enthusiasm and energy of each member generated exciting discussions about what we should be doing with our technology and how teachers and students would get the support they needed. A plan evolved whereby our new computer purchases would replace the old ones in our grade one classrooms, followed by the twos, and up to the higher grades as we could afford it. We talked about supporting ourselves with professional development and sent eight teachers to a local conference on technology. The group traveled together to the conference and indicated that a highlight was the two hour drive home at the end of the day. The sessions had cultivated new ways of seeing technology for many and the conversations in the van were buzzing with excitement. Shortly afterwards, I watched many covers come off of computers in the corners of classrooms.

An inservice in the spring opened up new conversations as I invited Katy to work with us in our exploration with the Internet. Having worked with her on several other projects, I knew that she would bring another perspective from the University while at the same time understanding the frustrations that we were facing in the classroom. A prerequisite for the workshop was that all staff members were asked to send an e-mail to Katy and we set up written instructions in the corner of our lab so that staff could complete the task according to their schedules. Those who were comfortable helped first-time users and several overcame the hurdle of delving into the Internet through one session with Katy. Now it is not uncommon to find teachers at school late Friday evenings, receiving and sending e-mails to new connections they have made all over the world.

Our Step-Forward committee continues to meet on a regular basis. In making our school plans last spring, and based on the recommendation from the committee, teachers unanimously voted to give up a half hour preparation period each in order to release an additional half-time position for technology support. With creative budgeting and utilization of our old computers, we have two labs and two technology support teachers. Our grades one, two, and three students can now explore computers in our second lab and exciting new conversations are opening up between young children as they help each other log on, find icons, and weave their way through programs. This has also facilitated exciting new team-teaching opportunities with Kathy as our second technology support teacher. Karen and Kathy have set aside Tuesdays (an hour after school) for drop-in professional development activities related to technology and each session is full.

This journey continues to be two steps forward and one back as we live with the elation and frustrations that technology can bring. However, it has also become one for forging new working relationships with each other and professionals outside of our school. In sharing our struggles with each other we are able to find safe, supportive spaces in which to continue the debate about how best to meet our students' needs.

Possibilities

We, as educators, need to continue to feel success in various aspects of our lives. In this way, we are able to experience the success and excitement of learning that we want each of our students to have. Technology in our school is offering educators the chance to experience this excitement. We have a variety of technological encounters available to teachers and, as we have made requirements manageable, teachers need not feel threatened by the enormity of learning to teach with technology. Rather, we all have the opportunity to experience being student and teacher as, together, we work our way along the technological highway.

Two questions arise from our personal/professional journeys with technology: first, is it the nature of technology itself that engages us in dialogue thereby facilitating collaboration? Technology demands dialogue since we are all beginners in many ways. At the same time, there are many threads of continuity, for although it is a new medium, technology does not dismiss the importance of relationships in our work. If anything, it offers new possibilities for broadening collaborative relationships. Second, is our staff already on the road to new ways of being teachers and learners with technology acting as a catalyst? We would suggest that our growth may be based on a combination of the two; our staff has the opportunity and is open to engage in reflective conversations about our practice. Technology offers many new landscapes for this dialogue and collaboration.

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Notebook Computers For All Faculty and Students at VCSU

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In 1990 The North Dakota State Board of Higher Education gave Valley City State University a mission. It was decided that VCSU should be the State University System's leader in the application of instructional technology. In August, 1996 this 1,100-student institution leaped into the 21st century as the first notebook computer university in the state and one of just two universities nationwide that provide notebook computers for all students.

The desire for a technology intensive learning environment surfaced on the VCSU campus a number of years ago. Beginning in 1989 faculty and staff started meeting and discussing the changes needed to prepare the institution for expanded use of technology in an environment of limited resources. The institutional Mission Statement was revised and included the following wording to reflect a new direction for the institution as approved by the North Dakota State Board of Higher Education:

> Faculty and staff are striving to develop a unique culture of innovation and commitment to continuous improvements in teaching and learning. In this spirit of Total Quality, it is assumed that every student is capable of high achievement . . . Pursuit of knowledge at VCSU is a dynamic, never ending process founded on a belief that the rapid emergence of technology as an intellectual, cultural, and economic force requires new types of relationships with other human beings and significant changes in societal institutions.

It soon became apparent that new and more formal planning was needed to insure that the campus obtained and maintained an adequate technology infrastructure to support the learning environment. A formal technology plan was prepared on the VCSU campus in May 1995 that called for implementation of a notebook computer campus by Fall 1996. This decision was not an easy decision for faculty, staff or students. Some faculty said it would not work and many students were opposed to the idea altogether. The administration, student senate, and many of the faculty leaders felt that implementing the technology plan would benefit the institution and its graduates.

Valley City State University's teaching and learning environment has been transformed in a dramatic way. In August 1996, every full time student at VCSU was issued an IBM 701CS computer. The computer features a 486 75MHz microprocessor, 720 MB hard disk drive, 12 MB of RAM, a color monitor, modem and an Ethernet card. This model has a unique expanding keyboard that results in one of the smallest, lightest notebook computers on the market. The computers feature the same software as the faculty computers: Windows 95, Microsoft Office Professional, Novel Groupwise and Netware Client, F-PROT virus protection software and a World Wide Web browser.

Faculty at Valley City State University have been using IBM 365CSD notebook computers since February 1996. Weekly training sessions specific to the software loaded on the computer were provided by our Center for Innovation in Instruction. Our University has also obtained a 1.7 million Title III grant that provided training for 10 faculty and 14 students in the use of multimedia development software that will be used in creating CD-ROM portfolios. The original 10 faculty and 14 students have become mentors for an equivalent number of faculty and students the next semester, until all faculty and students have been trained. The Alumni Association at VCSU also provided funds for faculty development that were used to purchase 46 hours worth of videotape training covering all the Microsoft Software included with the notebooks. The videotapes can be checked out of the library. Faculty were also provided with training sessions two weeks prior to the opening of the school term. Most faculty members attended these sessions that provided direct instruction in the use of the software and network resources. Many faculty are now using the WWW and have developed Homepages for their courses. This level of training will continue as VCSU's Bush grant for faculty development has been renewed for $180,000 over a three year period.

Seventeen classrooms on the VCSU campus have been renovated to "multimedia" classrooms. These classrooms feature student tables with electrical connections and 12 of the classrooms have tables with both electrical and network connections. Most classrooms have 36 inch wide tables where students sit across from each other to facilitate group work. Some of the classrooms have 18 inch wide tables where students all face the front of the room. All of the classrooms feature projection televisions that can display computer and video information.

Technology support personnel were restructured and realigned. Academic and administrative support personnel were combined and all information technology support personnel now report to the Vice President for Academic Affairs.

Nearly one million dollars was devoted to renovating and expanding the LAN (local area network). Conduit was trenched between buildings to house the fiber optic cable for the ATM backbone. All existing servers, routers, and switches were replaced in anticipation of the notebook computers and the daily academic application of network resources.

Faculty have taken advantage of the technology available to them and the majority are integrating it into their classrooms on a daily basis. Faculty and students are using computers to develop multimedia presentations, communicate with each other, prepare reports, and conduct research through the Internet. Students graduating in the next four years will also leave campus with a professional resume/portfolio on a CD-ROM.

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Collaborative Planning for Technology: Breaking Down Barriers within Universities

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Traditionally, there have been boundaries in universities based on content taught, department designations, or other classifications. These separations may have been brought about by a perceived need to protect one's department, college, or own area of expertise from being appropriated by another unit of the university. In many cases, much of this isolation has been sponsored and perpetuated by administrators rather than faculty.

Technology has been a good example of how common sense gets lost in the isolation shuffle. The very use of the word "technology" is confusing as it has become an umbrella term to define not only the hardware and software itself, but also the means to an end.

The old saying that a piano player does not need to know how to build a piano is appropriate for describing the two roads that technology is traveling, for we need to train both technology developers and users. Certain departments, usually computer science and other mathematics-based fields such as engineering, seem to have had a monopoly on technology. Our contention is that while this approach is necessary, in its isolation, it is a small piece of a larger entity. The applications of technology to all content areas is the real validation for technology to exist at all.

Faculty attitudes are yet another problem that needs to be factored into the effective use of technology across collegial/departmental lines. In the short period of the digital revolution, we have found faculty who have adopted the use of technology to expand the knowledge base and the effectiveness of delivery systems in their content areas. We have also found faculty who fight the technology as though it were academic blasphemy. Technology knowledge requires an effort and time commitment which many people refuse to make. This has often left the early users in non-technology departments with little financial or other incentive support. When funds did become sparingly available, the technology was distributed as minimally needed with little, if any, university-wide planning to make the use of technology fit into any coherent model or plan.

But that was in the beginning, a mere five or six years ago. Today, still without a cohesive plan, the use of the computer, and the type of computer found on faculty desks have become a symbol of status. In some cases, advanced users have barely enough technology to accomplish their goals—in others, minimal technology users have the most powerful word processors on the planet. The distribution is based on a mixture of chaos and status rather than need.

Three years ago, a number of professors at Governors State University who were heavy technology users, but tired of fighting for their needs in isolation, got together to see if there was another way to generate both heightened interest into what technology could afford educators and alternative funding for its promotion. This group came into existence as part of a university-wide effort to develop a new mission statement. Thus was born the Center for Technology and Information (CTI), an organization to promote and support the use of technology on all levels. The CTI is a voluntary organization comprised of faculty, administrators, advanced students, and support systems from throughout the university community. The CTI organizational structure is simple - no matter where you are in the hierarchy of the university, in a CTI meeting you are an associate director. To become an associate director, you simply have to attend meetings. The group meets weekly with about 30 people in attendance on a regular basis from a pool of approximately 70 members contributing throughout the year. This has created a positive proactive environment which has eliminated or at least minimized "turf wars." Faculty members from Computer Science, Business, Education, Health Professions, the Sciences, the Fine Arts, and the Humanities all work together.

Funding sources are many. Seed money for projects begins with a modest $25,000 stipend from the university to be used to secure additional resources or to fill in operational gaps. The CTI actively pursues manufacturers and developers, not for gifts, but for partnerships. While most manufacturers have considerable resource and development efforts, the ability to take a new product and place it for application development into the hands of so diversified a group as a university faculty, has led to many new applications of their products. In return, the manufacturers continue to support the efforts with state-of-the-art equipment. The equipment is not turned over to the university, but remains on the manufacturer's inventory and is then removed or exchanged as long as the partnership proves useful to both parties. Project teams are formed from within CTI based on interest - the teams usually coming from a number of different academic disciplines. To this day, funding and projects have never been put to a vote, but have come about as a result of healthy discussion and eventual consensus. While it was never intended to be a policy-making body, the university recognizes the CTI as a think tank and has asked them to establish budgetary protocols, equipment purchasing guidelines, and to establish a short list of supported software and to establish interconnective networks.

The CTI must keep a balance between protecting and promoting the high end users and establishing interest and training for the general faculty. These two purposes stretch the physical abilities of CTI and its members. While its successes have been many, it functions only out of a base of mutual respect and collaborative spirit.

The establishment of CTI has allowed faculty members from all departments to borrow any of the equipment purchased by CTI. This policy has made it possible to efficiently share resources between units. Traditionally, this would have been impossible because of "turf" and ownership issues. Colleges or departments no longer have to duplicate expensive or single-use equipment purchases in order to make them available to faculty. In this era of limited budgets, an organization like CTI can help the university to remain on the cutting edge by sharing hardware and software across units without overspending or duplicating efforts. Based on our success with collaborative planning and technology use, we believe that a similar structure could work within other universities, and even at the high school level.

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The Internet as a Classroom Tool

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Today's schools are charged with the formidable task of educating students to meet the needs of the job market of the 21st century. Our students will be expected to perform jobs in the future that have not been created or even conceived of today. In preparing students to meet this challenge, schools much change from institutions that graduate students with a standard set of skills to ones that produce future citizens who can manage resources and use information for problem solving and decision making. These are the skills that will help our students become lifelong learners who are actively involved in their own educational process.

In order to meet the needs of our students the role of the teacher must change from gatekeeper of knowledge to facilitator and manager of the learning environment. The role of the student must shift from passive learners to self-directed learners who set priorities and achievable goals and assume responsibility for reaching their goals. The Internet is one tool that will enable education to make this shift. It will enable students to engage in self-directed learning experiences and activities that encourage self-expression, cooperative learning and interaction with their immediate environment as well as the outside world.

> The Internet is a timely tool for educators who are reforming education. If we believe information is the bedrock of knowledge, understanding, and power, then universal access to worldwide databases and up-to-the-minute, global information and people-to-people networking is crucial to providing students with educational challenges. (McLain & DiStefano, 1995, p. iii)

While many teachers recognize the value of technology and the use of the Internet, the question remains, "How do I use the Internet in my classroom?" The purpose of this paper is to answer that question.

Incorporating the Internet in your Lesson Plans

Teachers are often most comfortable when they begin using the Internet by incorporating it into existing lesson plans. Since not all lesson plans are easily adaptable for use with the Internet, teachers must consider carefully which plans to use. The following are some guidelines to use when choosing lesson plans to use with the Internet (Source: "Make Your Lesson 'Net' Worthy," 1995, pp. 1-2):

1. Research on a particular topic such as life in space, Gothic literature, or irrigation
2. Comparing and contrasting information
3. Information gathering from human sources such as other students or experts
4. A multicultural or global aspect, such as foreign language
5. Critical thinking and analysis
6. Researching and writing a report
7. Using graphics and art
8. Collecting and analyzing data and building a database
9. Conducting a survey via questionnaire
10. Making a final presentation
11. Working in teams

To ensure that the Internet is an appropriate tool to use with a lesson plan, teachers must do some research to see if information is available on the topic which the students can use to meet the objective of the lesson plan. It is important that teachers have a variety of sites they want the students to explore and that they have thoroughly explored the sites themselves. This way teachers are aware of good, valuable sites that would benefit the students as well as sites that would be dead ends or inappropriate links before sending the class on the online assignment. However, teachers must not limit the scope of student research. Often the best sites for future lessons are those discovered by the student after they have accessed the sites suggested by the teacher.

The Internet is an excellent reference tool, but is only one of many resources available to the student. When incorporating the Internet into lesson plans, teachers can also use printed materials available in the media center. Integrating the new technology of the Internet with print and other resources can create a powerful learning environment for students.

To ensure that the Internet incorporated lesson plan meets the goals of lesson teachers can have a fellow teacher look over the lesson plan. This can be done online. Teachers can post their Internet lessons on newsgroups such as K12.chat.teacher and ask for feedback on the lesson. Once the teacher is comfortable that the lesson plan will meet the goals of the lesson and any problems with logistics have been worked out, it is time to give the lesson plan a classroom trial. Like all lesson plans, the lesson may not work perfectly the first time. Internet lesson plans may need minor adjustments to make it work better next time. However, if the goals of the lesson were met by the lesson plan, it was a success and in learning Internet search skills students have gained a tool they can use for life.

For the teacher who wishes to use the Internet, but is not sure he/she has the skills necessary to integrate this new technology into existing lesson plans, the Internet is a gold mine of hands-on, step-by-step methods for integrating the Internet into the curriculum. Teacher can use the Internet to access sites that list lesson plans in every curriculum area along with research links to complete the lesson. Some such sites include:

1. *The Hub* (http://hub.terc.edu/)
2. *Teacher's Edition Online* (http://www.southwind.net/~lshiney/index.html)
3. *Scholastic* (http://www.scholastic.com)
4. *Web66* (http://www.web66.coled.umn.edu/)
5. *Classroom Connect's Grades Database* http://www.classroom.net/cgi/rofm/eduFind.html).

The Internet for Research and Publishing

The Internet is the ultimate source for research. Using the Internet, we can teach students to search for, retrieve, collect and exchange information. More importantly, they will learn to analyze, write about, and then publish information on any imaginable topic. Using the Internet, the student can stay on top of international news, track and discover developing trends, gather, analyze and synthesize data and information from around the world in real time, parlaying that into career-enhancing knowledge (McLain & DiStefano, 1995, p. viii).

Students can use the Internet to research answers to real-life, problem-solving situations. They can then produce text-based publications, videos, and multimedia presentations that reflect originality and build self-esteem and interpersonal skills. When students are involved in authentic research, learning content becomes a part of the process rather than the end goal; they must master the content in order to solve the problem at hand. Students actually go out into the real world and learn to solve real-world problems.

Completed research projects can then be published to the Internet. The relevance of lessons are seen by students who realize that their work is of value to others in their community and around the world as they get feedback from others reading and observing their work on the Internet. Not only is self-esteem developed in students as they see their work published, but a real life skill is learned — the production of an end product that is used by others.

Another publishing opportunity on the Internet is the creation of school homepages. According to Web66 (host to many school sites) over 2,500 schools from 43 countries registered pages with Web66. Many schools have a school homepage and also provide opportunities for teachers and students to publish individual homepages. "By weaving their own informative, innovative Web pages, students move beyond passive learning and become global publishers." ("Create Your Own Internet Project," 1995-1996).

School and individual homepages offer much to the Internet community including: student poetry, scientific research results, school news, sports and club activities, description of the school's community, introduction of school's faculty, reports on field trips, and links to useful Web sites. The language of the web is HTML, or Hypertext Markup Language. It is simple to learn and can be developed using any word processing program or using specialized HTML editors such as *HotDog Web Editor, WebMaster, WebEdit, and Web Wizard.*

Before teachers allow students to begin publishing to the Internet they must be sure that students know the rules of publishing to the Internet. First, students must respect the copyrights of other Internet publishers. Because the Internet is an open environment and information can be easily copied from it, students may be tempted to simply take the work of another and claim it as their own. Teachers must research what the copyright laws are concerning Internet documents and graphics and ensure that students respect these rules. Student should also be made aware of how to cite electronic media, thus giving credit to the original author.

In the real world, students everywhere learn rules to make life easier and kinder. Because the Internet is relatively blind to the identity of the user and because that blindness makes rudeness very tempting at time, all users of the Internet adhere to a basic set of manners. This set of manners is commonly known as netiquette. Teachers should have a netiquette policy controlling the behavior of students on the Internet. Most policies forbid: putting unlawful materials (such as pirated software) on the system; the use of abusive language or behavior on the Internet; posting racially inappropriate comments; transmitting messages or programs designed to slow down or incapacitate a computer or network; and the use of the Internet for publication or retrieval of pornography. Any student who fails to adhere to the rule of Netiquette can and should lose Internet privileges (Williams, 1995).

Joining an Online Project

Online projects require students to use the Internet's navigation and communication tools to get involved in data exchange, team writing projects, virtual explorations, and even global grocery shopping. These Internet projects generate student excitement and expand learning potential. A large number of projects on the Internet today are teacher-created projects and can be powerful, valuable learning experiences for students. There are five different types of Internet projects students can join:

1. Online correspondence: Involves setting up keypal (e-mail penpal) connections between your students and their "wired" peers and subject matter experts.
2. Information gathering: Requires students to reach goals or solve problems using the Internet as on of their research tools.
3. Competitions: Information-gathering projects through which students must search the Net to answer questions or solve problems.
4. Interactive writing: Includes joint writing activities in which one class starts a short story, passes it along to another class writes another chapter, and so on.
5. Online conferencing: Requires students to use Online chat rooms or audio (NetPhone) or video conferencing (CU-SeeMe) software.

Teachers can access information about projects that their classes can join at the following sites (Source: "Internet Integration 101," 1996, p. 4):

1. Academy One (http://www.nptn.org/cyber.serv/AOneP/academy_one/project.index.html)
2. Global SchoolNet Foundation (http://www.gsn.org)
3. Hilites (http://archieves.gsn.org/hilites/)
4. IECC-Projects (http://www.stolaf.edu/network/iecc/iecc-projects.html).

There are twelve steps for creating a successful Internet Project (Source: Williams, 1995, pg. 226-227):

1. Think about your goals for the lesson. What do you want to accomplish?
2. Consider whether the Internet is the best way to accomplish your goals.
3. Identify and analyze the Internet resources that your students may use. Do they need access to e-mail? FTP? Tools for downloading, unpacking, and decoding files?
4. Check your hardware and software, including your telephone connections, before class begins.
5. List the steps necessary for success. Follow the KISS rule and establish a step-by-step procedure if that's the way your particular group learns best. The Internet is huge. Your students can, and probably will, get lost there more than once.
6. Set parameters for time. You need to consider not only how long completing the project may take, but also how much lead time you need to give your fellow teachers or collaborators on the Net.
7. Build in opportunities for feedback. When are students on target, and when are they just surfing aimlessly around the Net? How do you let them know where they stand?
8. Think about the final product. What should the final report, document, or outcome look like? What constitutes success? How will you grade it: rubrics, an analysis of printed documents, evaluating reflective writing in journals?
9. Identify how and when students should, can, or must use their fellow students, teachers, parents, and so on as resources.
10. Think about your role. How closely do you need to supervise the students? Should you answer questions?
11. Try it yourself. The potential for chaos/disaster/bizarre stuff is high on the Internet. Try the project yourself first.
12. Make time to look back and debrief. You'll find that there's more than one way to accomplish nearly every task in the Internet. Leave it to the students to startle you with new ways to link information and to locate new resources you'd never imagined.

A few of the ways the Internet can be used as a classroom tool were discussed in this paper. However, if a teacher decides to use the Internet he/she must plan carefully for the online experience. While planning an online experience is not dramatically different from planning regular lessons, careful consideration must be given to ensure that the lesson does not end in a technological disaster. Using the Internet can be a successful experience for teachers and students alike, if proper time has been spent on the planning stage.

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TELECOMMUNICATIONS: GRADUATE, INSERVICE, AND FACULTY USE

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Telecommunications in education, a.k.a. distance learning, means many different things to learners and institutions. The common thread is that the learner receives instruction in some way other than face-to-face in a classroom. This section of the Annual is devoted to post-baccalaureate learners: graduate students, teachers, and faculty. Last year, there were nine articles in the section; this year there are twenty-one. There would be more but some of the presenters were unable to meet the publication deadline. Last year, the only contribution beyond the 50 states came from the University of British Columbia (Canada). Within these pages find articles from countries as distant as Italy, New Zealand, and Norway.

Some Recent-Past History

In May 1995, I chaired a conference, Technology Education in the Use of Technology-Based Learning Systems, sponsored by the Society for Applied Learning Technology (SALT) and the American Association of Colleges for Teacher Education (AACTE). Speakers included representatives from the AACTE, the Association of American Colleges and Universities (AACU), the National Association for Equal Opportunity in Higher Education (NAFEO), the Council of Chief State School Officers (CCSSO), the Office of Technology Assessment (OTA), the Office of Science and Technology Policy, and the U.S. Department of Education (DOE). Everyone recognized the pressing need to integrate technology into the learning process, the need for adequate teacher-training and preparation time, and the need to use online technologies to bring the world into the classroom and the classroom into the world. At the same time, everyone agreed that, looking at the broad spectrum of K-12 education in America, very little had been done to date. In addition to the national organizations listed above, speakers included representatives of universities where educational technologies were viable parts of the pre- and inservice learning process and vendors who are working to create materials that compensate for underprepared teachers. The university speakers represented the University of Northern Iowa, Nova Southeastern University (FL), University of South Florida, National-Louis University (IL) and University of Virginia.

State of the Art?

The proposals for inclusion in this section were submitted in October 1996, only seventeen months after the SALT meeting and one year after last year's SITE submission date. Change is occurring at speeds we have never before witnessed. Whether it is the proliferation of the World Wide Web (WWW), with its ability to transmit images as well as text, the growing popularity of web browsers on home computers that is spurring education to follow, or the support of the Clinton administration in bringing telecommunications technologies to the schools, it appears that online communications in adult learning have arrived!

It is our collective job as teacher educators to make the delivery mechanisms effective and efficient tools that improve the teaching and learning processes. The papers in this section bear careful study. Each examines the "elephant" from another perspective; each contributes subject matter for discussion and reflection.

To contradict a point made above, articles are grouped by geographic locations and are referred to in terms of their universities or sponsoring organizations. The authors are listed within the papers. As the host country, we begin with our global guests. Within the United States, there is a single west coast entry, four from the mid-west, five from the central Atlantic states, six from Texas, and two from Florida. Is it premature to celebrate widespread telecommunications adoption in post-baccalaureate education?

Distant Shores. Stord/Haugesund College and Agder College, both in Norway, are developing a paradigm called ODL, Open and Distance Learning, in which the emphasis is on open access of learning material through electronic networks and the collaborative efforts among higher learning institutions. University of Waikato, New Zealand, runs an Internet service for 200 local teachers through its School of Education. The article describes inservice courses, delivered electronically, that focus upon incorporating Internet tools into regular classroom teaching

The Institute for Educational and Training Technologies (Italian National Research Council) reports on a process of moving to online delivery of teacher education and describes a teacher education activity aimed at making teachers aware of the educational potential of the new powerful information and communication technologies.

West Coast. The University of Southern California is the home site of ISLA, Information System for Los Angeles, a digital research archive of local materials in multiple information formats for research, teaching, and public access. ISLA's applications as learning and inservice tools are described.

Mid-West. Iowa State University offers a description of a masters program for high school mathematics teachers delivered over a state-wide, fiber optics network. Indiana University at South Bend uses the Internet, particularly the WWW, primarily as a library resource within undergraduate and graduate education courses.

At Emporia State University (Kansas), a researcher looks at the ways that the Internet is reshaping the teaching and learning process from a variety of perspectives in on-site learning environments. At Illinois State University, a professor examines ways to support constructivist activities through the use of the Internet by pre- and inservice teachers in K-12 classrooms. Examples of modeling constructivist approaches in teacher education are presented.

Central Atlantic. University of North Carolina at Wilmington is experimenting with a WWW "remote classroom" for state-mandated inservice professional development. Bloomsburg University (Pennsylvania) reports on the initial use of the Internet in the classroom by elementary and secondary public school teachers. These teachers had all taken an intensive Internet course at the University prior to adoption of the technology in their classrooms.

From South Carolina, collaboration between the Citadel and Low Country Children's Center, has resulted in online resources to help teachers identify and report child abuse and neglect. Several websites are listed and discussed. School-University collaboration exists between the University of North Carolina at Wilmington, New Hanover High School (NC), North Dakota State University, and the Center for Innovation in Instruction (ND). This work addresses opportunities and issues related to the use of the Internet and WWW as an emerging channel for the delivery of pre- and inservice teacher professional development.

The University of Delaware and the University of Agriculture in Nitra, Slovakia, embarked upon a cooperative, distance education experiment. The web was used to deliver course materials and to collect student assignments.

Texas. From Southwest Texas State University comes a description of a cooperative approach used in the development of a WWW group project. The project was a required assignment in a course in Advanced Instructional Technology, in a graduate program in Curriculum and Instruction. Our Lady of the Lake University has a new program that prepares classroom teachers to teach information processing in K-12 settings. Completion of the program meets the eligibility requirements for a state technology endorsement.

Texas A&M University at Commerce has identified some issues involved in preparing teachers to utilize Internet resources. This paper addresses the issues and describes ways in which education faculty can collaborate with discipline faculty to provide role models for their students. Midwestern State University views the Internet as a global classroom and learning center and presents an approach to induce teachers to pursue the Internet as a source of instructional resources.

Texas A&M University at Commerce discusses the evolution of an online graduate course for teachers. The rapid evolution of technology is paired with the sculpting of the course based upon reflection and student feedback. Rice University has two and four week intensive summer training models that empower teachers to take advantage of information technologies. Two projects and lessons learned from development are presented.

Florida. Nova Southeastern University presents impressions and recommendations of professors and doctoral students with online classroom experiences. From the University of South Florida come samples of web-based instructional materials for higher education. The applications described are a teacher's guide to the Holocaust and a teacher's guide to school networks.

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Inservice Training Through the Internet - Telecom and Open Learning as a Challenge to Institutional Cooperation

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In 1996, it was declared the *European year for life long learning*, stating the fact that there is an increasing demand in all walks of life for updating and refreshing existing knowledge and skills in order to keep abreast with professional and social requirements. With significant revisions of methods as well as content of professions, with tight working schedules and continuous challenges posed by new tasks and requirements, most professionals tend to postpone the extra effort required to embark on traditional continued education or inservice training programmes.

New information and communication technology (ICT) has for a couple of decades posed increasing challenges to the working force. A few adventurers and enthusiasts, on their own or by initiative from their employers, threw themselves into the technical whirlpool in the early 80s. Gradually they were mastering different operating systems, obscure user interfaces and arbitrary pieces of software available for their purposes. Improved user friendliness as well as escalating capacity/price ratio and popularisation of the technology have all contributed to an increasing application of ICT at all levels.

The combination of life long learning and ICT naturally leads to programmes for provision of inservice training through the use of computers and electronic networks. Both trans-European and different national initiatives have been launched in order to exploit the possibilities incorporated in the new technology. Several projects are in progress, gathering experience and developing new methodologies to suit both course providers and learners. The electronic learning environment may be a challenge to the traditional auditorium, classroom and hotel based seminars.

Cooperation between course providing institutions seems to be a fruitful track for saving efforts and resources. Through different projects in the field of ICT-based Open and Distance Learning (ODL), one has found that partners in production of learning material benefit a lot from exchange of electronic lessons, examples, programmes, etc. They tend to save on development costs, administrative systems and infrastructure, and at the same time increase the quality of final products and offers to target groups.

Future Role of Professionals

Life in the information and knowledge society puts new demands on professional roles and performances. Not only does the technology itself change the characteristics of traditional work, it also shifts the required skills for certain operations into completely different levels of understanding or detailed knowledge. In one direction, the visible results of efficient working in a store is changed from that of manually noting and adding numbers to that of pressing the correct buttons on a calculator or cash register - or moving the bar codes past a photo cell or similar device. On the other hand, the engineer does not need the same drawing skills as before when constructing a house or a ship, but must control the drawing facilities of a computer, requiring a higher level of understanding and insight into practical consequences of certain decisions.

In teaching, as well as in company training programmes, the role of the presenter or trainer is gradually changing from that of being a knowledge provider and a source of solutions to all problems, into being a guide or adviser for learners to find and choose from the information and instructional material available. In a society where information, and our access to it, is growing exponentially, it is becoming increasingly important to assist learners in acquiring skills to handle information. An important part of this is to develop a critical and reflective way of sorting, discriminating and interpreting the information provided. They must also be able to turn the acquired information into knowledge and understanding of their immediate surroundings and the challenges facing them.

IT and Telecommunication

Particular requirements are related to new technology as part of new professional roles. ICT is not only used as a tool and a source of information, it is also in its own right an important part of workmanship and required skills of future citizens. It is well accepted that a clerk expecting to work in the future must know how to apply word processing, and that an accountant will be obsolete if he does not know computer based accounting systems. Maybe it will also be expected that a journalist or a history teacher must know how to search in databases for interesting extensions to his lessons, eg., the present situation in the Middle East. But do we realise that it is equally important for a social science/biology teacher or an environmental adviser to manage system dynamics and simulation models in order to understand or communicate the challenges of local or global pollution?

Telecommunication seems to play an increasingly important role in future society. Capacity, bandwidth and speed of transfer of large amounts of digitised data, including sound and graphics, is covering greater parts of the world every month. From being a separate technology, it is now accelerating its integration into the computer and other information technologies, changing the PC from a stand-alone device into a small node in a world wide network of information. Large databases are included in the same network and professionals of all kinds are meeting in the virtual space to discuss their problems and points of interest.

Open and Distance Learning (ODL) as a Tool to Cope with New Demands

The ever increasing demand for updated skills and knowledge in different fields makes it impossible to cover it all through traditional education or training systems. Companies and public institutions have long traditions in arranging courses in-house or at hotels, etc. when new skills or principles are to be introduced into their activities. No credits or formal qualifications were attached to most of these courses. It was part of the inservice training offered by the employer and a requirement to be updated on the task to be performed.

An alternative for raising the qualifications of the staff was to let a selected few attend formal education programmes, acquiring new degrees or diplomas. Expenses related to such programmes could be born by the employer, by the professional her/himself or as a joint agreement between the two parties. Costs could be considerable for study programmes running over several years in order to obtain a degree, even in cases where the education or training was provided outside regular working hours.

Distance education has long been a practical way of taking courses and obtaining qualifications. Specialised institutions like correspondence schools and open universities have provided thousands and millions of citizens with interesting offers of initial and further education. In the age of new ICT it is natural to apply the technology for distribution of learning material. As a consequence of this, the importance of distance in the learning process is changing. It is now becoming more essential to talk about *open* learning, possibly combined with learning at a distance into *open and distance learning*, ODL.

The definition of ODL varies according to organisation, structure and possibilities. In this paper we will limit ourselves to the interpretation, where the *openness* is particularly directed to the *open access* of learning material through electronic networks. The *distance* of the students is not of the same importance to us; they may well be regular students inside the institution, staff members or individuals in another part of Europe. The important principle is that university courses, learning material as well as exercises and examinations, are available to the learners in their part of the world. With certain restrictions the services should also be available to them when it is required, i.e. asynchronous distribution and availability is the general rule.

Further and in-career training through ODL therefore makes it more easily available, costs and regulated working hours can be saved and the traditional universities and colleges may be opened to the public for life long learning programmes. The effort for traditional universities to change some of their traditional mass lectures and demonstrations into transferable, ICT-based learning material, is quite a scary exercise. It may not even be possible or desirable in many cases, in particular subjects or topics. The latter is certainly the case for some of the special aspects, e.g., in training of nurses or in teacher education, where important values can hardly be detached from the human touch. There are, however, lots of topics and courses related to teacher and nurses training that may successfully be offered through ICT based ODL, where positive results have already been observed.

Challenges to Institutions

The enormous efforts and resources needed for providing ODL material to new target groups of learners simply requires that parallel work and development of products should be avoided. All partners will benefit from cooperation instead of competition, exchange of material instead of protection, specialisation of competence instead of covering all fields at every institution, sharing of duties instead of providing double work. In particular the learners will benefit from the products and facilities resulting from such cooperation.

There must be regulations and rules to play by, however. Models for cooperation between academic institutions for the purpose of ODL have been tried out in several European projects, providing valuable experience that serve as a basis for revision of models and development of new ways for providing ODL to the optimal benefit of both students, staff and the institutions. Most valuable results and experiences have been acquired when both academic institutions and receiving organisations have been working together in the planning and development of ODL courses and material. Examples of such activities will be provided in the following sections.

Institutional Cooperation

Cooperation between academic institutions seems to be an educational policy, nationally as well as internationally, including the establishment of a educational cooperative network between centres of higher education and research. Several countries throughout Europe state in their White papers or other political documents principles and guidelines for cooperation and sharing of expertise between educational institutions. As an example of how cooperation between institutions and exchange of experience are stressed, the European Commission's Socrates programme has *partnership between educational institutions* as one of their criteria to allocate funding to projects.

Enterprises throughout the world claim that there is a huge need for updating of personnel skills. To meet this need we already see a growing tendency of real cooperation between enterprises and the formal educational system in order to update their employees. Normally the employer has the responsibility for updating their staff, but by now we more often see a combination of updating the staff by offering them formal qualifications. Development of necessary curriculum to obtain formal qualification is based on cooperation or enterprises between the companies and the formal educational system, where the companies play a central role in describing the needs and also are the ones to find or provide the know how.

Introduction of electronic networks, e.g. Internet, increases the functionality and facilitates practical activities among cooperating institutions. Both academic staff, learners and the outside learning society are supposed to benefit from diverse specialisation and expertise, sharing of duties between institutions.

Together, the collaborating institutions may be able to provide a greater variety of studies to their learners than any one of the institutions can manage on its own. Collaboration should emphasise the importance of being able to utilise the various profiles, specialities and professional expertise of the different institutions and enterprises. This should increase both the width and depth of the learning environment.

One example of how institutional cooperation has been practiced is the way the Norway-net with IT for Open Learning (NITOL) project has organised their work.. Four academic institutions in Norway have successfully practised their own model of cooperation since 1994.

Much of the success in this pilot project is probably based on longstanding relations and trust between the key personnel involved. The major goals of the project were to:

- gain experience and develop methods for ICT based, open, flexible and distance learning at university level;
- facilitate cooperative research and development between geographically separated academic units and personnel.

In order to approach these goals, partners had to:

- establish an open network making education within Norway-net available to students and other groups and individual participants from business, schools, administration, etc.;
- gain experience on distribution of educational materials through electronic networks;
- test the use of electronic conferences and mail systems as the basis for group work and cooperative learning;
- develop an extensive, dynamic and creative electronic learning environment based on local and wide area electronic networks.

Organising NITOL

Despite the close relations and friendship between the active partner representatives in the project, a formal organisation had to be established in order to be prepared for disagreements or conflicts that might arise over economy, responsibility for students, networks, software, academic property, etc. To meet this requirement two formal contracts were established, one general agreement of cooperation between the four institutions, signed by the heads, and one particular NITOL contract signed by the project representatives from each institution.

The signed contracts are mostly dormant. In a few cases they have turned out to be very useful as reference and guidelines for disputes that arose. The project agreement is mainly in line with the project groups' feeling of common sense, while the institutional contract is an important document especially when institutional authorities forget their commitments to NITOL.

Technical support and standards have proved to be important issues for an ODL project based on ICT. This always turns out to be a touchy issue between experts. Among the "experts" in such a project are tens of teachers and hundreds of students - who all have their own, well founded preferences for software and communication systems. On the other hand, there are also hundreds of "non-experts" or novices who need to be given simple solutions that fill their present needs. Among the latter group are also some of the course providers. It is therefore of utmost importance that the project group is able to make firm decisions, stick to the solutions given, and that there are able and committed people to support the technical system decided upon. As new technology develops and becomes available - outside the project - a careful balance must be found between existing, stable solutions and introduction of new, improved facilities for the project services. Responsibility for these technical decisions lies with the project group, while implementation and support is placed with one of the partners.

Objects of Collaborative Activities

Course Material

Together, the collaborating institutions are able to provide a greater variety of studies to their students than any one of the institutions can provide on its own. The collaboration emphasises the importance of being able to utilise the various academic profiles, specialities and professional expertise the different institutions stand for. The colleges are able to enhance their curricula at both undergraduate and graduate levels, thus providing their students with a greater variety of subjects than can be offered at any one institution alone. In addition, quite a few students want a more flexible programme that allows them to study at the time and pace of their own choice, with fewer restrictions on attendance and place of study. Collaboration around flexible and open learning makes this possible.

Because of the variety of professional profiles at the cooperating institutions, close collaboration strengthens the whole teaching and research environment at each institution. Experience shows that through electronic communication it is possible to work together in a close and efficient manner in a "virtual" environment of cooperation. This has already been established between the NITOL institutions, and is spreading throughout the rest of the IT environment. This is a system that effectively establishes and utilises contacts across the boundaries of institutions, regions and countries. Course material is developed along three different paths or models for institutional cooperation:

The Open Access Model. This is one of several models within the NITOL. This was the first one tested, where each institution offered some of their traditional courses, revised or redeveloped for electronic transmission to their own students as well as to outsiders.

The beneficiaries of this model were mainly the students, having easier access and more courses to choose between. The institutions and the professors gained experience in dealing with distant students and the colleagues' ways of presenting learning material. This golden opportunity, to look at how colleagues presented and designed their teaching material, was a fringe benefit.

The Composite Model. This model is applied when the institutions compose larger courses by joining two or more smaller modules developed at different institutions. The result could be a tailored study for special purposes or just an extension of a small course, which a single institution is not able to develop alone, due to restrictions on time, staff, expertise, etc. This model seems to have its strength especially when colleges/institutions are small or medium sized, where resources and the variety of the staffs' expertise is limited.

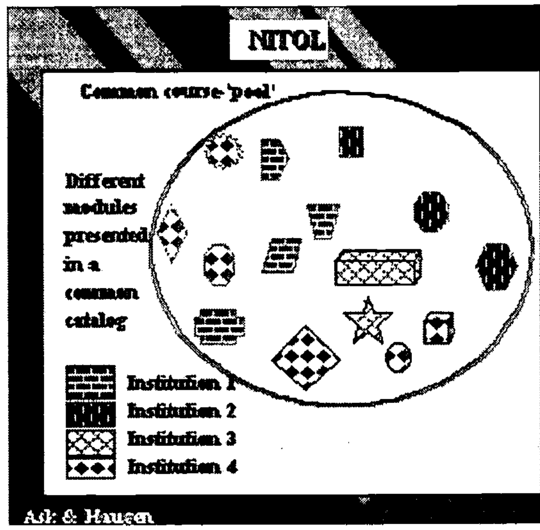

Figure 1. The Open Access Model.

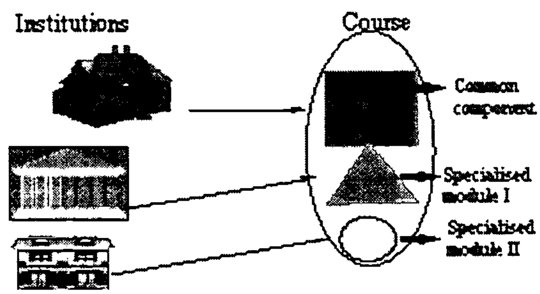

Figure 2. The Composite Model.

In the composite model, the institution responsible for the specific module also takes responsibility for the students' exercises within the actual module. Elaboration and marking of exercises are also tried out as a collaborative, composite work, while assessment normally has been dedicated to one institution.

Joint Venture Model. This is a model where the main idea is continuous, real collaboration between professional groups to develop course work (See Figure 3). This means that two or more institutions within the network join forces in developing open, flexible learning materials in the form of lessons. One or more lessons forms a module, and the final course consists of several modules. Mature students and professionals jointly contribute to the understanding and learning of a topic or subject. This is not utopia we are suggesting here, it is already a reality in the joint venture model. As an extension of the model, a virtual, joint venture learning society on the network does not seem far away.

A first evaluation of collaboration, assessing the intentions and the models described, identifies characteristics like *inspiration* both to students and professors, *improvement* in the quality as well as an *increase* in quantity of the courses offered. All parties involved seem to be satisfied and inspired to further efforts for open and flexible learning.

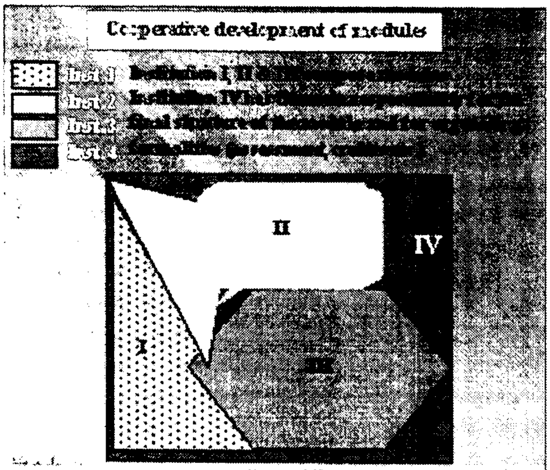

Figure 3. The Joint Venture Model.

Mutual Services. An important issue in the partnership agreement is the mutual recognition of credits, courses and modules between the partners involved. Students may thus choose modules and courses from a larger menu, combining it into more varied and specially tailored lines of study. It is, however, still up to the institution that issues the certificate to recognise the final combination of subjects and courses.

External funding has played a central role in the early stages of NITOL. Applications and proposals for funding have turned out to be more positively viewed in cases where a collaborative organisation has already been established. The NITOL partners have therefore in several cases joined forces in the process of application, and afterwards shared the benefits obtained through decisions by the project group. The basic principle is sharing of funds acquired in equal parts. Often the group agrees to reserve particular sums for special services, e.g., technical support, printing of catalogues, administration, etc., and then shares the remaining sum equally.

Marketing. Instead of competing over the same target groups with parallel courses in related fields, the NITOL group has consequently, from the start, issued a common course catalogue for all the courses provided by the group. Even though the courses are provided by individual staff members at separate institutions, and marked this way in the catalogue, there are great advantages in joint marketing. Distribution of information becomes easier, potential students get a better overview, and large scale customers, like the Navy, can find a more varied offering for their members.

After only two years, the NITOL concept already has more meaning to a lot of people interested in ODL than the name of each of the partner institutions. At the same time, each institution benefits from belonging to this group.

Visions

The models for ODL through telecommunication, taking advantage of the institutional cooperation described above, may open up for simpler access and higher flexibility for all kinds of professionals to obtain inservice and further education, as well as taking new formal degrees, without leaving their regular work/duties or their families. With the growing familiarity of Internet, telecommunication and similar facilities in homes and work places, the time may soon be ripe for higher education modules to be available *when* and *where* the learner finds need or desire for it. This will compose an important aspect in the policy and possible success of *lifelong learning*.

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Constructing an Interactive, Online, Social Studies Tutorial on Internet Use

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Since 1994, the School of Education at the University of Waikato in Hamilton, New Zealand, has been running an Internet Service for 200 local teachers. The service is called WeNet - Waikato Education Network (URL: http://www2.waikato.ac.nz:81/education/WeNET/WeNEThome/). WeNet provides SLIP access for a range of primary and secondary school teachers, and, as part of the service, undertakes research projects in Internet use and provides workshops and services based on the outcomes of that research.

Past projects have included The International Water Project in 1992 (Campbell, Christensen, Clayton & Knezek, 1993) and The Air Project in 1993 (Campbell, et al, 1994). These projects explored ways in which e-mail contacts between teachers and students might enhance classroom programmes. WeNet grew from the success of these projects, and the desire to move beyond e-mail and incorporate the results of the research into a complete range of curriculum teaching.

The Project

In 1996, funding was obtained for developing a resource to help teachers incorporate Internet tools into their regular curricular programmes. The aim was to establish programmes which saw Internet tools as more than topics of study. The proposal was that an inservice course be developed which drew on previous projects to help teachers incorporate Internet tools, not only into their daily classroom programme, but actually into the whole range of curriculum subjects.

Design

In choosing the topic and the design for the inservice course, it was decided to canvas WeNet teachers. The 200 WeNet teachers constitute a group that now has at least two years experience in SLIP access to a range of Internet tools. Regular workshops are held on using the tools (Making the Most of Eudora, Netscape, Search Engines, etc.) as well as workshops on a range of issues (Acceptable Use Policies, Classroom Organisation for Single-Computer Use, etc.). The Helpdesk facility works with WeNet teachers on a regular basis. Regular bulletins and news issues are provided. Based on this exposure and support, it was reasoned that WeNet teachers would be a good source of guidance for designing the inservice course. A sample of 30 teachers was contacted in a telephone survey and seven additional teachers were interviewed in-person. These seven were teachers who had come to the attention of WeNet staff as being particularly interested in the service and as demonstrating a high level of usage.

The results of these surveys altered the preconceived plan, which had been to produce a workshop on accessing the Internet and learning to use the basic e-mail and browser tools. Teachers reported that they were able to manage these tasks with the help that ISP's provide, with assistance from colleagues and technical support at the school. The assistance that was most often requested was help in incorporating Internet tools into regular curriculum teaching.

It was decided to mount a series of workshops on WeNet as web-based courses. Each course would demonstrate an individual curriculum area and would guide teachers through issues and procedures that would help them incorporate Internet resources into their teaching in an efficient and effective way. It was decided to start with a course on social studies teaching because previous research had provided most experience of Internet use in that curriculum area (Barr, 1994).

Issues

In designing the course, specific teaching objectives were established as well as some criteria for outcomes that would not be sought. For example, it was reasoned that the inservice clientele for the course would not require guidance in teaching or in delivering the social studies curriculum; it was decided that the course would cater to New Zealand teachers, and not provide pathways for teachers who might access the web pages from abroad in order to utilise the course in their own national curriculum.

After taking this course, teachers will:

- have interacted with course material to develop their own cognitive model of the principles and practice for utilising Information Technology (IT) tools in Social Studies curriculum teaching;
- have satisfied their curiosity about structural mechanisms and procedures for utilising IT tools in social studies curriculum teaching;
- have had the opportunity to discuss developing ideas with course tutors and with course members;
- have planned and developed a successful social studies unit which utilises IT tools;
- have reflected on, analysed and restated in a cogent form, their ideas, understandings and experiences in utilising IT tools within social studies curriculum teaching;
- feel empowered to adopt a mentor or tutor's role for future courses.

It was considered important that the course attempt to be interactive. The reasoning was that "Active Learning" should be a good goal and that "Net Surfing" could sometimes be seen as an exercise in flitting among quantities of "Good Stuff" without commitment. (In New Zealand a popular retort to salespersons in retail stores who approach shoppers with the intent of persuading them to buy, is "Just browsing, thanks.") To this end it was decided to require enrollment and to require active responses from course members.

Social contact between course members was deemed important. Staff at the School of Education frequently comment on a preference for face-to-face teaching rather than teaching by distance modes because of their perception of the importance of social interaction among the group of learners. The metaphor for the interface design was specifically chosen to suggest a familiarity with face-to-face courses and in-person site visits. A chat section as well as e-mail contact was devised, and a procedure implemented which enrolled course participants into groups that were identified to members, so that they could share their experiences with the course with each other another.

Course credit was considered. While designing the course materials and resources so that teachers are free to explore those features which they feel are important, it was recognised that it might be reasonable to formally recognise the achievements of participants who succeed in developing their knowledge, understanding and practice to a certain extent. A course that is designed to require the participant to identify and be responsible for accessing the information that is of greatest benefit to that individual is potentially a very valuable experience for that individual. Such a course is also open to very cursory participation. Assessment and accreditation are issues that required some careful thought. A two-tiered approach is currently being investigated. It is possible to pass through the sections of the course without asking for credit, in which case no attempt is made to evaluate the work of the course member. Teachers who do request credit are asked to provide a document outlining the results of their reflections and to provide a theoretical position to support these. The record of their participation is then passed to a course mentor, together with their document, and is assessed. Feedback is given and successful candidates are offered a position as mentor or course tutor for future groups.

The development and extension of the course was considered. An obvious factor relating to the initial course is that it depicts one class taking one topic. Accepting the aim of providing course participants with the vicarious experience of participating in a class, it would obviously be of benefit to provide a range of classes and topics so that participants can choose ones that are of personal interest. Using an approach similar to Group Hypermedia, described, for example, by Acker (1990) in which users collaborate in a common workspace and build information structures through co-use (Stevens, 1989; Akscyn, McCracken, & Yoder, 1988), it was proposed that new tutors and mentors might bring with them resources from their own experience with the course and add them to the resources originally provided.

Production

The production process proceeded in a number of trial-and-revision stages. In order to provide the vicarious experience of "sitting in" with a class undertaking a unit, it was necessary to arrange for a class and teacher to allow the recording of a social studies unit. Having achieved this, it was important to record, in as much detail as possible, the events of the unit's planning, preparation and implementation. Audio and video recordings were made, photographs taken, participant observer's notes were recorded and samples of the children's work were collected for scanning and photographing. The unit was taught during two weeks; prior planning, subsequent reporting and feedback added a further three weeks.

In reconstructing the unit for the course, original recordings were repeated in many cases in order to obtain clear audio and photographic records. Using the original recordings as guides, reminding the children of the events they had previously experienced and explaining the need to repeat those events, it was possible to record remarkably close approximations of the original reality in ways that produced informative pictures and sounds. At this stage it was also possible to make recordings for parts of the course that had not been foreseen, such as an audio description of the class by the teacher (when a visitor enters a teacher's class to observe their programme, the teacher will usually describe the class to the visitor) and an audio discussion of her objectives (a written record had been collected, but a less formal, conversational explanation was deemed to be also in keeping with the metaphor being used.)

Piloting

Piloting began during the design phase. During the early part of the production phase, an approach was used that involved laying out the structure of the course in diagrammatic form, in relation to the structure of the unit planning and lesson implementation of the class being recorded. During the whole production stage, the model (first its design and structure; later the design together with examples of the resources) was demonstrated for feedback. The audience included staff teaching pre- and inservice courses in curriculum social studies, preservice students, and academic staff, students and researchers involved in educational technology and web-based course design. Suggestions and comments were acted on throughout the production phase. Once a pilot version of the course was completed, it was provided in an off-line form to four teachers identified as being experienced in utilising IT tools in social studies teaching. These teachers were asked to work through the course as a group, accessing the course material from files on their personal computers but communicating with each other and with the project organiser by e-mail. They were asked to record full comments on any issues they felt needed addressing.

Future Development

The course is currently available through the WeNet Teachers Page (http://www2.waikato.ac.nz:81/education/WeNET/teachers/teachers.html). It is proposed to monitor its use and to canvas feedback to allow for its development. It is proposed to produce courses in other curriculum areas and utilising classes in a range of age groups. It is planned to monitor course participants with a view to clarifying, and hopefully resolving, the issues outlined above.

Conclusion

Social Studies On The Web has generated a large amount of interest for the people involved in its production and trial. It has raised issues worthy of further investigation and has provided impetus for careful thought and exploration of those issues. It was not spurred by an interest in utilising new technological tools, but has utilised leading edge technologies for their intrinsic value to the project.

Early responses indicate that there might be considerable interest in the production of future courses in a similar mould. Valuable outcomes can be seen for social studies teaching; for teaching in all other curriculum areas; for the educational use of Information Technologies and for the purposeful use of educational technologies in producing useful, teacher-centred courses in classroom applications of theoretical positions.

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Teacher Education To Design Online Cooperative Learning Environments

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At the Italian National Research Council - Institute for Educational and Training Technologies - we have designed a Virtual Class that implements an online cooperative learning environment. In the context of this project, we have carried out a teacher education course aimed at making teachers aware of the educational potential of the Information and Communication technologies.

After a brief overview of the project, we describe the course and highlight modalities, difficulties and results of the experience. Specifically, we focus on the advantages of an online phase of the training activity, during which teachers have planned the Virtual Class activities; this phase has proved extremely useful to allow teachers to fully appreciate and understand potentialities and functions of the telematic tools.

We have adopted the Bulletin Board System (BBS) technology to develop both the online learning environment and the online teachers' training phase; BBS's with graphic interface have proved efficient in fulfilling the communication needs of the learning/teaching process. Rapid developments in interactive communication technologies are quickly leading towards a new model for our society - at least in the developed regions of the world - which will be based on the Information Society principles.

Since it is a very deep social transformation, the educational system must play an essential role in developing this modification process: only schools can effectively lead - through specific curricula and by adopting technology for teaching/learning processes - to a full transition to the Information Society. The educational system must promote and sustain the innovative vision of the Information Society, by introducing - as early as possible in the child's scholastic life - pedagogical activities based on the new interactive electronic communications.

Furthermore, the Information Society is based on the same communication technologies which represent huge potential for education. As a consequence, during the past few years, it has been easy to imagine an educational system that - by adopting these technologies and suiting them to its own educational needs - would be able to play the educator role for the incoming Information Society.

However, this process might be delayed because of a teacher's incorrect approach to the new technologies. Actually, underlying the idea of a school as a promoter of the Information Society is the teacher's awareness that computers are learning tools and not merely objects to be studied. It is not easy to get teachers to develop this awareness, mainly because of the way computer science has been historically introduced in the educational system.

That was the time when the concepts which are basic to a view of the computer as a real and effective didactic resource - Multimedia, Hypermedia, Telematics, and so on - were not yet mature, both from a hardware and from a software point of view. Therefore, the computer was regarded as a technical (but not didactic) laboratory tool, and it was introduced as a subject of class curricula: the purpose of its introduction was to teach students how to use it, rather than to exploit the computer as a real learning tool.

Because of this view of the computer, only those teachers who were interested in the technical and programming aspects of computers (generally speaking, teachers of technical disciplines) became familiar with computers. Most of the other teachers were not really interested in the computer, since it could not be used as a tool to support their activities. To make things worse, the non-graphic interface of the first computers, and an initial skepticism towards the new devices, discouraged the adoption to computers.

During the following years, since the applications aimed at developing cognitive and meta-cognitive abilities (such as self-learning systems based on the hypertext paradigm, or telematic applications for cooperative learning) started being introduced into the learning process, most of the teachers have been still feeling the initial view of computers; consequently, it is extremely important make teachers aware of the new role of computers as didactic support resources.

In our Institute, we have designed and carried out, as tutors, a teacher education activity, aimed at making teachers aware of the educational potential of the new powerful information and communication technologies. In particular, this is to help them use the new technologies in the context of a Virtual Class designed to implement an online cooperative learning environment.

This paper aims to point out the difficulties encountered in training teachers who are often tied to traditional teaching methods and work in logistically unfavourable situations, and to point out the key elements in the training process, which have produced satisfactory results. Finally, it should be noted that we report on an Italian experience in a socioeconomic context which is very similar to many developed countries that are going to develop an educational system projected into the Information Society.

The Online Cooperative Learning Environment

The online cooperative learning environment we have designed is aimed at analysing the advantages and problems related to the use of telematic tools at school and how Telematics modifies teaching/learning processes.

The learning environment, which in the first year involves four classes (20 students each, aged between 12-13) belonging to two secondary schools in Palermo, is based on Bulletin Board System (BBS) technology with graphic interface. BBS allows users to communicate through several easy-to-use tools (E-mail, chatting, by exchanging messages through conference areas and files through shared areas, and so forth) and modes (synchronous vs. asynchronous), thus enabling different communication styles and strategies, according to the needs of the different educational moments.

The activities inside the developed learning environment have been subdivided into a preliminary stage and three subsequent stages. Through the different moments, the students (grouped according to sociometric criteria) and their teachers have been gradually encouraged to experiment with the telematic communication tools and with different communication paradigms, thus creating a concrete experience of Virtual Class. During the online activities, the groups exchanged ideas on various themes of special sociocultural interest, concerning the different geographical areas they come from, and concentrated on the study of a monument.

As indicated before, the different stages are characterised by different communication models, which have been designed to develop innovative and creative interaction strategies, and to increase the incentive and motivation to learn.

The model of the preliminary stage regards the presentation of students, by a telematic identity card or *home page*, created according to their fantasy. The aim of this first phase is to allow each student to meet fellows online and to familiarise students with the telematic tools. The second and third stages of the experimentation form the main part of project. Their aim is to lead the groups to learn and to cooperate by using the telematic resources.

In the second stage, remote groups are coupled so that two corresponding groups gather information about the same subject; the first group deals with the general aspects of the subject, while the corresponding remote group analyses a specific case regarding the subject. At the same time, a bi-directional communication flow between couples of corresponding groups takes place on a common argument in a horizontal way, from general aspects to particular ones and vice versa.

The third stage implies a transversal interaction model so that the groups which have studied general aspects cooperate and, in the same way, the groups which have studied particular aspects cooperate between teams. The aim of this stage is to guide students to analyse analogies and differences and to reciprocally integrate all the pieces of information.

During the second and third stages, teachers and tutors assess the participation of each group (and of each member within the group) to the study activities, by evaluating both the production of materials and the amount of interaction with the other groups. According to the results of their observations, teachers and tutors can suitably modify the role of each member within a group and the task distribution among the groups; similarly, they can vary the communication flows, e.g. by proposing new discussion topics, or stimulating the interests of the students into the material produced by groups less active in the online communication.

Finally, the fourth stage implies is a *free discussion* model: all the students are invited to discuss topics, which have been deepened during previous stages by each single group. During this phase, each student can cooperate *with and between* groups, because all of them can study the results of the research activities of other groups and ask some questions, making their curiosities about specific topics clear and suggesting new reflections. The aim of this stage is to allow the groups to learn the materials produced by the remainder of the students, thus giving everyone a complete view of the research work.

The Teacher Training Course: From Face-to-face to Online Meetings

The training course described in this paper has fallen within the context of a school lacking in information and communication technologies, and where technology, until the beginning of our experience, had been left out of educational activities. Both the schools involved in the experience had only a few computers, essentially used to familiarise students with the basic elements of a computer.

Results of questionnaires handed out to the teachers before the training course started indicate that, among the teachers attending the course, computer science expertise was very poor and this reflects the general situation in these schools. As a matter of fact, two thirds of the teachers had never used a computer before. This situation caused practical difficulties on the top of the purely methodological problems.

The teacher training has focused on the basic aspects of educational multimedia and telematic technologies, in order to familiarise teachers with the instruments for the definition and the management of online cooperative environments. The course consisted of three phases: in the first and second phases, we have proceeded according to traditional methodologies, with teachers and their trainers meeting in the classroom. The last phase has been aimed at the online planning of the didactic process.

The aim of the first two phases of the course has been principally to provide a general view of the multimedia and telematics concepts by stressing their role as useful technologies within the teaching/learning processes. To be more precise, the first phase has focused on the theoretical aspects of the two concepts; the second one has been based on practices on the use of the computer and, more specifically, of the *FirstClass* communication software.

As far as the theoretical aspects are concerned, after the definition of the terms Multimedia and Telematics, we have moved on describing their basic features. Then, we have illustrated the major application fields of Multimedia by highlighting the potentialities of multimedia communication for education and by proposing concrete examples of didactic, self-evaluation and self-learning hypermedia and hypertext systems.

As regards Telematics, firstly we have pointed out the key-role of telematic networks in educational contexts; particularly, we have argued how, by means of suitable communication models, telematic networks are able to enhance the extremely important socio-relational component of a learning process. Secondly, we have highlighted the advantages and problems of the two basic network uses (accessing remote resources and synchronous/asynchronous communication), both for teachers and students.

Furthermore, we have dwelled upon the added value of the telematics in different moments of the didactic process (planning, management and teaching/learning activity). Finally, we have stressed the opportunity to use telematics to implement new teaching/learning methodologies, useful to introduce meaningful changes in the way of teaching.

The need to provide teachers with a concrete example of innovative didactic methodology, such as the Virtual Class, has made it possible to clarify the theoretical concepts and describe in detail the different stages and communication models of the designed online learning environment.

The aim of the second phase has been to really guide teachers towards the basic elements of computer, by means of practices, in order to enable them to fully understand and appreciate the several potentialities offered by the FirstClass BBS software.

During the second phase we have guided teachers (organised in small groups) to practice with the different basic functionalities of the telematic tools (which had been previously learned at a theoretical level during the first phase). In order to make teachers really appreciate the features and functionalities of the communication tools, we have simulated interpersonal communication sessions, both in synchronous mode (chatting sessions) and in asynchronous mode (e-mail). In addition, teachers have experienced the enormous potentialities offered by graphic user interfaces.

At the end of these practical activities, the teachers had understood the differences between the functionalities of E-mail, chatting, file exchange mechanism, and so on; however, they had not yet really focused on the different contexts of use of each tool. This result would be reached at the end of the next phase, as reported below.

During the third phase, we have guided teachers to meet us and remote teachers through the BBS, in order to plan the activities of the Virtual Class. Our role, as tutors, has been central to the success of this stage: we have encouraged the use of the BBS to produce, send and exchange all the documents concerning the planning of the activities of the Virtual Class (such as the socio-metric questionnaires used to group the students), and to handle most of the activities concerning the Virtual Class (the distribution of the study activities among the groups, the organisation of guided tours to the studied monuments, the communication paths between couples of groups, the communication mechanisms between students, students and teachers, teachers and tutors and among teachers themselves), as well as to discuss their technical difficulties in using the BBS software itself.

The third phase has proved to be extremely effective, as it has given teachers the opportunity to experiment with the communication technologies and methodologies that make for optimal use. Only in this context have they learned how to adopt suitable ways of telematics according to the changes in their communicative needs, e.g. when to exchange files, when to communicate via e-mail rather than via conferences, when and how to organise meetings in online chat sessions.

It should be noticed that, at the beginning of the training activity, the teachers showed a strong preference for interactive online discussions vs. asynchronous ones, probably because synchronous communication is the way they are used to communicating in their class. Consequently, teachers tried to use chatting also in situations where that mode was not well-suited. In addition, it has been noticed that the more the teachers acquired the skills to effectively use the BBS tools, the more they found useful and effective to manage their meetings through the BBS, since they could work according to their own space and time constraints. Consequently, they got used to phoning only for urgent problems and questions, and to reducing the physical meetings on particular circumstances. In other words, they really felt the concrete advantages for their activities.

During the whole training period and, above all, during the online stage, other interesting aspects have emerged. Firstly, telematic technologies can really help communication among teachers in specific communicative situations, by avoiding a direct relational component which, sometimes, might generate complex dynamics. Secondly, the use of telematic networks for educational planning has made the teachers realise that traditional curricular activities can be successfully supported by the methodologies provided by the new technology. Consequently, teachers have begun to consider computers as a useful support for the whole educational process. Thirdly, looking ahead, the recording of online discussions, via e-mail or discussion forum, concerning problems on didactic organisation and technical questions, will be the starting point for producing, in a short time, Frequently Asked Questions documents to be published on BBS and Internet. Finally, it should be noticed that communication amongst the actors of the Virtual Class (teachers, students and tutors) has been significantly simplified by using the graphic interface of BBS software like FirstClass which, through immediately comprehensible icons, allows the visualisation on desktop of all the folders corresponding to the carrying out different communication models.

Conclusions

Teacher education is crucial to successful experiences based on the introduction of innovative communication technologies in education. In this context, not only should the training activity make the teachers acquire the technical know-how and skills related to the new tools, but above all it should make them understand the potentialities offered by the new information and communication technologies for educational purposes; in addition, the training activity should point out the changes these technologies impose throughout the learning/teaching process.

In this paper, we have reported on a Virtual Class project, designed to implement an online learning environment, and we have focused on the corresponding teacher training activities we have designed. Among the several activities, we have guided teachers to design and plan the activities of the learning environment directly on line; this has been proved very efficient to enable teachers to realise the real potentialities of the new media, thus going beyond the simple use of new attractive tools.

The concept of computer as a tool for communication and learning has enabled teachers to acquire really innovative ideas about computer science at school. Through the experience described in this paperm, we have fostered, in the teachers involved in the project, the change in the concept of computers, from simple objects to be studied to effective learning tools.

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Learning with ISLA: An Information System for Classroom Integration of Humanities Materials

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ISLA (Information System for Los Angeles) is a digital research archive of Los Angeles materials in multiple informa tion formats for the purpose of research, teaching, and public access. Its scope includes the widest variety of information from all historical periods, linked by spatial and temporal coordinates. The primary, long-term goal is to create a system that will enable all kinds of users, including K-12 students, to search and access a rich and diverse range research materials residing in many different locations. The system seeks to enable an open information-exchange network for all persons seeking to study the metropolis of Los Angeles.

ISLA is developing the specific information system requirements for researching large metropolitan areas in a multi-disciplinary fashion. "Los Angeles" is defined as broadly as possible: by an approximate 60-mile radius around downtown LA. This encompasses about 15 million persons, half the population of California. Large metropoli like Los Angeles are only effectively knowable from many finite vantage points, each merely a small segment of the whole living historical entity. ISLA will maximize access to a critical mass of interdisciplinary data about Los Angeles in multiple formats. This will aid the process of learning about and solving long-term questions and problems facing all large metropolitan regions at the end of the 20th century.

The design of ISLA is a joint creation of researchers and is also an open project, inviting collaboration with area institutions and communities. The specific project defined here is entitled Learning with ISLA: An Exploratory Regional Information System for Classroom Integration of Digital Humanities Materials. This project is funded by the National Endowment for the Humanities (NEH) with the purpose of adapting a powerful interface to the World Wide Web; training pre- and inservice teachers in the use and development of curricular materials from the continuing-growing interdisciplinary resource; and connecting K-12 teachers and students to the digital humanities resources held in a very large, University-based digital archive.

ISLA Functional Overview

ISLA is designed to maximize access to a critical mass of interdisciplinary data about Los Angeles in multiple formats. It involves two components: (1) a library of multidisciplinary digital materials (texts, photographs, quantitative data, and other formats) about the Los Angeles region; and (2) a specific search and retrieval method involving a space/ time/ full-text/ format index.

Materials

The prototype ISLA contained digital spatial data made available from Thomas Bros. Map Company and the Bureau of Engineering of the City of Los Angeles, historical data layers from the 1939 WPA and land use maps, 1945 and 1928 Fairchild aerial photography, and representative photographs. During this project additional items will be added to the growing ISLA digital archive. These include, for example, the first surveyed map of Los Angeles (1849), at least 25 large-format nine-color maps from 1939, English- and Spanish-language newspapers, 2,000 historical photographs, and other materials such as audio-visual media audio, video, film) and demographic data. The University and area archives hold a great wealth of valuable historical photographs about the Los Angeles region. For example, the University alone holds 1.5 million photographs covering the entire period from the 19th through the 20th century. From these collections, materials will be selected to provide classroom use of a critical mass of digitized materials capable of supporting open-ended investigation by students in three focused periods: the Native American, Spanish, and Mexican Periods of California History, the Great Depression, and Contemporary Period. In addition, the project has defined two major thematic areas: Human Geography, Ethnicity, and Neighborhoods; and Popular Culture, Folkways, Literature and the Arts.

Search and Retrieval

The interface capitalizes on the space/time/full-text/ format indexing to search for and retrieve materials. ISLA allows multiple time and space areas to be defined. In addition, conventional indices of author, title, subject, or other cataloging fields, the attributes of Geographic Information System (GIS) vector layers, the gazetteer, or the full text of documents can be searched via the full-text line at the bottom of the screen display. A full palette of logical operators is available.

But the ISLA design goes beyond these indices by integrating a spatial-temporal element, (historical data layers, e.g., orthophotography, or "registered" scanned maps), into the search and retrieval infrastructure. The intent is to allow users to define their search in a historically-appropriate setting. In effect, users will be able to take a "core sample" of a geographic area, through layers of time. The hypothesis is that intuitive exploration without the barriers of time and space may facilitate conceptual breakthrough and allow creative integrated learning.

A primary objective of the ISLA interface is to promote flexibility and ease of spatial definition. In keeping with this objective, the ISLA interface allows users to define their search using different digital spatial layers such as neighborhoods, streets, orthophotography, zoning, land use, census areas, and parcels. Also, every effort is being made to lend a realistic, lifelike appearance to the map by using satellite imagery at a small-scale, and high resolution orthophotography at a large-scale, and projecting into California State Plane V for display.

It is important to note that no knowledge of these features is necessary for a search definition; the default values allow zoom from the Landsat TM image to current orthocorrected aerial photography with generally appropriate vector overlays. Whatever database is being displayed can be viewed at its full resolution. The highest resolution available at this time is 10.4 inches/pixel.

The ISLA interface will allow users to choose historical base layers upon which to define a search. For example, a student investigating the environment and wanting to research a site across time might be able to pick several dates of orthophotography, roads, or parcels upon which to finely define a search. The interface allows patrons to zoom in from space and/or back in time. The intent is that, in time, users will no longer have to guess from the present concerning the past in defining a search, but will be able to integrate historical definition into their search request. The capacity to show spatial layers at different times allows students and researchers to develop intuitive approaches to search construction without the barriers of time and space.

Since its inception, a primary goal of the ISLA project has been to create a system capable of providing uniform search and retrieval access to a very wide variety of information formats: textual, quantitative, still photographic and graphic, time-based (audio, video, film), and spatial data. Very advanced software systems have been developed for digitally handling all these data formats, but to date, no single interface has been designed that can weave them all together to use primary sources of the historical period. ISLA is particularly suited to assist in the fostering of participation and critical thinking skills, and in the development of information literacy skills.

The view of this project is that one of the keys to the success of technology into the classroom is appropriate teacher training, both in technology use, integration, and classroom teaching approaches. This is accomplished in the project through innovative teacher and technology training for both preservice and inservice teachers. The methodology employed in the teaching of teachers and the design of applications is the instructional technology process. This process supports designs based on solid learning theory and which emphasize evaluation, both formative and summative, as an integral part of design and development. This process emphasizes, regardless of the pedagogy, the role of communications an essential ingredient, communications between teacher and student, and among students. Our specific pedagogy views the role of the teacher as assisting students in constructing their own understanding of the content, based on the use of a rich set of learning materials, e.g. ISLA.

The other key to success is implementing technology into the classroom in approaches that are integrated, interactive, cooperative, and authentic. The design of the student curriculum will be based on the student collaborative-project based model which provides a high degree of interactivity and student exploration. Students will interact with real data and solve problems using their own experiences, learning styles, and culture. The approach also provides learning which has meaning beyond the classroom, and which provides links to students' own neighborhood communities.

Preservice Use

As part of the USC Teacher Education Program, ISLA will be incorporated into the required teaching credential/ master's degree course entitled Computers and the Curriculum. The purpose of this course is to provide preservice teachers with the necessary computer literacy and experiences with integrating computer technology into the K-12 classroom. At present there is inadequate focus in this course, except in the area of Language Arts, in the Humanities. It is also noted that it appears that existing courses at other institutions also appear to focus more heavily on computer applications in other content areas, namely the Social Studies, Science, and Mathematics.

Preservice students will develop a basic understanding of the ISLA system and of the necessary skills to search and retrieve from ISLA. Based on this foundation and working in cooperative learning groups, they will develop a humanities focused lesson plan for their specific K-12 curriculum interest level. Their lesson plans will be presented to the class for critique and discussion. These developed lessons will be available for in-service teachers to review, evaluation, and modify for possible classroom use. (It should be noted that some of the students in the Computer and the Curriculum are already existing classroom teachers).

Inservice Use

A new version of the USC (University of Southern California) master's degree in Instructional Technology is being offered through the Institute for Technologies and Learning, a joint collaboration of the USC School of Education and the Los Angeles County Office of Education. This degree program is based on a learning-cohort education model which uses a constellation of learning services, major of which is the virtual classroom (electronic network).

A similar pedagogical approach will be undertaken as with preservice students. Those teachers in the program who teach humanities, or components of humanities in their classroom, will develop a basic understanding of the ISLA system and of the necessary skills to search and retrieve from ISLA. Based on this foundation, they will develop humanities-focused curriculum materials for their specific K-12 curriculum level at various layers: the lesson plan, a unit of study, and the thematic unit. All teachers will develop an ISLA-based lesson plan; a portion of these teachers will also develop and implement in their classrooms a broader unit of study which uses the ISLA humanities component. ISLA will also be used to develop several interdisciplinary thematic units, such as A Study of Culture: Southwest Native Americans, and How and Why an Areas Changes as Detected by its Arts.

Additionally, several of these applications will include integration of other existing WWW resources. Through the use of hyperlinks, existing humanities-oriented WEB resources (such as the "4th Grade California History Review" which provides lessons on aspects of California History, and "California's Natural Resources" which includes some information on cultural diversity) will be linked to the ISLA-based system.

It is also proposed that several of these applications include student-input data. For example, students will explore their neighborhoods and provide unique data (such as current neighborhood photographs and interviews/oral histories of residents) to update the ISLA repository.

Evaluation

A standard methodology is being developed to evaluate the results of using ISLA. Several of the stellar-model (exemplary) ISLA-based curriculum applications will be evaluated in more depth by ISLA-project personnel. Specific examples of techniques to assess the outcomes of using ISLA in the Humanities curriculum could include achievement of specified learner outcomes and behaviors, content achievement, cognitive skill development, attitudinal assessment, amount of time-on-task, curricular improvement, teaching improvement, etc. It is also expected that an educational doctoral dissertation(s) will be focused on the evaluation of the use of ISLA.

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A University Degree Program Using an Interactive Fiber Optics Network

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The use of fiber optics distance education to link various locations in Iowa is possible due to the Iowa Communica tions Network (ICN). This network is the telecommunications system installed by the state of Iowa to handle its telephone, data, and video/audio transmission needs. The ICN uses over 3000 miles of two-way, full motion, interactive fiber optic cable, supplemented by the Instructional Television Fixed Service. The network connects the three state universities, 15 community colleges, and Iowa Public Television. In addition, there is one site in each of Iowa's 99 counties with connections to various libraries, hospitals, and postal services. By the year 2000, 600 ICN sites are projected. Currently, at Iowa State University, there are nine on-campus ICN classrooms.

Iowa State University offers a unique graduate program, the Master of School Mathematics (MSM), intended for inservice high school mathematics teachers. This graduate degree is built upon three themes:

- the enhancement of knowledge of geometry, calculus, and discrete mathematics,
- the importance of problem solving in learning and teaching mathematics, and
- the use of computing technology in learning and teaching mathematics

The course work includes geometry, topics in discrete optimization, intermediate calculus, a seminar on current literature in mathematics education, a statistics course, electives and a written creative component, totaling 36 semester credits. Completion of the MSM program fulfills the Iowa Masters Teachers Certificate. The program is structured so that all or most course-work can be completed in three summers.

Evaluations of the MSM program have generally been positive. However, we felt that the ICN provided an opportunity to reach mathematics teachers in remote, rural regions of the state who might otherwise not have the opportunity to leave their communities to obtain a higher degree. Although Iowa State University is located in very nearly the geographic center of Iowa, teachers in the western half of Iowa must travel two or three hours one-way to attend classes at Iowa State University, their closest in-state option. Moreover, there is no other master's degree program like the MSM in the state of Iowa so we felt we could draw mathematics teachers from the eastern half of the state as well.

The MSM program together with Iowa State University Extended Education jointly developed a survey to indicate interest in taking courses leading to the MSM degree. During the spring 1994 semester, this survey was administered to all secondary school (7-12) mathematics teachers in the state of Iowa. One hundred sixty mathematics teachers returned the survey indicating they were "very interested" and an additional 200 mathematics teachers indicated they were "interested" and wanted to know more about the requirements of the program. These results encouraged us to pursue the matter of putting the MSM program "online."

By the middle of summer 1994, the MSM program had been approved for the ICN by the Iowa Coordinating Council for Post-High School education. In the fall of 1994, an ICN prototype course was offered on campus with no remote sites. During the spring 1995 semester, a continuation of that course was successfully offered on the ICN. Then, in the summer of 1995, we offered the regular intermediate calculus and discrete mathematics courses over the ICN. After these inaugural ICN course offerings were enthusiastically received by the students in the program, we moved to a totally-ICN program. The response to this change was incredibly positive; enrollment in the MSM program increased 50%. We are delighted that we chose to offer the entire MSM program over the ICN to better meet the needs of our students.

Literature

During the 1995-96 academic year, the instructors of the MSM courses worked diligently to learn about effective and successful teaching via distance education. In terms of pedagogy, lecturing for long periods of time is unacceptable (Beers, 1996; Baker, 1993; Schoenfelder, 1993; Zbiek & Foletta, 1995). The use of cooperative group work with students at a given site (Beers, 1996) or at combined sites (Zbiek & Foletta, 1995) could also facilitate student interaction. Bialac & Morse (1995) found that students at the remote sites would sometimes sit back and watch as the students at the origination site answered questions. However, many researchers (including Bialac & Morse) reported methods to maintain meaningful interactions with students through e-mail (Zbiek & Foletta, 1995) or through conscientious eye-contact by the instructor (Schoenfelder, 1993). Baker (1993) also found instructors to be more successful when they took the time to learn student names immediately in order to call on them. In order to accomplish such solutions, Beers (1996) indicated that large class sizes, such as his class size of 50, were not workable and should not be attempted.

By spending some of the opening class period teaching students to run equipment (Bialac & Morse, 1995), all students become more comfortable with the microphones, camera, and the other technology such as facsimile machines (LeBaron, 1994). In fact, Beers, (1996) indicates that each site will somehow appoint a member of the class to be the "de facto technician for that site" (p. 680). Most experienced distance educators have had success teaching the course by traveling to each of the remote sites at least once (e.g. Beers, 1996; and Bialac & Morse 1995). Preparation of all materials in advance (e.g. Baker, 1993; Beers, 1996) is vital to successful classroom interactions and information sharing. After studying the findings of such researchers, we felt prepared to deliver our first ICN course.

Results

During the summer of 1996, Iowa State University offered the mathematics education course and the statistics course over the ICN. In the mathematics education class there were five remote sites along with the Iowa State University classroom site for a total of 25 students. The authors of this paper team-taught the mathematics education seminar course. Although we felt our experiences supported much of the literature, we also discovered three primary results.

First, even though remote-site students sometimes appeared to be off-task, we were delighted to learn that they were not off-task. Rather, they have learned an effective use for their previously developed "TV-Mentality," which helps them to focus on their monitor when an important occurrence happened. This was actually a different situation to which the instructors had to become accustomed. Particularly with graduate students, we were each used to all eyes being focused on us so that we could verify that our students had heard and understood our every word. Another minor finding related to this idea was the breaking of our unfortunate habit of looking at the monitors showing remote-site students or at the real-live students at our site, rather than at the camera. With practice, we corrected this problem.

Second, we successfully used a set of two end-of-the-semester evaluations (See Appendix A). The first evaluation focused on the system, equipment, and distance education in general and the other evaluation centered on the course and the instructors of the course. Prior research (Beers, 1996) consistently indicated that students would deliver a poor evaluation of the course and hence, instructor, when, in fact, it was the equipment that had failed in some capacity.

Third, we were fortunate to have had the help of an efficient assistant during the planning and delivery of the course. Her skill at handling a multitude of time-consuming details, such as mailing TI-92 calculators and algebra tiles to the various sites helped the class move smoothly. As teachers, we were able to concentrate on the teaching of the course and not on the housekeeping details. She also helped us to handle the technology of the origination teaching station. It is essential to have an assistant to help with the planning and delivery of the course. This assistant gathers information, acts as a liaison with students, takes care of mailings and photocopying, and takes care of the mundane tasks which often impinge on an instructor's time.

Recommendations

In addition to verifying many of the previous researchers' solutions to possible discouraging situations, (e.g., being certain to plan ahead, writing text items in 28-point or larger, and not using a lecture-style of teaching), we also discovered a few simple tricks for effectively teaching through distance education:

1) A highly successful strategy for eliciting student responses was to put the camera on that classroom and wait. Admittedly, each of our sites had a relatively small number of students. In fact, we found the success of this strategy to be inversely proportional to the number of students at the site. Once the site housed 5 or more students, it was less effective. This is an interesting adjustment to "wait time."
2) As instructors, we learned not to wear clothing that sported stripes, plaids, or large prints.
3) On the first day of class, we collected the e-mail addresses of all students and created a listserv that afternoon. The mathematics department employs a technology person whose job includes such activity. One of the most effective uses of this listserv came into play whenever we ran out of time. When a distance education course runs out of time, all transmissions are ceased. Consequently, students learned to check their e-mail for final comments from classmates or instructors.

4) The class was scheduled for one hour each day. However, we were able to successfully solicit funds from our Dean's office to increase daily transmission for thirty minutes to have "office hours." The students were able to use those 30 minutes to ask questions of the instructors, to discuss professional topics with fellow classmates, and generally to bond with one another. Therefore, our class was one hour long, but we had the cameras on for one and one-half hours.
5) In accordance with suggestions from previous researchers, midway through the course, we planned a picnic for a Saturday afternoon. This served two purposes. First, as instructors, we provided an opportunity to visit face-to-face with all of our students. Second, we had initiated a class project that could be completed only when all students' work was combined. The picnic offered the opportunity to complete the class project.

During class prior to the picnic, the instructor asked the two students from Bettendorf whether or not they would attend. This site is well over 3 hours from the picnic site. Neither student from that site attended. When the instructor indicated that they would be excused because they were so far away, they countered with a reality check. "That's funny, we think it's you who are so far away." This reminded the instructors to be sensitive to the feeling of isolation that students encounter through distance education. We were careful not to make such comments in the future.

6) One of the most successful ways to ensure that all students are involved in the distance education course from the first moment is to use a roll call developed with the help of such software packages as Power Point®. This form of attendance gathering was created by two Iowa State University Professors: Ricardo Salvadar and Michael Simonson. Within the first week of class students at all sites were required to create a Power Point slide with their name and containing a photograph, phone number, e-mail address, school where teaching, and other interesting facts. By the end of the first week, the finished product on a floppy disk was sent to the instructors who developed a Power Point roll presentation for the class. As we scrolled through these slides each day we asked a question, or other days the students would merely indicate "presence" or "absence." This was an excellent way to learn student names immediately.

Most students had no experience with Power Point prior to our class and were apprehensive about whether they could find and use it. However, it was a readily available software package which our students, regardless of location, were able to find and use. A few students were not able to access a scanner and either sent pictures to us for scanning or used the available graphics in Power Point.

7) Remote site students seem unable to appropriately decipher some non-verbal communication. Consequently, we felt that in the future, the pace of material coverage needs to be reduced. It is simply impossible to cover the same amount of material when so much of the communication process is lost or debilitated. These thoughts were supported by the evaluations we received at the end of the semester.
8) Student access at remote sites to relevant articles in the literature would appear to be a problem, especially in graduate courses. However, this was not the case. Prior to the course articles were identified, approval for reproduction of these articles was obtained, and then the articles were scanned onto a CD using a CD writer. Students were sent these CD's along with other class materials prior to the first day of class. All students had access to CD readers and were able to make hard copies of articles as desired.
9) Several students had to travel to other regions of Iowa for personal matters on occasion throughout the summer session. They were able to attend classes at other remote sites without missing class which was an unanticipated benefit.
10) Outside resources were used successfully during the class. For example, a classroom teacher having considerable experience with the TI 92 calculator spent a class period with us when this topic was discussed. A remote site close to where the teacher lived was used by the teacher- one not normally used but readily available for this activity.
11) Evaluation of students revolved around group presentations and a portfolio final. No formal pencil and paper examinations were given.
12) Several cooperative groups consisting of members from different sites worked very well. These students were able to use the ICN during "office hours" and group times. Other technology such as e-mail, listservers and facsimile transmission aided interaction.
13) One site had only one student and no official technology staff person. The student became very proficient with the technology at that site. He learned to let himself into the room, turn on the equipment, and set up all cameras. Nevertheless, we felt each site should have a minimum of two students in the event of technology problems and to aid in the student interactions and discussions.
14) Our experience suggests a maximum of five remote sites and the originate site. Three or four remote sites would be better. It is difficult to successfully manage and ensure a good educational experience for students when more sites are used.

In general, our experiences with the course were quite successful. As an accessible opportunity for professional development among high school mathematics teachers, this type of course offering will provide the teachers with unparalleled opportunities for furthering their education.

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Integrating the Internet into the University Curriculum

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With the rapid adoption of Internet browsers, easy access and utilization of the Internet is significantly changing how we deliver instruction at all levels. As desktop computers changed our lives, so has the Internet changed the way we learn and teach. This paper will address how the Internet, particularly the World Wide Web (WWW), has been integrated into both undergraduate and graduate Education courses, and a MBA Economics course.

The WWW as an Education Teaching and Learning Tool

With the introduction of user friendly Internet browsers, teachers and students can readily enter the Internet universe of information. However, the ease of entry can soon turn to frustration if students cannot find their way around or locate relevant information. The new Web user is often confused and experiences disorientation regarding spatial relationships on the Internet, where things really "are," gets "lost in space," and is unable to find his or her way back to a reference point. There is a real need to help students conceptualize the relationships on the Internet, where things begin and end, and how they are linked together. They need to understand how the Internet is structured, where links are connected, the structure of a homepage, and how to utilize efficient search and retrieval techniques - how to find what they are looking for. These issues will be discussed in the context of several course homepages used by the authors.

Integrating Technology into Teacher Education Courses

The first thing university faculty must understand in integrating technology into their courses is what students know and how they can use it. Undergraduate Education students generally have more familiarity with E-mail and the Internet than Graduate Education students. Having grown up with video games, they are much less apprehensive than graduate students in exploring the technology. However, we have found their familiarity to be superficial regarding the Internet. They have seen it, but cannot really utilize it effectively. Graduate Education students, except for the technical coordinators in the schools, generally have never sent E-mail or even seen the Internet. A few of them border on being "technophobic," and need much support in exploring the technology. In both undergraduate and graduate Education courses, we have worked to guide students to the understanding that e-mail and the Internet are no longer just part of instructional technology and computer education classes. This way of communicating and learning needs to be integrated into all subject areas and at all levels of teaching. Our philosophy is that the university must model this integration with our students so that they have sufficient time and practice to move from guided to independent practice and utilization.

In both undergraduate and graduate Education classes taught by this instructor, all students were required to send one e-mail to the instructor. While this was a steep learning curve for just one e-mail, formative evaluation from graduate students support continued use of this requirement. Student questions indicated they needed help understanding where messages go, how they were accessed, and that they actually came back if they were not received by recipients.

Course Hotlink Websites

All students were introduced to Netscape, the browser used in our networked student computer labs. Graduate students who had less knowledge of the Internet, as compared to undergraduates, watched a 40 minute instructional video and spent a total of 3 hours in a computer lab receiving hands on instruction in sending e-mail and using Netscape. All students were given information on mini-classes offering further instruction conducted by our computer services staff. Lab assistants were also available in all student labs. Both undergraduate and graduate students were introduced to the course syllabi on the Internet, shown how to access the IUSB Library Homepage, do ERIC searches, and do interlibrary loan requests by computer. They were also introduced to specific course hotlink pages developed by the instructor to assist them in finding websites that would help them in looking for teaching and research materials which related to specific course assignments. The following organizational chart, Figure 1, Marcia Sheridan's Website for Education Materials (http://sun1.iusb.edu/~msherida/), demonstrates the two hotlink websites developed for the Education students in two different courses. One is oriented towards general reading materials useful for middle and secondary education teachers of all subjects; the other is devoted to the topics students study in a course on Education and Social Issues.

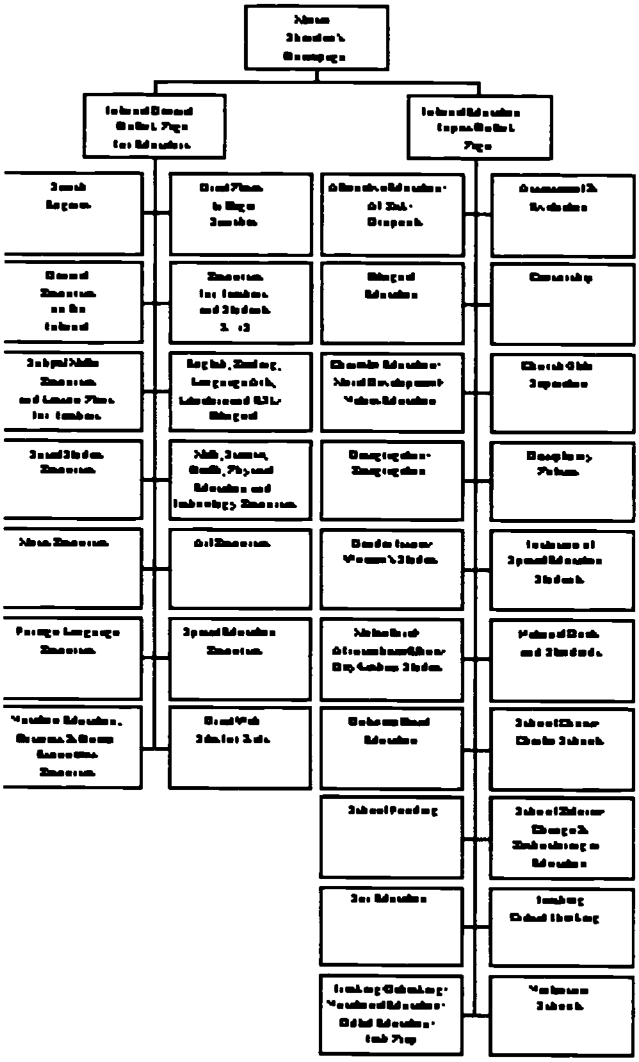

Figure 1. Marcia Sheridan's Website for Education Materials.

While we have seen some K-12 facilities in our area with excellent technology available for students, much of it is underutilized. Future and practicing teachers must learn to utilize technology or the money devoted to it will be poorly spent. Preservice and inservice teachers in university classes need to learn to use the Internet as a research tool, as a resource for planning and accessing lesson plans in various content areas, as well as locating Internet sites which can be used with elementary, middle and secondary students if teachers are ever to integrate the Internet into their teaching. They can learn these if teacher educators integrate this new form of learning into university curricula as an integral part of instruction. Teachers are busy people, and unless a school corporation has an active professional development program which provides time for this practice, the kids in the school will remain the most adept users of the technology. At a minimum the goal should be to help future and practicing teachers reach the same level as some of the best K-12 students. When they are both at the edge of the technology, they will be learning together as new developments occur. But teacher educators need to be there as risk-takers and models of how this happens.

Course Syllabus Website

The entire Education course syllabi for three courses were placed on the Internet, and students received hard copies as well as had time in a computer lab accessing them through Netscape. The following organizational chart, Figure 2. Marcia Sheridan's Website for Education and Social Issues (http://sun1.iusb.edu/~msherida/h520co~1.html), illustrates one syllabus homepage used for a graduate course on Education and Social Issues.

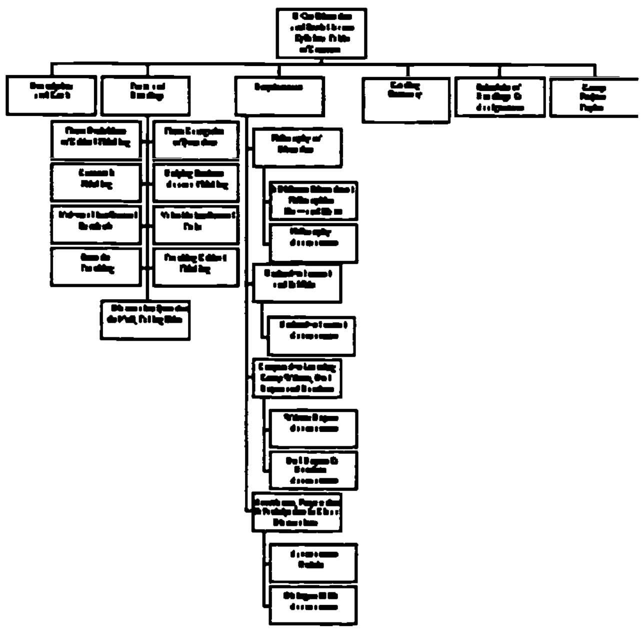

Figure 2: Marcia Sheridian's Website for Education and Social Issues.

When incorporating a homepage as an integral part of an instructor's course, the instructor must teach the homepage as a new study skill. A course homepage can deliver material developed by an instructor, course related materials developed by others, links to relevant associated materials on the Internet, as well as previous student work. The instructor must be sensitive to the problems that the students are likely to encounter on the Internet and offer techniques for solving these difficulties: getting lost, time delays, not finding what you are looking for, and wasting a lot of time surfing. Students need to realize that the WWW is constantly changing: sites appear, disappear, and move.

Furthermore, the use of the WWW does not mean that libraries are no longer necessary, but that perhaps libraries and librarians will be playing a different role in the electronic future. Also students need to understand just what is and is not there, at least yet. And, lastly, copyright issues are just as important on the Web as they are in the libraries: we need to discover new ways to reimburse authors and creators of new knowledge who want to be paid for their knowledge.

While graduate students were given the latitude of utilizing the Internet in their research papers or not, some embraced the technology more than others. Quite a few, as did the undergraduates, made efforts to connect their home computers by modem to the university or to subscribe to online services for e-mail and the Internet. Undergraduates were required to utilize material from the Internet in their lesson plans and units. Cooperative learning groups assisted this process as those who were more knowledgeable assisted others. Two of the five cooperative learning groups in the undergraduate Middle/Secondary Reading Methods class asked to be allowed to develop homepages instead of an instructional unit utilizing Internet materials. These students have become comfortable with the Internet and its applications. They are bringing their expertise into other courses and, in doing so, are bringing an influence on other professors to become more familiar with the Internet and how students are using it.

Delivering Course Content Over the WWW

A different use of the WWW is to deliver a majority of course materials and content developed and produced by the instructor for his or her class. Examples and experiences from an MBA Economics course that uses a homepage to deliver lecture notes, chapter handouts, quantitative problems and solutions, and research materials will illustrate this approach.

A502, Managerial Price Theory is an MBA Economics course which applies economic theory to business situations. As prerequisites, the students are to have an understanding of introductory economic theory, statistics, and mathematics. The objective of the course is to apply economics to managerial business decisions. The students come from a wide range of backgrounds: about 40% have an engineering undergraduate degree and work full-time in a technical job, about 40% have a business degree and work full-time for a service or manufacturing firm, and the rest generally have a liberal arts degree and often work in the nonprofit sector. Furthermore, a portion of the students are international students. The international students are usually the only ones who are full-time students. Unfortunately, given these diverse backgrounds and the fact that many have been out of college for quite a few years, much time during past semesters was spent reviewing economic theory and statistics as well as working on hypothetical problems, with insufficient time left for real world applications.

Organization of Course Homepage

Recent technological developments have allowed the instructor to resolve the dilemma of content versus application in the A502 class. The class now uses the WWW and collaborative learning techniques to improve student learning and research. All of the economic content in A502 that was previously presented in class via lecturing and hypothetical problem solving has been put on a homepage (http://sun1.iusb.edu/~fhersche/a502.html). This includes lecture notes with hotlinks to external economic and business sources, hypothetical problems that in earlier semesters had been worked on during class, practice problems, homework problem sets, and answer keys for all these problems. Supplementary materials such as handouts, grades, and previous examinations, have been also put on the homepage. The homepage has hotlinks to specialized economic search engines, economic resources, freeware, and grades. The following organizational chart, Figure 3. A502, Managerial Price Theory, demonstrates the organization of the A502 homepage.

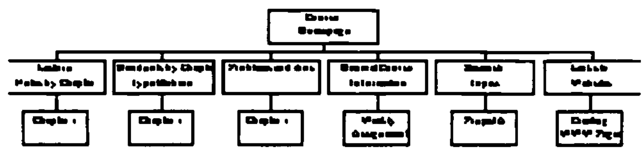

Figure 3: Course Homepage for Managerial Theory.

Impact of a Course Homepage on Teaching and Learning

The primary impact of the course homepage is that the instructor has dramatically changed the organization of class time as well as the focus of learning because the dilemma of content coverage vs. application has been alleviated. In the past, in order to develop mastery of the economic theory and the use of this theory to solve problems, the instructor spent class time lecturing and working out hypothetical problems and having the students individually work out hypothetical problems. Thus, there was a very limited amount of time applying the economic concepts to the everyday work experiences of the students. Currently, however, lecture material is offered on the homepage and there are numerous hypothetical problems with solutions as well. Quantitative, hypothetical problems are still assigned as homework, and they remain the central focal point of the examinations.

Class time is now almost entirely oriented toward student-centered learning. Each class period of two-and-one-half hours is devoted to one chapter. Each chapter is divided roughly into thirds. For each third the instructor spends about five minutes highlighting the main points of the respective section of the textbook. This brief review is supplemented with a detailed chapter outline which links each important concept to the relevant class handouts, homework assignments, and in-class problems. Next, the students participate in teams in a problem solving exercise. For purposes of in-class work and the major research project, the students are divided into three to four person teams that are carefully selected for a wide range of experiences. The teams are handed an in-class discussion problem composed of three parts. Part A states the major concepts of that part of the chapter and the students are to see that all team members are familiar with each concept. Part B asks the team members to collectively work on a quantitative, hypothetical problem that requires them to apply the concepts of Part A. Part C, the core of each exercise, then asks the team members to discuss the economic concepts in light of their actual work experiences. Given the diverse background of the team members, generally more than one person in each team can draw on his or her work experience. The in-class discussion insights are then shared among the teams and the instructor. During this stage the primary focus is on Part C, the sharing of real world experiences. Since the solutions to the problems are on the homepage, little time is spent on this activity.

The second major benefit of the homepage is that it allows the instructor to supplement lecture material with links to real world applications and data on the Web. In this sense, by assigning the students to read not only the lecture notes but also the links on the lecture note sites, subject matter content becomes alive and much richer than if it was presented merely as a classroom recitation. Of course, the richness of the learning varies by chapter at this point since applied economic and business materials are much more available for certain topics than for others.

The third and not insignificant advantage of the homepage, especially given the nature of the university's MBA students, is the convenience to the students and instructor of having material on a website. The MBA students tend to travel fairly often for business (it's not unusual to have 10-15% absent any one week), and so in the past much time and effort was devoted to faxing materials to the absent students. This has been entirely eliminated as a result of posting all course materials on the homepage. A related aspect of the course is that the instructor strongly encourages the students to use e-mail to communicate with the instructor. Given the dispersion of the students over northcentral Indiana and southcentral Michigan, the frequency of business travel, and the already widespread use of business/personal e-mail among the MBA students - communicating over the Internet has dramatically increased the amount of contact between the instructor and the students, in the neighborhood of fivefold.

Student Evaluation of Using the Internet

Although measuring some of the benefits of using the Internet in this course is difficult to measure (such as the students becoming familiar with an important technology and gaining experience with collaborative problem solving), there are some indications that the use of the homepage has had a positive impact on learning. The just described innovations have been in place for two semesters, and compared to examination results of prior semesters, students' performance on quantitative homework problems and examinations indicate that students who use the homepage and collaborative learning, even without class lectures, perform just as well as students in earlier semesters. There are no significant differences in grade results. Also, the student evaluation of the use of the homepage indicates that the homepage has significantly improved their learning. The results of the Fall, 1996, student evaluation reported that: (a) 11% accessed the A502 homepage 0-4 times per month, 83% accessed the homepage 5-10 times per month, and 6% accessed 20 or more times per month; (b) in terms of the homepage's "usefulness ... in terms of your learning the material for A502," 56% rated it "very helpful," 39% rated it as "helpful," and 5% rated it as "of little value."

Conclusion

The simplicity with which Netscape and other browsers have made easy entry into the Internet masks the important point that there is a wide gulf between surfing and learning. As university educators we need to guide our students in efficiently and effectively finding information for their projects and lessons. Proper modeling of accessing the Internet through a well designed course homepage is an important first step in this process. Using the web to find materials for research projects, lesson plans, and class related learning is another critical step on the path to enhancing student learning. The course homepages described in this paper can serve as possible first examples in using the web to enhance learning and teaching.

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K-12 Teacher Use of the Internet: A Research Report

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This dissertation research involved a review of Internet sites and resources, a survey, and individual teacher interviews regarding the challenges, problems, and successes of online technology used for teaching and related professional activities. The teachers selected for this study used the Internet frequently and for diverse applications. They and their students reached beyond the physical classroom boundaries to become linked via voice, video, graphic, and text communications to other classrooms or sites in the same school, city, or nation, as well as to other countries. Their classroom windows were open to the world. They used the information highway to reach beyond simple information gathering to collaborative online learning and activities that used higher-order thinking skills.

The Problem

As classrooms connect to the information highway, "the world" becomes more available and traditional curriculum and instruction practices change. While access to the information highway continues to increase, a minority of classrooms are connected. There is also a difference between connectivity and skillful integration of telecommunications into curriculum. Effective integration of educational online activities has not been extensively researched. Thus, school districts faced with limited resources, time, and personnel need additional information so that curriculum and technology are designed and implemented wisely. The need to examine the successes and problems experienced by teachers who are frequent telecommunications users, an area of limited formal documentation, led to the design of this research project.

Objectives of the Study

Five questions served as a basis for this investigation:

1. How are teachers using the information highway for instruction and for related professional activities?
2. Is student thinking and learning being enhanced?
3. Has this technology been a catalyst for changed educational practices?
4. What obstacles have teachers encountered that served as barriers to usage?
5. What do teachers perceive to be the future direction of curriculum design and instruction which includes the information highway?

Review of the Literature

The partnership of educational reform and technology in shaping new frameworks for curriculum and instruction was examined. Armstrong (1994), Eisner (1994), and Gardner (1991, 1993), considered educational reformers, advocate multidimensional, sensory learning that is beginning to be found in Web sites, CD-ROM software, and commercially prepared curriculum that some teachers are using. Researchers (Bonington, 1995; Dede, 1992; Schrage, 1990) have indicated that hypermedia structures may even develop more user metacognition than linear text, such as found in textbooks, because these structures demand continuous choices and navigation from learners. The Web mimics the structure of human long-term memory development as its many linkages provide networks and bridges for transforming fragmented databases of information into richly detailed worlds of usable knowledge. Dede (1992) also observed that students using the Web might not be frustrated by cognitive overload, because they navigate imbedded content at their own pace, which aids in assimilation and manipulation of ideas.

Dede (1992), Shapiro (1995), and Trotter (1993), indicated that multimedia also has the potential to bring a greater variety of materials to students and to address multiple learning styles because of the self-directed discovery learning format. Dede (1992) explained that virtual reality technology is currently complex and expensive, with limited Internet sites, but enhanced learning may be possible. He warned, however, of potentially troubling effects of undetectable technological manipulation of human experience so that it is difficult for anyone to determine authenticity.

Another negative aspect of telecommunications use is the gender gap that Hughes (1994) noted for Web users—94% were male, with 56% of them between the ages of 21 and 30. He also stated that K-12 students were only a minority of Internet users. If indeed, the future belongs to those who can access and apply information, with those who cannot being left behind (Johansen & Swigart, 1994;

Naisbitt & Aburdene, 1990; Toffler, 1990), inequities in usage, whether based on gender or economics, are significant. Toffler noted that the American workforce has struggled with a shift to an information-based economy, and Naisbitt and Aburdene warned of the difficulties in absorbing the large amounts of information that whiz by people daily.

With this global information age, according to Reinhardt (1995), the Secretary's Commission on Achieving Necessary Skills (SCANS) report (1992), and Sizer (1992), business, government, and educators alike are suggesting the need for a different type of education. This puts pressure on students to be more flexible, better educated, technologically sophisticated, and skilled in interpersonal communications. Similarly, educators are challenged to address these needs, yet often without addressing finances. The review of the literature revealed a movement to blend educational reform and technology to prepare students for a changing global information age that is shaping new frameworks for learning.

Procedures Used

For this qualitative study, findings from a survey and scripted interviews were presented as case studies of three elementary and three secondary teachers from several urban and suburban areas of the United States. Interview transcripts were checked by these teachers to insure data accuracy. Educational web sites and Internet listservs were also monitored to provide triangulation during the study. Peer examination was employed as findings emerged to verify interpretations with technical experts. The researcher's biases were also disclosed (experience in using technology). The survey and interview instruments were pilot tested and revised before mass distribution.

The population from which the sample for this survey and interviews was chosen was purposely selected from K-12 schools who have access to the highway and were documented as frequent Internet users at the beginning of the 1994-1995 school year at a Web site listed in Ellsworth (1994). The survey instrument regarding online classroom activities was mailed to each individual in the sample. The returned surveys were analyzed to find three K-8 and three 9-12 teachers from a variety of urban and suburban areas who used the information highway most frequently and in the most diverse, sophisticated ways. These teachers were individually interviewed using a scripted instrument of 28 closed- and open-ended questions plus 9 items regarding school and teacher demographics, with additional probing questions added as needed.

Results of the Study

An analysis of patterns began to emerge first from the results of the survey, and then expanded as individual teachers were interviewed.

The Survey

This database, consisting of twenty-six completed surveys, revealed information about teacher experience with the information highway, education, access, and background information. The majority of the educators responding indicated that they were frequent users (at least once a day) of the information highway for basic activities such as e-mail and listservs. Survey respondents included nine elementary teachers, sixteen secondary, and one with K-12 responsibilities. The subject areas most frequently taught by responding secondary teachers were science, math, and computer technology. An equal number of males and females responded. Respondents represented eleven different states from the east and west coasts and the midwest. The majority of schools were urban and suburban; only four were rural. Over half the teachers had Internet access from their classrooms and homes. The teachers had similar proportions of length of experience—about half were beginners and half had experience ranging from five to twenty-five years. Fifteen had at least one or more master's degrees and five had doctoral degrees.

Teachers reported student use of the Internet as early as kindergarten. Nearly all teachers used the Web for professional activities, but seven had never used it in the classroom. Twenty-one reported that they had telecommunications access from home, and fourteen had access from their classrooms. Twelve teachers had multi-station labs, ranging from five to 40 computers. The survey indicated that the classroom activities these teachers planned utilized the Internet for cooperative and individual learning. The activities also included accessing information resources, communicating with subject-matter experts and peers, visiting online museums and virtual reality sites, and participating in data-gathering projects. The majority of the respondents indicated that they used the Web at least once a week, although seven respondents never used it in their classroom. Ten schools had developed a site on the Web. Few teachers, however, reported classroom use of virtual reality sites.

The respondents indicated successful experiences with the Internet. For example, all of the teachers felt that the Internet created opportunities for educational improvement and enhanced student motivation. Teachers were most positive about Internet-related improvements in student achievement, social and emotional skills, and the ability to learn how to learn. A majority of teachers felt that the Internet helped students develop workplace-related skills. Responses were mixed when it came to deciding whether the Internet had led to information overload or addictive behavior. In terms of student assessment practices, less than half had used any type of alternative assessments.

With regard to using the Internet for teaching, the vast majority reported that it had changed the way they taught. All of the teachers also noted that the Internet had enhanced communications with colleagues. Responses were mixed regarding the opportunity it provided for teachers to be freer to work with individuals. The majority of teachers noted that the Internet helped them access and share curriculum and find other education-related resources. Teachers were split as to whether or not their experiences had been frustrating as a whole.

The Interviews

The six selected interviewees had all used the Web for classroom and personal professional activities. Four taught at schools that created their own home pages on the Web, and information from these Web sites as well as the interview was included in the findings.

Types of Activities Reported. The teachers noted that online activities were successful with students of all ability levels, from at-risk through gifted. Many activities were structured to integrate the technology and the subject matter and take advantage of local community resources. Both local area networks and the Internet were used in some schools, so being "online" had multiple connotations. Collaborative activities were reported within the same classroom, with higher-grade classrooms in the same building, as well as with classrooms around the globe. All of the teachers used some type of authentic, responding, online audience for their students to share their ideas, creative writing, and products, as well as to collaborate. Teachers also noted that they and their colleagues sometimes learned more about the Internet from students. Indeed, students in some schools accompanied their teachers to conferences and community events to participate collaboratively in formal presentations regarding online activities.

Some teachers reported that their students also enjoyed preparing lists of their favorite Internet sites, and even compiled Web statistics. Students visited online museums, participated in global gathering of online data about issues or scientific experiments. Others went on online scavenger hunts designed to improve geographical and multicultural literacy. One secondary teacher even had her students volunteer to help other teachers prepare online-enhanced lesson plans. Some individual students and some classes had created Web pages to share their activities, personal information, or the local culture. Online discussions often included querying subject-matter experts, such as the "Ask Dr. Math" forum. Many of those activities evolved into longer-term mentorships. Secondary students also mentored with university students at campuses they wished to attend upon graduation.

Impact on Teaching and Learning. The Internet changed the way teachers taught and students learned in many positive ways. For example, students worked on projects that involved learning about the importance of peaceful conflict resolution as an alternative to violence and shared their feelings via their school's Web site. Teachers also noted that students exposed to a world outside their own classroom saw the importance of education in changing lives for the better and the power of individuals to make a positive difference in a community. Teachers praised the ability of the Internet to help both students and teachers get out from behind their classroom walls literally and figuratively.

Teachers also reported increased motivation, communication skills, and writing skills. They noted students were increasing their ability to solve problems and question—"learning how to learn" and think critically. Overwhelmingly, students enjoyed online experiences, increased motivation and on-task commitment, as well as creativity. With teacher guidance, students engaged in metacognitive reflection. Students also learned without regard to the ethnicity, race, age, special needs, socioeconomic class, etc. of their online partners. Indeed, teachers reported that students grew in their knowledge and understanding of other cultures and improved social skills and esteem.

Students with language backgrounds other than English, as well as students studying another language, also enjoyed opportunities to converse online with speakers and learners of that language. High school students often became so skilled with online activities that local employers hired them. The teachers also grew professionally as they increased their technology and curriculum development skills. They reported that they began to guide learners in ways very different from previous traditional teaching. They helped students learn actively (the constructivist model) rather than passively, and some started to assess learning in new ways. These teachers knew that they and their students were becoming catalysts for educational and even global changes.

Professional Activities of Teachers. Teachers reported receiving assistance from local universities and school districts to learn the Internet. Several used the networking found in listserv's to connect with like-minded colleagues and to solve problems. They also used the Internet to locate lesson plans and teaching resources quickly and inexpensively. Some complimented their national professional organizations for showing leadership in addressing online classroom activities in their publications and at conferences.

Obstacles. Teachers consistently reported time-consuming, on-going efforts to implement classroom activities connected with online learning. While some teachers were recognized and praised by their districts and/or national groups for their extraordinary efforts pioneering this technology in their schools, a few noted lack of constructive support, even resistance or hostility to change, from administration and colleagues. Several felt their districts could do a much better job of providing training for both beginning and advanced users of online technology.

Equitable access to technology was a major concern of all teachers interviewed, both in their own districts as well as nationally. Frequent frustrations with equipment, both hardware and software, led to time lost in learning and planning. The main theme in terms of "inadequacies" consistently revolved around teacher time and money issues. Additionally, teachers complained about not having the computing tools to match their ideas and the enthusiasm of the students—both were often ready for more than was presently within their reach. There was very much a feeling of "we could do more if only...". While these were very real individual concerns, the teachers also noted that this was an important challenge for America in terms of melting the divide between technology-rich and technology-poor schools.

Another obstacle teachers reported was that the physical limitations of their classrooms or computer labs had prevented better integration and use of the information highway. For younger students, lack of keyboarding skills was sometimes a reported drawback, but they could point and click with a mouse. Acceptable use issues challenged some interviewees. Teachers took individual responsibility to discuss netiquette issues with students and following through, when necessary, to remove online privileges of those students who did not respect acceptable use policies and expected courtesies. Some teachers expressed personal or community concern regarding access of inappropriate materials on the Internet. However, one teacher felt strongly that educators needed to help guide students to develop their own sense of what might be appropriate or inappropriate access, rather than risk censoring anything on the Internet or restricting access. When reflecting upon the obstacles and challenges that they had faced, however, all of these teachers felt the inconveniences experienced did not overshadow the joys and positive results of online learning for them or their students.

Implications

This research indicated that the information highway is allowing students and teachers worldwide to bring vast resources and people into their classrooms and use them positively. To make this a reality for all students, access for every classroom in America in the very nearest future should be a high priority at local, state, and national levels. The experiences of teachers in this study indicate a need for greater progress in funding, technical assistance, training, conference attendance, released time for curriculum development, and other types of support—all still unsatisfactory conditions in too many districts.

Teachers in this investigation indicated that they found that the information highway served as a catalyst for changes in their curriculum design and instructional models. The Internet is thus providing a framework that is beginning to reflect the goals of education reform. Indeed, Internet use may be one of the fastest ways to accomplish these goals. Students as well as teachers are becoming powerful agents of change, collaborators, and explorers of content areas. A mass distribution of Internet technology may help to bring greater empowerment and hope to forgotten inner-city schools and children of lower socioeconomic class by expanding opportunities to learn and increase motivation. Schools with inadequate libraries and outdated textbooks might instantly have better resources. Children from homes without adequate study resources and parental guidance might benefit from online materials and mentors. A well-educated citizenry is crucial for any democracy to survive, and the information highway might be that catalyst to move us closer to that goal and away from slippage towards a third-world status of under-educated, under-employed citizens. Perhaps the greatest investment in its future that America might make would be to give *every* school child and teacher a portable computer, from kindergarten through university levels.

Whether this ever becomes a reality, teachers using the information highway today must encourage students to use this technology in positive ways. Sadly, growing reports of online criminal activity and hate messages raise the issue of character education as yet another partnership with technology instruction. Online activities afford excellent opportunities to introduce components of peace and multicultural education into classrooms around the world, and present opportunities to empower students to feel personally responsible for and capable of doing good works, as teachers in this study have reported.

To use online activities most effectively, teachers will also need to watch for possible network addicted students (some examples reported in this study), and provide direct instruction regarding the difference between online facts, opinion, and propaganda, as well as the ethics of original work versus copying off of the network. Also, as technology sophistication grows, students and teachers alike may have difficulty distinguishing between "real" and "phony" online photographs and documents. Virtual reality technology may allow new learning opportunities previously unavailable because of physical danger from hazardous materials, curriculum complexity, or geographic limitations. These types of issues are emerging and changing our notion of how we teach in a high-tech world.

In addition to new notions of literacy skills, curriculum in general will have to be revamped in other ways. For example, one of the elementary teachers interviewed mentioned that she had a secondary-level colleague upset because her fourth-graders were learning at the same level of complexity as high school students. This was threatening to the secondary teacher who feared that when these fourth-graders reached her classroom, there would be nothing left for her to teach. Thus, this research indicated a possible downward shift in curriculum that could have a major effect at the secondary level in a few years.

Advance planning and retraining will be required if the needs of students like those fourth-graders are to continue to be met. This downward shift may be uncomfortable for teachers, yet it raises a vision of successful learning experiences at earlier ages and in ways not imagined previously. With more students using the Internet in kindergarten, the population that reaches high school nine years later may be more sophisticated learners than any previous generation. Perhaps they will be students who have become quite expert at learning how to learn anything desired whenever and wherever they wish. Teachers must prepare for these changes, and one area where additional leaders may emerge is from professional subject matter associations that have or need to establish and promote national networking, online curriculum sharing, and peer support systems. Additionally, related student organizations in subject matter areas might also play an important collaborative partnership in the implementation of telecommunications.

The African proverb, "It takes a whole village to educate one child," may also apply to the online global village. As classroom walls disappear with the windows to the world that the Internet offers, collaborative lifelong learning may know no boundaries. Bertrand Russell said: "The first step in wisdom as well as in morality is to open the windows as wide as possible." To achieve these goals, educators must be skilled Internet users and developers of curriculum that partners the best of educational reform models and the most sophisticated use of online technology. They must insure student opportunities to move beyond online information retrieval to gain in wisdom and morality in the spirit of "we're all in this together."

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Using Internet in Teacher Education: A Model for Constructivist Learning

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Dede and Griest allege that technology can facilitate school reform if it is used to support new models of teaching and learning (O'Neil, 1995; Griest, 1996). The social constructivist approach with Internet as a scaffold can provide this new model for reform. This paper presents a literature review as a foundation for the development of this new model.

Ways to support constructivist activities through the use of Internet by preservice teachers and inservice teachers in the K-12 classroom are examined. The principles of constructivism are presented first. The four general ways in which Internet can be used to support a constructivist classroom are presented next. The paper concludes with examples of modeling constructivist approaches using technology in teacher education.

The University of Colorado at Denver, School of Education maintains good Web sites with links to information about constructivism in education (http://www.cudenver.edu/~mryder/itc_data/constructivism.htm) and information about teaching and learning on the Internet (http://www.cudenver.edu/~mryder/itc_data/net_teach.htm).

Defining Constructivist Learning

Roblyer, Edwards, and Havriluk (1997) in their new text for technology education identify the following characteristics of constructivist learning:

- Authentic problem solving activities
- Wide variety and format of resource of materials
- Collaborative work groups
- Emphasis on the process of problem solving rather than the product
- Authentic assessments with qualitative methods such as portfolios

A constructivist classroom provides students with an information rich environment where they can actively manipulate and synthesize information to construct their own knowledge (O'Neil, 1995; Ryder & Wilson, 1996; White, 1996). As a result of this new environment, the role of the teacher changes from an information provider to a facilitator of learning (Nicaise & Barnes, 1996). Authentic learning experiences are provided through collaboration within the classroom community, the local community, and the global community. Active learning through the manipulation of information and interaction with others on Internet anchors learning to genuine tasks in situated contexts (Ryder & Wilson, 1996).

Internet Activities for Constructivist Learning

The constructivist model is supported by four general categories of activities that integrate Internet into the classroom. Harris (1994) divided educational telecommunication activities into the following three categories: interpersonal exchanges, information gathering, and problem solving projects. Harris' three categories have been adapted for this paper and a fourth category, content generation, has been added as Web publication has become easier and more accessible. These four categories address the characteristics of constructivist learning set forth in this paper. The categories are as follows: computer mediated communications (CMC), resource retrieval, collaborative projects, and content generation. Each of these categories is explained with K-12 examples as illustrations.

CMC in education usually means communication through e-mail, listservs, or newsgroups. Students can discuss real problems and gather information from other students and experts in relevant areas. CMC may be enhanced to include desktop conferencing using digital video over the Internet with CU-SeeMe software. Students at Rocky Run Middle School in Chantilly, Virginia, and students from three schools in New Zealand used CU-SeeMe to access health information prepared by two medical doctors from the University of Otago (Todd, 1996). Students first used e-mail to become acquainted and teachers used e-mail to plan student activities. Another CU-SeeMe activity between the schools was the production of a news show at each site that featured fashion, movie reviews, sports, weather, and local, state and national news. These students were engaging in collaborative authentic problem solving activities. Assessment was based on an authentic activity.

The second category is retrieving resources from the Internet. The number of text objects on the World Wide Web has increased from several thousand to several million during the past two years (Ryder & Wilson, 1996). Access to information is the first step in knowledge construction. Internet provides a multitude of information on a wide variety of topics and in many formats. Gleaning useful information from the plethora of available information requires advanced searching skills. Students need guidance learning effective use search engines and search trees and in how to refine searches to reduce the number of hits (Brehm, 1996). Once relevant information is located, the validity of the source must be evaluated. Kathleen Schrock maintains a Web page with links to guidelines for the evaluation of Internet information (http://www.capecod.net/Wixon/eval.htm). Harris (1995) reports on a student research project using the Internet and describes a 13-step process for interpretation and application of information.

The third general category of constructivist Internet activities is collaborative projects. An authentic problem is proposed on the Internet. Classrooms sign up to participate by gathering data or information from that site. When all the data are gathered, they are analyzed by the students and hypothesis or problems are confirmed, modified, or rejected based on the data. The results and conclusions are evaluated by the participants (Brehm, 1993). Educational projects encourage collaboration and community development both on site and at a distance. Emphasis is on the process of problem solving with the process and the conclusion providing information for reflection. Assessment is embedded in the project and can be monitored through the decisions made during the project.

Brehm (1993) describes the "Most Livable Places" project in which students from sites around the world suggested factors that make a place livable. After a discussion of the factors, students at the host site developed a survey for ranking each site on livability. Sixteen sites around the world rated their site according to the survey. A lively online discussion followed the survey summary. Students debated the criteria used by individual sites to determine the ratings and whether or not rural sites were fairly rated since they had very few fast food restaurants and rock concerts. Data was collected on pre- and post-test questionnaires and from classroom observations. The two middle school classes participating in the "Places" project ranked significantly higher in problem solving ability and had more time on task than the four other middle school classes. Four control classes in the same school district studied similar information but did not participate in the telecommunications project.

Students can generate content for the Internet by publishing in electronic magazines, posting a web page, or posting a summary of information such as an interview with an expert (D'Iganazio, 1996; Nicaise & Barnes, 1996). Students create content in areas that they have selected and publish for a real audience. Ryder and Wilson (1996) suggest that students create Frequently Ask Questions (FAQ) web sites on topics of interest such as snow boarding or roller blading. D'Ignazio (1996) suggests publication on an intranet, a small private network for a school. Students reap the benefits of publishing pictures and information with personal identification for a real audience within their school but without the risk of making their identification accessible to strangers.

State of Technology in Teacher Education

Even though teachers value the use of technology in education, they do not feel that teacher preparation programs adequately prepare them to use technology in the classroom (O'Neil, 1995; Topp, 1996; White, 1996). The U.S. Congress, Office of Technology Assessment (OTA, 1995) study found that most teachers who do use technology use it in traditional ways. Dede (O'Neil, 1995) predicts that if schools do not effectively use technologies, a decade from now many students will join the growing trend of independent schooling and the voucher system. Public schools will educate only a few of the most difficult and poorest students. Teacher education programs need to integrate technology if they are going to continue to attract students and meet NCATE standards (Barksdale, 1996).

For preservice teachers to utilize the rich resources of Internet during field experiences and as new teachers, they must be adequately prepared in technology and must see technology integration modeled during methods classes. About 50% of teacher education programs require students to take a technology class and another 35% offer an optional class (Topp, 1996). The 50% that do not require a separate class report that they integrate technology instruction into methods classes. Over 85% of the recent graduates that he surveyed (n=135) who did not take a technology class rated their preparation in technology as inadequate or very inadequate. Roblyer (1994) suggests that while technology integration into methods classes is the ultimate goal, he found that successful integration is infrequently achieved.

Over two-thirds of Topp's respondents rated the importance of an educational computing class as "should be required." Another 26.7% selected "very important." Ninety-two percent of White's (1996) survey of 387 preservice teachers rated technology integration as "definitely important in teacher education."

The OTA study (1995) reports the training that teachers do receive often focuses on the mechanics of operating computers rather than on the classroom uses of technology.

An example of this approach is the practice of giving students Internet accounts in college but not teaching them to use Internet to search for resources (Barksdale, 1996).

The OTA study (1995) also reports that 66% of teacher education faculty members reported some anxiety about working with information technology and that those faculty were likely to communicate this anxiety to their students. Professors, preservice teachers, and teachers need working models of technology infused constructivist classrooms (Nicaise & Barnes, 1996). The results of two recent surveys (Topp, 1995; White, 1996) call for more modeling of computer use in preservice education methods classes. White suggests modeling by using technology to teach and by having students apply technology in class projects and field experiences. Cotty (1996) concludes that teacher educators must find ways to model constructivist activities so that their preservice teachers will incorporate active learning into their teaching. The remainder of this paper focuses on how teacher educators can model the constructivist approach through the use of Internet in classes.

Modeling Internet Activities for Constructivist Learning

Nicaise and Barnes (1996) used technology to assist students as they employed constructivist methods to develop a geometry curriculum in a mathematics methods class. Groups of their students engaged in collaborative activities which illustrate three of the four categories of Internet use. Examples of relative and reproducible activities from other methods classes are included under each category. This is not an exhaustive literature search but rather selected examples of how constructivist activities using Internet are modeled in education methods classes.

During the mathematics methods class, some students used an online address book of U.S. Teachers to initiate communication with practicing teachers (Nicaise & Barnes, 1996). One such connection was with a mathematics teacher in Hawaii who shared examples of constructivist tasks and assessment from his classroom. This is an example of the use of CMC to connect with online experts in an authentic problem solving activity.

Another study involved 11 English student teachers and two professors (Thomas, Clift, & Sugimoto, 1996). Two university classes were also delivered on site. Each student received a laptop computer with an internal modem to use for the semester. As part of these two classes, students were required to submit assignments online. Each week they submitted responses to required articles, one question per chapter, lesson plans, and classroom journals. These students reported using Internet primarily because it was required for the class.

Sixteen elementary students and five professors from Appalachian State University participated in a year long telecommunication project. During the first semester, one-half of each day was spent in a university class and half in a K-12 classroom. The second semester 10 weeks were spent student teaching in the same K-12 classroom. Students were required to send two e-mail messages per week. General education topics such as describing the reading or language arts program in their classroom emerged as the focus of a significant number of messages. These researchers found that professional conversation occurred spontaneously through e-mail. They conclude that this conversation has the potential to strengthen and vitalize teacher preparation (Schlagal, Trathen, & Barton, 1996).

Technology can provide the infrastructure to support teachers who use collaborative and constructive learning. The teacher no longer has to know all of the information but instead needs to know the process to access information (O'Neil, 1995). Retrieving resources from the Internet allows students to spend more time on higher level reflective thinking and less time gathering and organizing information (Nicaise & Barnes, 1996).

Merideth and Williams (1996) first teach an introductory lesson using search engines and setting bookmarks. Then their language arts methods students use search engines to locate and bookmark at least four resources that can be incorporated into a lesson plan. Students construct meaning by evaluating the information through sorting, sifting, and saving only what is important. They directly cut the pertinent information from the Web site and paste it into a database. The finished lesson plans incorporating web information are published on the web. Nicaise and Barnes (1996) have their students find and retrieve geometry lesson plans which are then evaluated for classroom use.

Collaborative projects using telecommunications became popular about ten years ago on the FrEdMail network. That network, now the Global SchoolNet Foundation (www.gsn.org), continues to facilitate problem solving projects and continues a highlight listing of excellent projects.

The book, *James and the Giant Peach,* provided authentic context for a collaborative project between a fourth grade class and an elementary methods class at Otterbein College in Ohio. The college students posed weekly discussion questions focusing on James' travails. Elementary students evaluated activities from the college students' proposed lesson plans. Fourth grade students provided feedback about the ease of understanding, reading level, and appropriateness of the lesson plans. Thus, assessment for the college students was incorporated into the lesson plan development (Barksdale, 1996).

Cotty (1996) in a capstone class, School and Society, had students design and analyze a cooperative distance learning project for fifth grade students. They communicated with classroom teachers for feedback while designing the project. During the class students maintained portfolios which included ideas, feelings, insights as well as a record of information exchanges, data valuation, and feedback from peer partners at various stages of project completion. She suggests that distance learning in her classroom supported the constructivist paradigm by actively engaging the students in constructing their own knowledge including the incorporation of input from distant sources. Inclusion of distance learning made the content personally relevant and encouraged self-regulated learning.

Publishing Web pages has become popular in teacher education as well as in other areas. Data is not yet available on the benefits of publication versus the time involved learning to write HTML code or to use an editor. As programs such as *Adobe PageMill* for the Macintosh and *Microsoft Front Page* for Windows computers become more sophisticated and more common in the schools, web publication is likely to blossom.

Classes of several teacher educators included in this paper posted completed projects to Web sites. Students from the Geometry methods class created a web site to publish the math curriculum that they had developed for others to use as a resource. Nicaise and Barnes (1996) see this project as an authentic activity for a real audience. As such, they conclude that the ownership of knowledge is returned from the teachers back to the students. They also suggest that a significant amount of teacher time was spent monitoring students by demonstrating resources and posing questions. Teachers learned new assessment procedures and imbedded assessment into activities throughout the semester.

As direct Internet access becomes widely available in K-12 classrooms, students have access to information rich environments which support knowledge construction. For new teachers to use technology, they must see it modeled in college classrooms. This paper has presented a theoretical structure for the connection between constructivism, technology, and teacher education. It concludes with examples of teacher educators who are currently modeling constructivist Internet activities in the teacher education classroom.

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JUST-IN-TIME PROFESSIONAL DEVELOPMENT USING THE WORLD WIDE WEB

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Teachers in North Carolina are required to participate in inservice professional development as a part of a five-year licensure renewal cycle. This training normally takes the form of workshops conducted at a central site over the course of several days or even several weeks, typically during the summer months. Drawbacks to this type of staff development include the time and money required for travel to the workshop site; the artificiality of professional development done in isolation of the classroom, wherein teachers must wait until the school year begins again to apply their learning; the logistical problems of attempting to support teacher change once teachers have returned to their schools; and the difficulty inherent in trying to keep teacher training current in a discipline such as mathematics education where knowledge and practice are rapidly evolving.

This paper discusses a World Wide Web site being piloted for teacher training to address the above shortcomings. Using this technology, just-in-time professional development and support is available to teachers at their home or school during the school year, and the online training and resource materials can be updated on a continual basis to maintain teacher awareness of current trends. Further, sufficient interactivity can be built into the system so that teachers feel that they are a part of a community of educators despite potentially being the only workshop participant at their school.

Background

Brush, Knapczyk, and Hubbard (1993) identified some important aspects of distance performance support systems intended for use with practicing teachers:

> ...a support system for distance instruction would need to aid in the delivery of the content of the training, to provide a mechanism for interaction between instructors and students, to offer options for feedback about assignments and projects, and to give the program staff alternatives for evaluating the training and maintaining quality control over activities. (p. 39)

Schrum (1996) elaborates on the need for balance in a telecommunications environment, noting that "Freedom to explore and investigate individually is important, but some structured activities and minimal weekly requirements are also essential" (p. 422). As Mandviwalla and Olfman (1994) suggest, users should also have the capability to meet synchronously or asynchronously, as appropriate, and the tools for carrying out these interactions should be contained in a single system.

The Mathematical Sciences Department at the University of North Carolina at Wilmington (UNCW) is currently piloting a World Wide Web site called INSTRUCT, which stands for *I*mplementing the *NCTM* School *T*eaching *R*ecommendations *U*sing *C*ollaborative *T*elecommunications (http://instruct.cms.uncwil.edu). INSTRUCT is intended to assist high school mathematics instructors in implementing the National Council of Teachers of Mathematics *Professional Standards for Teaching Mathematics* (NCTM, 1991) while providing them with the opportunity for reflection through dialogue with colleagues (Novick, 1996). INSTRUCT's design integrates hypermedia training materials with aspects of groupware, or software intended to support group interaction, to expand its use beyond being simply a storehouse of instructional material.

INSTRUCT's Design

Following is a listing of the options available through INSTRUCT with a description of their function:

Check Here for the Latest News

This option gives training coordinators a means of making announcements of online meetings and other events which do not necessarily require responses from trainees.

A Hypermedia Version of Standards for Teaching Mathematics (NCTM, 1991)

This choice links users to a Web page with the following menu items: Worthwhile mathematical tasks, Teacher's role in discourse, Tools for enhancing discourse, Student's role in discourse, Analysis of teaching and learning, and Learning environments. Each of these items link to Web pages which employ multimedia to provide the user with an introduction to the NCTM Standards for Teaching Mathematics using authentic classroom activities and materials.

Each sub-menu page contains its own Check for Understanding form for users to fill out and submit to training coordinators in order to assess mastery of the standard. Assignment of licensure renewal credit is in part dependent on successful responses to questions about the standards and on teacher reports about their implementation of classroom activities intended to reflect the standards.

Online Educational Resources

Choosing this menu item takes the user to a table of links for education-related sites on the World Wide Web. Sites are grouped by category, such as Geometry and Chaos, History of Mathematics, Lesson Planning, National Agencies and Information Sources, Statistical Data Sources, and Technology Resources. Additionally, this page provides direct links to the North Carolina Department of Public Instruction and K-12 Schools online.

Attend a Meeting

Choosing this menu item launches "Netscape Chat," connecting users to the Internet Relay Chat server located at UNCW. As indicated above, trainees are given assignments to carry out in their own math classes in order to promote teacher active participation in and application of INSTRUCT training. An intentional by-product of these assignments is to encourage the need for sustained interaction and collaboration among participants and coordinators (Honey & McMillan, 1994). The meeting option provides a means for teachers both to brainstorm and to reflect together on implementing the standards in their classes, and for INSTRUCT training coordinators to provide additional professional development materials and support to users. Participation in these meetings is another requirement for receiving licensure renewal credit.

Join in a Discussion

This option connects users to a threaded hypermail message board (WWWBoard) allowing them to communicate asynchronously with other INSTRUCT users at their own convenience. The format benefits teachers by involving them in more long-term discussions about issues raised in the NCTM Standards, by providing just-in-time support for implementing instructional changes in their classes, by facilitating the sharing of news and other items of interest between colleagues, and by affording users continual access to previous communications via discussion histories.

Send a Message

This choice provides Internet mail access for communicating privately with a training coordinator.

Pilot Project

During fall semester 1996, four mathematics teachers from two counties in southeastern North Carolina have been involved in an INSTRUCT pilot project using their home computers. The project has been granted licensure renewal credit by the state Mathematics and Science Education Network in recognition of the time participants will be spending online using INSTRUCT. Each teacher received face-to-face training during summer 1996 in navigating the Web, publishing Web pages, and communicating synchronously using "Netscape Chat." As a part of their training, teachers meet online before and after the implementation of each standard in their classes. Following the final meeting for a standard, teachers are required to complete a Check for Understanding form summarizing their comprehension of and experience with the standard.

The teachers have been enthusiastic about sharing teaching ideas during online meetings and have been equally diligent about reading and responding to messages posted in the discussion area. Records being kept as a part of the project include messages posted in the discussion area, transcripts of online meetings, and submissions from the Check for Understanding forms and the pre- and post-tests of Professional Standards knowledge. Initial results from the project provide a preliminary notion of the ways in which teachers benefit from just-in-time professional development using the World Wide Web:

1. Consistent Opportunities for Reflection and Sharing with Colleagues. Cohen, McLaughlin, and Talbert (1993) noted that "The only way we change our teaching is to talk to people who are also changing" (p. 93). For each standard, teachers have the opportunity to be engaged in two online meetings, one to discuss the hypermedia material and brainstorm ideas before implementation, one to reflect on implementation attempts and future applications. Additionally, teachers have unlimited access to each other through both the message board and e-mail. The asynchronous format allows for more prolonged and thoughtful exchange of ideas, as can be seen in the following excerpt from a discussion thread on the use of calculators:

> Teacher 1: What I said about hating the fact that students had been allowed to use fraction calculators is that even my Adv Alg 2 students have no idea whatsoever the concept of fractions. I kid you not that 70% of them could not tell me how to change 1 into 4ths and almost none of them could tell me how to divide the no. 2 by 3/2. They are completely oblivious as to how fractions work. They even struggle with canceling when multiply-

ing fractions as they never had to worry about canceling with the calculators.

Teacher 2: Yes, [Teacher 1] is correct. Fractions and the basic concepts are a weak link even in the 7th grade. They come to me lamenting about long division and fractions. Is the Explorer (fraction calculator) to blame? Maybe, in part....I suspect teachers are using those calculators for quick and easy answers, and students have gotten sluggish in their mental math...

Teacher 1: My main concern is that if kids don't understand the basics it is hard for them to interpret what the graphing calculator is telling them and gosh knows they can't tell if their answer is reasonable!

INSTRUCT appears to be promoting the formation and maintenance of a virtual community through its blending of synchronous and asynchronous communications tools, which when combined with online professional development materials and resources for lesson planning provide teachers with a rich, safe and self-sustaining environment for implementing changes in instructional practice.

2. Shortened Cycle for Training, Implementation and Evaluation of New Practices. The problem of attenuation of training between workshop and implementation is a constant cause for concern in traditional professional development (Guskey, 1986). A key aspect of professional development on the Web is the natural capability for conducting training during the school year, thereby giving teachers a realistic chance to plan classroom implementations that might be attempted the next day or the next week, instead of the next month. Further, with the ability to reflect on successes and failures with colleagues each week, it is more likely that implementation attempts will be sustained and not just one-time efforts. A project teacher noted in her Check for Understanding form that "INSTRUCT has become an essential element of my classroom planning. I have visited the resources and every week put something in my lessons that I want to try."

3. Teacher Empowerment through Direct Access to Information. Information access is, of course, one of the powerful elements of the World Wide Web generally. For teachers, this access is even more critical because of the oft-times isolated world in which they find themselves. The following online meeting transcript segment provides some notion of how the Web can make a difference in instruction:

Teacher 1: I did a technology problem this week to find the correlation between team batting avg and earned runs avg to games won. We used data from American League. Pretty cool with the World Series going on.

Facilitator: what year was the data from?

Teacher 1: Unfortunately 1988 was what was in the book....

Teacher 2: .How about current data from ESPNet?

Facilitator: Actually, that's not a bad idea.

The difference between 1988 and 1996 represents half a lifetime for high school students. Thus, the ability to use more current data in math classes can foster an increased sense among students of math's relevancy in their lives. The facilitator provided Teacher 1 with the Web address of ESPNet Sportszone, which contained 1996 statistics for both the American and National League baseball teams. This exchange ultimately resulted in a new INSTRUCT multimedia vignette on statistical analysis of data and determining lines of best-fit.

Some limitations to Web-based professional development have also been discovered in the course of the pilot project. Successful web-based instruction depends on the presence of self-directed learning (Shotsberger, in press), though it should be noted that self-direction in distance education is a function not only of the individual learner, but also the instructional facilitator and the sponsoring institution (Eastmond, 1995). Since teachers must essentially carry out an independent study of INSTRUCT's hypermedia materials, it is evident that those involved in this type of professional development need to be self-starters who desire to improve their classroom practices. Similarly, teachers must have a base of experience from which to evaluate and discuss ideas for classroom implementation. Pilot project teachers ranged in experience from two to 19 years of classroom teaching, with a mean of nearly 11 years. This type of technology would be of limited utility for the new teacher who possesses neither the time nor the maturity to take full advantage of the variety of resources offered.

A Model of Web-based Professional Development

Guskey (1986) has posited a model of teacher change resulting from face-to-face professional development. It is essentially a linear model wherein staff development impacts teacher classroom practice, which in turn influences student learning outcomes, finally resulting in changes in teacher beliefs. The present author has adapted the Guskey model to describe the unique characteristics of just-in-time professional development using the World Wide Web (Figure 1). This new model represents an initial attempt to represent and thereby better understand the complex dynamics of Web-based professional development and is intended specifically to serve as a guide for implementation of INSTRUCT on a wider scale.

The new model diverges from Guskey's in two fundamental ways. First, it takes into account the shorter cycle of training, implementation and evaluation of new practices, as noted above, by allowing for changes in teacher beliefs to affect future staff development efforts. Thus the new model is cyclical rather than linear. Second, an attempt has been made to display the effect that each of INSTRUCT's options has on the overall professional development cycle. Note especially that some elements of training carried out using the Web, such as Asynchronous Discussions, can both affect and be affected by various components of the cycle. The model will likely be modified and elaborated based on future applications of INSTRUCT with different user populations.

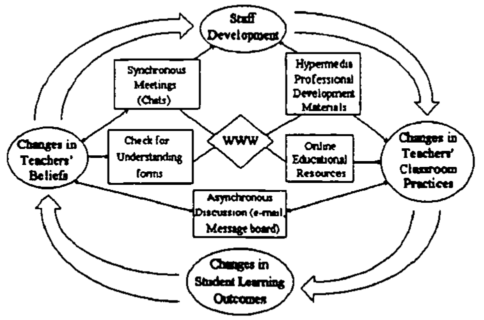

Figure 1. A Model of Just-in-time Professional Development Using the World Wide Web.

Future Plans

Brush et al. (1993) observed that for their performance support system, "...the formation of cohort groups of teachers was important not only to operate the program efficiently but also to produce ongoing benefits to the teachers after they have completed the program" (p. 40). Pilot project teachers agreed that they would benefit from continued use of INSTRUCT's resources throughout the remainder of the 1996-1997 school year. Teachers plan to meet online approximately every two weeks to report on their progress. INSTRUCT's hypermedia training materials and links to web resources will continue to be expanded to provide teachers with fresh ideas and perspectives.

The Mathematical Sciences Department at UNCW has been awarded a Dwight D. Eisenhower Professional Development Program grant for expanding the use of INSTRUCT in southeastern North Carolina. During spring semester 1997, a total of 21 high school teachers will be recruited from public and private high schools in three counties surrounding UNCW. The UNCW Science and Mathematics Education Center will coordinate a four-day, 24 contact hour summer program that will meet during summer 1997. This face-to-face portion of the project will emphasize participants becoming comfortable with navigating the World Wide Web and using both synchronous and asynchronous communications tools. Two high school mathematics teachers from the fall 1996 pilot project have been selected to act as lead-teachers for 1997. The 21 teachers from the summer sessions will continue their participation in the project by using INSTRUCT during fall semester 1997. During the distance training phase, participants devote a minimum of five hours online for each of the six standards, for a total of 54 contact hours devoted to the project.

Summary

INSTRUCT employs the capabilities of the web to provide math teachers with just-in-time professional development. INSTRUCT's features include a hypermedia version of the Standards for Teaching Mathematics (NCTM, 1991), links to online educational resources, an asynchronous discussion area, and the capability to meet synchronously using "Netscape Chat." Results of a semester-long pilot project involving four teachers using their home computers provided an idea of benefits associated with web-based professional development: consistent opportunities for reflection and sharing; shortened training cycle, implementation and evaluation; and teacher empowerment through direct access to information. A tentative model of just-in-time professional development using the World Wide Web was introduced representing the complex dynamics of this learning environment and guiding the expanded implementation of INSTRUCT.

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Considerations in Implementing an Internet Course for Teachers

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In the Summer of 1996, twenty-seven graduate students enrolled in a course at Bloomsburg University titled "Internet Applications for Educators." This was an experimental "hands on" computer course in which students explored the World Wide Web and studied the structure, organization, and use of the Internet, Internet tools and their potential. The students used a variety of applications through the use of Netscape including Telnet, FTP, Usenet News, Gopher, Internet Relay Chat, WAIS, and Intranet. Each graduate student constructed a personal Web page and made a personal "hotlist" of web sites. Students also studied the use of multimedia, video, and phone conferencing on the World Wide Web. Final projects, including web sites and hotlists, were mastered on a CD-ROM for distribution to class members. A web page was constructed to link all home pages of class members and to maintain future contacts with the teachers after they returned to the classroom. The students used *Internet for Educators* (1995) as a text and *The Educator's Internet Companion* (1995) as a reference.

Questions

Since this was an experimental course, it was designed to consider the following questions:

1. Is a separate course on Internet necessary for teacher training or should Internet be taught through integration into other graduate courses?
2. What content should be taught in an Internet course for teachers?
3. How can teachers avoid Internet information overload and use Internet as a classroom resource?
4. How should teachers have their students use Internet?
5. What are the problems associated with student use of Internet?
6. How can teachers and students use Internet with limited access to computers and computer labs?
7. How can teachers use personal web pages to enhance their teaching effectiveness?
8. What are the problems associated with the construction and maintenance of web pages?

Procedures

Individual interviews were conducted with the Internet course students during late fall by the course instructor to determine their classroom use of Internet. Seventeen of the 27 students who had completed the summer Internet course were teaching full-time in an elementary or secondary school. They were asked to respond to the following questions:

1. Do you use Internet as a resource for yourself? If yes, please describe.
2. Do you use Internet as a resource for your students? If yes, please describe.
3. Do you have access to Internet in the school? If yes, please describe.
4. Do your students have access to Internet at school? If yes, please answer the following questions :
   A. How many computers are available with Internet access?
   B. What types of activities are Internet used for during lessons?
   C. Does your school have special software for blocking specific web sites?
5. Do you have access to Internet at home? If yes, how often do you use Internet for school-related activities.
6. Do you use a personal web page for school activities? If yes, please describe.
7. Following is a list of topics from the summer Internet course. Please indicate if you used any of these areas during the last several months and indicate how you used them:

Internet Basics	Multimedia on the Web
Telnet	File Transfer Protocol(FTP)
Gopher	Usenet Newsgroups
Keypals	WAIS
Listserv	Technology Planning
Intranet	Web Page
Freenet	Instructional Design
Internet Relay Chat (IRC)	

8. What recommendations would you make for future Internet courses? Describe what topics should remain in the course and suggest new topics that should be added.

Results

Problems

Most of the teachers reported limited or no access to Internet in their schools. The availability of equipment and lack of support was a common problem. Many of the schools were planning to implement Internet access during the school year. Six teachers had Internet at home. None of the teachers had updated their class web page from the Internet course.

Classroom Use of Internet

Nine of the teachers reported the use of Internet as a personal resource for the classroom. Two of these teachers joined professional newsgroups and six used e-mail. Several teachers were taking leadership and initiative to implement Internet into their schools. Two teachers reported that their classes regularly visited a single Internet computer station in another part of the building. One teacher reported limited access to Internet for her entire class. She visited a classroom lab on three occasions to introduce the students to Internet basics. A follow-up survey will be conducted in the spring as schools begin to connect with Internet.

Recommendations

Following is a list of recommendations in consideration of Internet courses for teachers:

1. Due to the enormous amount of information, a separate course should be offered to teachers on Internet.
2. The content of the course should include the topics outlined in this report and should also consider new areas of Internet development.
3. Web page construction and use of multimedia and video on the Internet should be considered in an advanced course.
4. The focus of the introductory course should be to address the issues associated with Internet use in the schools. These issues are:
   - limited access to Internet for both students and teachers.
   - student access to uncensored information.
   - Internet training & support for teachers.
   - use of Internet with one computer, several computers, or an entire lab.
   - meaningful activities beyond Internet navigation which promote student learning, problem solving , and critical thinking.
   - using the unique characteristics of Web Sites which provide current and spontaneous information.

Summary

Although many faculty members do not embrace technology (Cummings, 1996), the teachers who completed the Internet course were beginning to use and explore the Internet in the classroom. However, the lack of access to Internet and Internet support is obviously a problem as schools begin to implement Internet technology into their curriculums. In addition to equipment, teachers need continued inservice training and collaboration with other educators to optimize the potential of Internet technology.

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CHILD MALTREATMENT: TRAINING EDUCATORS WITH INTERNET RESOURCES

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Educators in school settings serve as a critical first line of defense in assisting with the identification and prevention of child sexual abuse. Due to the extensive interaction between teachers and students during the school day, educators have an important opportunity to observe children, establish a reasonable level of suspicion, and report suspected incidents. However, teachers typically do not feel equipped to address their evolving role in safeguarding the emotional and physical well-being of children. Moreover, confusion over appropriate responses to victimized children has resulted in a pervasive failure of significant adults to protect children and ensure their safety.

This paper addresses the tremendous gap which exists between teacher training and the increasing demand for support of victimized children. Although there is a legal mandate for educators to report abuse and neglect, most teacher education programs make only a cursory mention of child maltreatment. Once in school settings, the majority of teachers are given no additional inservice training on this issue. If assisting vulnerable children is a priority for educational systems, then action must be taken to create a pool of educators with the skills to identify and respond to child abuse. Similarly, administrators need to develop their awareness of the legal and ethical issues associated with reporting maltreatment, including the psychological stress involved in the decision to report suspected abuse.

In order to bridge this rift, the investigators have explored the use of on-line resources for child maltreatment as a means to increase educators' awareness and understanding of child abuse and neglect. As mandated reporters of child abuse, educators may access references and interactive materials on the Internet while they improve their skills for identifying, reporting, and responding to suspected child maltreatment. The Internet allows teachers to link with on-line forums for professionals, gain information on relevant conferences and trainings, and access professional bulletin boards on child abuse issues.

Child Abuse Rates: A National Crisis

While reported incidents of child victimization continue to grow, accurate statistics on the prevalence of the problem remain elusive (Russell, 1983), and estimates regarding the scope of the problem vary. The National Center on Child Abuse and Neglect (1981) reports that barriers to identifying and reporting sexual abuse will continue to hamper the collection of precise data on the actual incidence and prevalence of child victimization. Early figures of the under-reporting of child sexual abuse estimate that only 20% of cases reach professional attention (Finkelhor, 1984). Barriers exist due to historical, sociocultural, and familial impediments to the child protection process.

The *Third National Incidence Study of Child Abuse and Neglect* (Sedlak & Broadhurst, 1996) reported that an estimated 2,815,600 children have been abused and neglected in the United States. Prevalence estimates range between 19% (Finkelhor, 1984) and 38% (Russell, 1983) of female children under age 18 have had sexual abuse experiences and approximately 9% (Finkelhor, 1979; 1984) of male children have been sexually victimized. As a guideline for educators to comprehend the pervasiveness of this issue Crenshaw, Crenshaw, and Lichtenberg (1995) estimated that during a three year period, teachers service between 60 to 400 children. "Even if just 1 in 10 students is being abused—a conservative estimate—most teachers would teach between 6 and 30 abused children over a 2-year period" (Crenshaw, Crenshaw, & Lichtenberg, 1995, p. 1110). Based on these figures, within a 2-year span each classroom teacher should be confronted with at least one suspicion of abuse which necessitates mandatory reporting.

The Role of the School

Schools represent an important system involved in safeguarding the well-being of children, and often are the first intervening system to interact with the victimized child, assess an incident, report suspected abuse, and provide supportive services for the child. All 50 states have reporting laws which identify school teachers and administrators as mandated reporters of child abuse to child protective service agencies. Despite this legal responsibility, educators typically remain unclear about applicable laws and reporting procedures. Even when teachers are aware of their mandatory obligations, they are significantly less likely to report sexual abuse than other education professionals (Crenshaw, Crenshaw, & Lichtenberg, 1995).

An integral role may be played by educators in this process; however, teachers lack confidence in their range of knowledge of abuse and their ability to provide appropriate intervention services to victimized children. Consequently, as society struggles to address the rising tide of incidents of child abuse, educators often find themselves inadequately prepared to confront the growing number of victims in the classroom.

Linking Educators to On-Line Resources

This training initiative focuses on introducing issues of child abuse to teachers. The purpose of this endeavor is to promote a clear understanding that educators, who may be among the first professionals to interact with a child during and following their victimization, should (a) serve as informed resources, by being knowledgeable about child abuse; (b) respond appropriately to the disclosure of abuse, including accessing crisis intervention for the child; (c) react appropriately to emotional and behavioral indicators of sexual abuse in the classroom setting; and (d) report suspected abuse to the proper authorities as required by mandated reporting laws.

By accessing Internet resources, teachers may be engaged in an exploration of child abuse and the role of the educator in supporting the victimized child. Through this training model, participants may explore mandatory reporting laws and ethical standards, discuss when and how to seek outside assistance in order to address issues related to victimized children, develop skills as liaisons between the school and community to create environments in which children may feel protected and supported, and discuss the impact of child victimization on academic and socio-emotional functioning, including common myths.

Based on the premise that child maltreatment can only be effectively addressed through a multidisciplinary decision making approach, educators are introduced to the use of the Internet as a means to participate as a member of a larger team of professionals and community members who are committed to stemming the tide of abuse. This is facilitated by exploring key Internet offerings on child victimization as well as their application to teacher education courses. Specifically, students are given the opportunity to access networks which distribute a substantial collection of policy information and research on child maltreatment. This expanded technology is then utilized to foster educators' interaction with professionals on child abuse and neglect. Through these linkages teachers may evolve a greater understanding of their roles and responsibilities in addressing child maltreatment and become part of the community of caring, informed professionals who are meeting the needs of vulnerable children.

Child Abuse Resources on the Internet

In order to mediate the risk of perpetuating myths and misinformation which are so prevalent in the field, the identification of relevant sites is a vital first step in the process of accurately informing educators regarding child maltreatment. Since the Internet is a dynamic and evolving medium, descriptions of sites quickly become outdated as information is continually updated and revised. Moreover, since numerous Web-sites are not refereed, it is important to direct teachers to links which are associated with major, reputable organizations and institutions which are promoting awareness of child abuse and neglect.

The authors have developed a recommended sequence of instruction using Internet resources to facilitate educators' understanding of salient issues. The epidemic of child victimization is emphasized through the *Executive Summary of the Third National Incidence Study of Child Abuse and Neglect* which is available at the NCCAN Site. The study results reflect a prevalence estimate of 2,815,600 children who have been abused or neglected in the United States. Further data on the crisis of violence against children is accessed via The Virtual Hospital Web-Site link to the U.S. Department of Health and Human Services report *A Nation's Shame: Fatal Child Abuse and Neglect in the United States: Executive Summary*. This information provides the background for the impact of this problem on children and establishes a context for the necessity of informing educators about their role and responsibility in identifying and responding to child abuse.

Once the problem of abuse is identified, teachers are introduced to guidelines on identification, reporting, intervention, and prevention. *Child Abuse: A Guide for Mandatory Reporters* which is available through The Virtual Hospital Web-Site provides educators with specific information on indicators of abuse, abuse categories, reporting law and procedure, issues of confidentiality, and the process of addressing the needs of a victimized child. Teachers also are directed to the NCCAN Clearinghouse Catalog where information on ordering free resources, including a user manual series with training guides for educators, can be accessed. Topics covered include why educators should be concerned with child maltreatment; how to recognize and report child maltreatment; what happens when a report is made; and how to implement prevention strategies.

NCCAN also offers specialized services to allow teachers to explore their own state statutes. As educators reflect on their state law and district guidelines, *Child Abuse: A Handbook for School Staff*, which is part of the Frontenac County Board of Education's Web site, serves as a guide for developing procedural information and resources on child abuse which is disclosed to or suspected by school personnel.

The following is a list highlighting a few informational sites which educators may access for information on child abuse and neglect.

Child Abuse on the Virtual Hospital.

URL: http://vh.radiology.uiowa.edu/Providers/ChildAbuse/CAHomepg.html

The Virtual Hospital was created by the University of Iowa through a grant of the National Library of Medicine. Patients, healthcare providers, and others can access medical departments, multimedia textbooks, and connections to other relevant sites. Approximately 250,000 contacts are made to this web site per week.

Within the Virtual Hospital is a child abuse home page that provides references and interactive materials designed to increase awareness and understanding of child abuse and neglect. This site was developed with the cooperation of the Iowa Child Protective Training Academy (CPTA), a multiuniversity collaboration that provides extensive training for child protective service investigators. Sources of information such as *Child Abuse: A Guide for Mandatory Reporters* and a multimedia textbook entitled *A Nation's Shame: Fatal Child Abuse and Neglect in the United States*, are available with the entire text on the Web at this URL. Additionally, this site connects to most significant child abuse Web operations, including the National Committee to Prevent Child Abuse (NCPCA), the American Professional Society on the Abuse of Children (APSAC), the National Clearinghouse on Child Abuse and Neglect, the National Center on Child Abuse and Neglect, the National Resource Center on Child Sexual Abuse, the National Child's Advocacy Center, and the Department of Health and Human Services.

The link to the American Professional Society on the Abuse of Children (APSAC) includes an introduction to the organization, information on APSAC publications, task forces, legislative relations, state chapters, and other APSAC activities. Additionally, registration forms for colloquiums can be accessed for printing.

Child Abuse Prevention Network

URL: http://child.cornell.edu

This site is an initiative of the Family Life Development Center at Cornell University. The network is dedicated to enhancing Internet resources for the prevention of child abuse and neglect, and reducing the negative conditions in the family and the community that lead to child maltreatment. The Child Abuse Prevention network has been awarded a 3-Star Rating by the Mental Health Network. Through the site, key resources identified as being of assistance to professionals addressing child maltreatment are described with suggested bookmarks in the area of child abuse prevention. Top web sites can be accessed, including APSAC; *Child Maltreatment* (APSAC's professional journal); National Data Archive on Child Abuse and Neglect (NDACAN), an extensive child abuse research database; LifeNET, an alliance for building a network designed to support all professions concerned with prevention of child abuse and other forms of child endangerment; Children's House, a resource being built to address program and research issues that affect the well-being of children; CD-Mom, a site of information for parents to make family life less stressful and more positive; child abuse listservs to keep track of intervention, treatment, and research within the field; and child abuse newsgroups which provide support for victims an perpetrators.

National Data Archive on Child Abuse and Neglect

URL: http://www.ndacan.cornell.edu or via Child Abuse on the Virtual Hospital (http://vh.radiology.uiowa.edu/Providers/ChildAbuse/CAhomepg.html) or via Family Life Development Center (http://child.cornell.edu/fldc.home.html)

This data bank is housed at Cornell University and is used to facilitate the secondary analysis of research data relevant to the study of child abuse and neglect. It serves as the major repository for key studies funded by the National Center on Child Abuse and Neglect (NCCAN). A listserv for child maltreatment researchers also originates at this site.

Kempe National Center on the Prevention and Treatment of Child Abuse and Neglect

URL: http://electricstores.com/kempe/default.htm

The Kempe Center has provided leadership in child abuse awareness, education, and the development of innovative programs. Its web site provides information on the history of the organization, Answers to Frequently Asked Questions by Parents and Other Consumers on Responses to Child Abuse, and information on Kempe programs.

Higher Education Center Against Violence and Abuse

URL: http://www.umn.edu/mincava

This web-site provides a wealth of information on publishers, journals, books, and handbooks which can be accessed on-line. Especially salient for educators is the link to *Child Abuse: A Handbook for School Staff* which is part of the Frontenac County Board of Education's Web site. This resource provides explicit guidelines for handling abuse cases within the school setting. Additionally, a site for *Voices for Children*, a non-profit book project on Child Abuse, provides access to true stories from the case files of a child abuse attorney.

National Clearinghouse on Child Abuse and Neglect Information (NCCAN)

URL: http://www.calib.com/nccanch/

This resource provides information on the prevention, identification, and treatment of child abuse and neglect. This site describes the latest materials from the Clearinghouse, including manuals, research reviews, studies, and reports. Information also may be accessed on up-dated statistics, child welfare, child abuse and neglect prevention, and state statutes. Additionally, this site allows links to the Clearinghouse Documents and Prevention Programs Databases. More than 22,000 records on child abuse and neglect can be searched and information on effective community-based prevention programs from around the United States can be found.

Conclusion

The pervasiveness of child abuse necessitates appropriate training of educators to fulfill their legal and ethical responsibilities in detecting, treating, and preventing child abuse and neglect. Moreover, school personnel are in a unique position to serve as advocates for children which may be an imperative function, especially when a parent is not either emotionally or physically capable of serving in this capacity.

Although educators are vital to the intervention effort, they do not function in isolation. Child abuse is a community issue which requires collaboration between community members and agencies. The Internet helps facilitate linkages between professionals by providing a forum for the exchange of essential information and innovative ideas.

In order to address the needs of victimized children, teacher education programs have an opportunity to create meaningful training experiences by reaching out to Internet resources for information. This initiative highlights the sharing of information among diverse professional groups with the common mission of promoting the positive growth and development of children. By joining forces with other agencies which advocate for young people, teachers may play a critical role in reaffirming the value of children.

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Web-based Teacher Professional Development: Current Implementations and Future Prospects

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This paper addresses opportunities and issues related to the use of the Internet and World Wide Web as an emerging channel for the delivery of preservice and inservice teacher professional development. The benefits and risks of using the Web as an educational delivery vehicle are explored from the perspective of two systems specifically being developed to address the needs of practicing teachers. The authors are involved with two Web-based projects that are using the Internet as a development platform to carry out teacher professional development at a distance. An overview of each of these projects, and future prospects for Web-based teacher professional development, are briefly described in this paper.

UNCW INSTRUCT Project

The Mathematical Sciences Department at the University of North Carolina at Wilmington (UNCW) is currently piloting a World Wide Web site called INSTRUCT, which stands for *I*mplementing the NCTM *S*chool *T*eaching *R*ecommendations *U*sing *C*ollaborative *T*elecommunications (http://instruct.cms.uncwil.edu). INSTRUCT is designed to introduce high school mathematics instructors to the National Council of Teachers of Mathematics *Professional standards for teaching mathematics* (NCTM, 1991). INSTRUCT's design integrates aspects of groupware, or software intended to support group interaction, to expand its use beyond being simply a storehouse of instructional material. INSTRUCT provides teachers with hypermedia training materials, links to online educational resources, as well as the capability for users to communicate both synchronously and asynchronously, as appropriate.

During fall semester 1996, four mathematics teachers from two counties in southeastern North Carolina have been involved in the INSTRUCT pilot project using their home computers. The project has been granted licensure renewal credit by the state Mathematics and Science Education Network in recognition of the time participants will be spending online using INSTRUCT. Each teacher received face-to-face training during summer 1996 in navigating the Web, publishing Web pages, and communicating synchronously using a text-based chat tool.

During the pilot project, trainees work on six professional standards, including meeting online before and after the implementation of each standard in their classes and completing a Check for Understanding form summarizing their comprehension of and experience with the standard. Records kept as a part of the project included messages posted in the discussion area, transcripts of online meetings, and submissions from the Check for Understanding forms and the pre-and post-tests of Professional Standards knowledge.

INSTRUCT's initial results are very promising. INSTRUCT appears to be capable of promoting the formation and maintenance of a virtual community through its blending of synchronous and asynchronous communications tools, which when combined with online professional development materials and resources for lesson planning, provide teachers with a rich, safe and self-sustaining environment for implementing changes in instructional practice. During 1997, use of INSTRUCT has been expanded to include twenty-one teachers from southeastern North Carolina whose training is funded through a Dwight D. Eisenhower Professional Development Program grant.

NDSU/US WEST Multimedia Project

With financial support from a US WEST Foundation grant awarded to North Dakota State University's (NDSU) School of Education/Tri-College University's Educational

Administration program, a consortium of universities and school districts are developing a multimedia training program for teachers. The project, "Collaboratively Created Multimedia Modules for Teachers" (http://www.ndsu.nodak.edu/~stammen/uswest), is developing and implementing a series of Web-based multimedia modules to assist K-12 teachers and university teacher educators to integrate multimedia education and training into their day-to-day teaching activities.

The primary objective of the NDSU/US WEST project is to develop competency-based training modules for preservice and inservice education through a systematic curriculum and instructional development process. The SCID (Systematic Curriculum Instructional Development) model for curriculum development from the Center for Education and Training for Employment (CETE) at The Ohio State University in Columbus, Ohio, was chosen for this purpose. The SCID process involved selecting a group of experts with varied backgrounds (computer technicians, multimedia specialists, curriculum developers, classroom teachers, teacher educators, students, administrators, and practitioners), and asking them to collaboratively describe and develop the tasks needed for successfully using multimedia in the classroom. During summer 1995, a group of 24 people were trained by the Ohio State CETE personnel to develop a series of learning guides for a competency-based curriculum in using multimedia in the classroom. This group identified the following seven duties during this process:

1) Acquire Basic Computer Skills
2) Improve Curriculum with Multimedia
3) Deliver Instruction with Multimedia
4) Utilize Support Services
5) Improve Teacher Communication with Multimedia
6) Promote Multimedia in the Classroom
7) Pursue Professional Development

The modules (duties), which are comprised of learning guides (related tasks), have become the competency-based curriculum package.

During summer 1996, technical designers proceeded to put the learning guides into electronic form (i.e., code them in the hypertext markup language) for access via the World Wide Web. Allowing access to these learning guides over the Internet was seen as an important step. Although many of North Dakota's teachers are geographically isolated, they are connected to the global Internet. Thus, turning the learning guides into Web-based documents made it possible to have them accessed and used at a distance.

Currently, we are in the training and implementation phase of this project. This phase activates the training plan, its evaluation, and documents learner achievement. Our initial program evaluation is still underway and the project's impact on the learning environment in North Dakota's schools and universities remains to be seen. Evaluations from the SCID training sessions have assured us that the project has already motivated and enlightened approximately thirty educational professionals. Approximately twenty-four K-12 school districts have agreed to participate in this project. We expect that, as the project reaches these districts, hundreds of teachers will be affected by this project.

Future Prospects for Web-based Professional Development

We believe the experiences and lessons learned from the Web-based teacher professional development projects described in this paper can be successfully applied to other educational systems as well. Already today, the explosive growth of the Internet is having a dramatic effect on the way teachers and educators view professional development. We are seeing many ways in which multimedia systems can be used to enhance education at a distance (Stammen, 1995). Remote and collaborative teacher education is just one of the many applications for this emerging technology.

Teachers are embracing the World Wide Web in increasing numbers. The network and software technologies needed for carrying out effective group and collaborative work applications over the Internet will continue to mature and evolve in the next few years, but there are also many remaining challenges. For example, it is still not well understood how the roles of instructor and learner change as professional development is carried out at a distance (Shotsberger, in press). Although the potential for multimedia training systems in teacher education is great, we must still address social concerns in order to build successful systems. It is also imperative that systems designed for teacher use do not become so sophisticated that they are rendered unusable on the hardware typically available to educators (Shotsberger, 1996). This limitation will likely persist in the near-term and needs to be given serious consideration by Web site developers.

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Teaching GIS via the World Wide Web: A Distance Education Experiment

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Over the past three years the University of Delaware and the University of Agriculture ("VSP" in Slovak) in Nitra, Slovakia, have exchanged faculty and graduate students in various management disciplines. This program, funded by a grant from the US Information Agency, established an Institute of Business Development and Management (IBDM) at the College of Economics and Management at VSP. A primary objective of the IBDM program was to "support interdisciplinary empirical analyses of local/regional resources and their development." This objective "grew out of the recognition that a holistic approach is needed to assist in the restructuring of the Slovak economy" (IBDM, 1995.). The IBDM program also financed the purchase of computers and other instructional materials for VSP.

Several faculty members visiting Delaware from VSP were introduced to research in Geographic Information Systems (GIS) at the University of Delaware's Spatial Analysis Lab, and later requested that I teach a short course in GIS at VSP under the auspices of the IBDM program. During the summer of 1996 I prepared a GIS lab design and a short-course curriculum for VSP. In October 1996, I spent three weeks in Nitra establishing a computer lab for GIS and initiating an experimental GIS training program under the sponsorship of this project.

A GIS supports geo-referencing, display and analysis of various types of geographic data derived from digitized maps, global positioning systems, airphotos and/or satellite imagery. GIS technologies are used to model a wide variety of natural and human-generated spatial processes, including drainage and erosion problems, habitat requirements of particular species, transport mechanisms and fates of environmental pollutants, land use changes, etc. The power of a GIS lies in its ability to combine and analyze spatial relationships in data from diverse sources.

GIS technologies are of particular interest in Slovakia, since the country's emergence from communism in 1989 has led to widespread privatization of land resources. Slovakia also faces significant environmental problems, including toxic waste problems from communist-era industrial sources, contamination of aquifers and waterways from agricultural chemicals and fertilizers, increasing traffic congestion and air pollution from both factories and automobiles. The country is still developing the institutional framework to deal with these problems, and has urgent need for GIS technologies to ensure that new environmental protection policies are efficiently designed and targeted. The purpose of this project was to establish a core capability in GIS at VSP from scratch.

GIS technologies are typically expensive and difficult to learn. The typical GIS lab requires a start-up investment of at least $50,000 for computer hardware, software, data acquisition, technical training, in addition to employee salaries. Depending on the complexity of the problems to be analyzed and the availability of local GIS data, it may take anywhere from three months to two years for the lab to reach a satisfactory level of productivity.

Unfortunately, VSP itself has almost no money for computer workstations, expensive commercial GIS software or GIS data acquisition, and the IBDM program budget could only provide minimal funding for this project. While the IBDM program could have funded me for additional time in Nitra, I could only spend three weeks away from Delaware. Thus the principal challenges were (1) to build a functional GIS lab and develop a basic set of local GIS data at minimal cost, (2) teach GIS skills to a core group of students over three weeks, emphasizing the transferability of those skills to other students, and (3) establish a distance-learning program to support the continuing development of GIS capabilities in Nitra after the termination of the Delaware/VSP project in November, 1996.

The basic objective of this project was to create self-sustaining GIS research and teaching capabilities at VSP. The project targeted an initial group of students who began training in October. This class was intended to produce a core group of GIS users who will eventually train other students in the GIS lab using local Web training materials, and who can revise these Web materials as VSP's GIS capabilities continue to develop.

GIS Lab Configuration

The GIS laboratory was developed around a 120 MHz Pentium PC reconfigured as a UNIX server. This server runs GRASS 4.1.3, a UNIX-based public-domain GIS developed by the Construction Engineering Research Lab, US Army Corps of Engineers. Like many GIS's, GRASS handles both raster and vector data structures. A raster data structure represents sets of geographic features as values in numeric arrays representing regularly-spaced points in a grid covering a geographic area. A raster structure is most appropriate for modeling continuous surfaces or storing scanned image files. A vector data structure represents geographic features by sets of coordinates defining each feature's shape or outline. Vector data are easier to plot on conventional hardcopy devices. GRASS is a fairly comprehensive collection of raster manipulation functions, raster analytics, image processing tools, vector functions and raster-vector-point conversion utilities.

The server's operating system is Linux (Slackware 3.0 release), a shareware UNIX operating system for personal computers, including full X-window functionality via Xfree86 (8-bit color) and various shareware X utilities, and full network functionality. Networked PC's can access the server using any standard X emulation software. Two unused X-terminals were located and networked to the server. VSP provided the Pentium microcomputer as well as the spare cabling and X-terminals. The Delaware/VSP project purchased extra RAM and an additional 1.6 GB hard disk for the server locally for less than $400. The server's IP address is 193.87.98.7, with the registered name gis.uniag.sk. Unlike most GIS labs, the VSP GIS lab setup does not include any hardcopy output device. This reflects both budget limitations as well as an emphasis on GIS for spatial analysis rather than cartographic production. Although the lab is indirectly networked to a standard black-and-white laser printer, College policy restricts student access to this printer in order to minimize costs of paper and toner. The College network has no color printer. Consequently, students are encouraged to prepare their GIS work for presentation on the World Wide Web rather than on paper. This offers several advantages over hardcopy: students are not charged for paper and toner; they can prepare presentations more quickly, combining text with in-line color maps; and submission of work via the Web avoids costs and delays of mailing work from Slovakia to the US. The student Web pages are now served from a separate Linux server in the College (pefstud.uniag.sk) accessible through the main GIS WWW page at VSP, sun.uniag.sk/macknzie/public.html/. To maintain its computational efficiency, the GIS server itself does not double as a Web server.

The lab setup benefited from extensive volunteer assistance provided by interested VSP faculty members and students. An undergraduate with extensive (self-taught) knowledge of Linux oversaw the configuration of the server. The College's computer systems administrator took charge of the network connectivity and X-terminal configuration. Pre-compiled GRASS software and various GIS data in native GRASS format were brought from Delaware on CD-ROMs and installed directly onto the server. The complete lab setup required five days and approximately 100 work hours.

Data Sources

The critical element in any GIS is data. The official CERL distribution of GRASS includes a fairly extensive GIS data set for two 7.5-minute quads around Spearfish, South Dakota, US, including digital elevation models (elevation data at regular grid sampling intervals), geology, soil, vegetation, streams, roads, etc. This data set reflects the wide range of public data available for the continental US, and is very useful for teaching principles of spatial logic and map algebra. Unfortunately, the available GIS data for Slovakia are extremely limited.

The IBDM program funded the purchase of two sets of satellite imagery for southwest Slovakia where Bratislava (the capital), Nitra and most of the country's prime farmland are located. For a base map, I acquired geo-referenced August 1986 Landsat Thematic Mapper satellite imagery from USGS's EROS Data Center. These data are comprised of 7 spectral band files—3 visible light bands and 3 near/mid-infrared bands at 30-meter pixel resolution and one thermal infrared band at 120-meter pixel resolution. These data were resampled by EROS to UTM coordinates (World Geodetic Survey 1984 datum) using well-defined ground control points. Total cost of these data was $425. The geo-referenced Landsat TM imagery are currently being used to create a series of digital vegetation and land-use maps. They also support geo-referencing of other GIS layers.

The project also acquired raw July 1994 SPOT multispectral imagery for a 65 x 65 KM region to the southeast of Nitra. The 3-band SPOT image data (near infrared, visible red and green bands) underwent initial processing in Delaware, and then ftp'ed to Nitra and geo-referenced to UTM coordinates using reference points from the Landsat imagery. Total cost of the SPOT data was $975.

Additional GIS data include 30-arc-second digital elevation model (DEM) data for Europe, developed by EROS in lat-long coordinates, and distributed by EROS from edcftp.cr.usgs.gov. For congruence with the satellite imagery, these data were resampled to UTM coordinates. The DEM data are readily analyzed to create terrain slope and aspect maps, as well as 3-dimensional terrain models.

These data also support delineation of watershed divides, calculation of overland drainage volumes and inferred drainage channels, analyses of erodability, etc.

These GIS data resources were intended to increase both the local relevance and the functional value of the course. The fully processed standard sample data from the US allowed students to experiment with GRASS's various analytic functions. The raw local data let students learn the fundamentals of GIS data development—radiometric and geometric correction of raw imagery, image processing and classification, terrain modeling, etc. In reality, most GIS professionals spend far more time on data development than data analysis.

One fifth-year student at VSP is using the 1986 Landsat TM imagery and 1994 SPOT multispectral imagery to support thesis research into recent cropland fragmentation patterns in southwest Slovakia. Most of this fragmentation is associated with privatization of Slovakia's collective farms since 1989. Among other things, this research can help identify the effects of ongoing privatization of agricultural land on water quality.

Course Syllabus and Software

VSP students attended 14 2-hour class sessions combining lecture, demonstration and hands-on lab exercises over three weeks. The classes included introductory sessions on the UNIX operating system, GIS data structures, and projection systems (all taught while the lab was being set up); GIS display techniques; map logic; raster manipulation and analysis functions; on-screen digitizing; satellite imagery acquisition, processing and classification (using the imagery of Slovakia); and HTML basics for student project presentations via the World Wide Web.

Students are required to complete at least two of four assigned projects which run the gamut of GIS operations. The first project involves determination of optimal habitat areas for an endangered species which prefers proximity to fast-moving streams, a certain elevation range and terrain orientation, certain vegetation, etc. This introduces spatial overlay and buffer concepts, and the Boolean logic of the problem requires extensive use of the GRASS reclass and map algebra utilities. The second project involves calculation of rock overlay to be blasted out by a mining operation, and combines buffer and logic functions with volumetric analysis and simple AWK programming. The third project involves creation of a raster digital elevation model from vector hypsography (elevation contour line) data, and introduces data import, vector-raster conversions, surface interpolation, and terrain analysis and visualization. A demonstration of these techniques using DEM data for Slovakia is posted on the GIS Web site at VSP. The fourth project involves development of a land-use/land cover map from raw satellite imagery. It introduces image enhancement, color compositing, geometric correction, texture analysis, cluster analysis and maximum likelihood classification techniques. This project uses the satellite imagery acquired for southwest Slovakia.

The syllabus and project assignments reflect my own research interests in natural resource management, and my uses of GIS as a spatial analysis tool rather than a cartographic production tool. My objectives are to teach students to "think spatially," i.e., to conceptualize dynamic spatial processes. This approach differs in several ways from GIS instructional programs emphasizing vocational training in a specific GIS software. This is reflected in the choice of GRASS as the GIS software used in the course. GRASS is not a commercial GIS package. It lacks some of the vector capabilities of a high-end commercial package such Arc/INFO, and lacks some of the image processing capabilities of a high-end commercial image-processing package such as ERDAS. GRASS also lacks a visually attractive graphical user interface.

But the advantages of GRASS are substantial. First, both the C source code and compiled binaries for various UNIX platforms are freely available (via ftp from the Construction Engineering Research Labs, US Army Corps of Engineers, at moon.cecer.army.mil or from European mirror sites), and it is well supported by an active online news group (grassu). Second, it uses open (non-proprietary) data structures for storing geographic features, which makes GRASS highly programmable. Third, GRASS is extremely robust software: it is actually comprised of several hundred independent modules which exploit a common set of global environment variables defined at the start of a GRASS work session. Failure of one module does not compromise any other module. Fourth, GRASS is fully transparent to the UNIX shell and thus works with any other installed utilities (sed, AWK, Perl, Xview, Image Alchemy, xanim) and is programmable with standard shell programming. GRASS teaches general expertise in UNIX programming and system administration—skills which are useful throughout the UNIX world. There is no need for students to learn any special macro language. Finally, at least compared to other GIS software, GRASS has a reasonably smooth learning curve, and, once familiarized with GRASS and the GIS operations it supports, students can learn other GIS's very rapidly.

While most GIS problems are treated as two-dimensional (static and planimetric), my approach encourages students to experiment with three- (2D through time or synoptic 3D) and four-dimensional (3D through time) modeling. The first hands-on lab session introduces GRASS's 3D terrain visualization capabilities. The shell programming examples include scripts to simulate down-gradient flow processes, create terrain fly-over animations, etc.

World Wide Web Course Materials

The class sessions were complemented by World Wide Web course materials condensed from similar materials used in the University of Delaware's graduate-level spatial analysis course. A fairly complete set of the source materials, developed over the past two years, is available from bluehen.ags.udel.edu/spatlab/ or www.udel.edu/johnmack/frec682/. These materials are still being adapted for VSP students using local data and applications. Updated materials are prepared in Delaware and ftp'ed to the server in Nitra. Remote editing of links from existing Web materials in Nitra is done with the vi editor, and is slow. Draft English versions of the Nitra Web materials are currently available from sun.uniag.sk/macknzie/public.html/, but will be moved shortly. Additional funding is now being sought to pay for local maintenance of the GIS lab's Web site in Nitra, and for eventual translation of the class materials into Slovak.

The design of the GIS Web site at VSP is simple. The home page links to (1) the course syllabus page, which links to instructor e-mail, project assignment pages and pages providing detailed treatment of each course topic; (2) a student projects page, with links to each student's own GIS home page and individual project pages; (3) a local resource page cataloging local GIS data resources, satellite images and 3D terrain models from the GIS server; and (4) an external resource page, linking to other GIS sites around the world, including GIS data distribution sites.

The initial group of students is now submitting their own projects for grading via the Web. Since GIS presentations are typically graphics-intensive, the Web is well-suited to presentation of them, and provides an adequate substitute for hardcopy. As mentioned previously, students have no easy access to any hardcopy device. Since conventional mail service between Slovakia and the US can be slow, the Web also provides relatively efficient communication between Nitra and Delaware. Connections between Delaware and Slovakia are often slow during peak load periods, but are reasonably fast during evening hours in the US. Since students are very aware that their Web submissions can be viewed by anyone, they typically take considerable care to assure the quality of their work.

From Delaware, I maintain regular e-mail contact with students in Nitra. Students contact me for technical help with their projects, and notify me when their Web submissions are ready for grading.

Conclusions

Although this project is still underway, it has already had some apparent successes. Two students out of an initial group of 12 have already completed the course requirements and are pursuing further research interests in GIS. One of these has assumed local system administration responsibilities for the GIS server, and provides local help with the GIS software. Both of these students are planning to start graduate study in the US next year. Six other students are making good progress on their class projects, and should be completing the course over the next few months. Four students have unofficially dropped out of the class, citing frustration with UNIX, the complexity of GRASS software and the difficulty of the projects.

This success rate more or less mirrors the success rates of students in my graduate spatial analysis course at Delaware: a handful in each class become GIS fanatics, and a significant minority fail to complete the course. As noted above, my basic objective is to teach students to "think spatially," and students evidently have varying aptitudes for this. Student expertise with UNIX at the start of my courses also varies widely. My general observation is that students who become GIS fanatics do not necessarily have strong computer backgrounds, but they are typically enthusiastic about spatial logic problems and are quick to perceive spatial patterns in data. The students who fail typically have weak knowledge of UNIX, and often articulate frustration with spatial logic problems.

In conclusion, the GIS lab design for VSP succeeded in minimizing setup costs while providing very adequate GIS and image processing functionality. The lab setup depended on significant local expertise, and would probably have failed without it. The GIS data resources are already supporting preliminary research efforts, including thesis research on fragmentation of farmland in southwest Slovakia due to privatization of the economy. The accelerated class has produced at least two GIS enthusiasts who will be active promoters of GIS at VSP for as long as they remain there, and the Dean of the College of Engineering and Landscape Design is now a strong supporter of continued GIS development at VSP.

Development of GIS capabilities at VSP now appears to be self-sustaining. The GIS Web materials and e-mail communication between VSP and Delaware provided project continuity at a critical phase after my departure from Slovakia. Control of VSP's GIS Web materials is now being turned over to local system administrators, and these materials will keep evolving as VSP's teaching and research in GIS continue to develop.

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Teaching WWW Page Creation: A Cooperative Group Approach

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The purpose of this paper is to describe the method and discuss the results of a World Wide Web (WWW) group development project. The project was a cooperative group effort and was a required assignment of an Advanced Instructional Technology course at Southwest Texas State University.

The course titled *Advanced Instructional Technology* is a graduate course in the Department of Curriculum and Instruction. It is offered twice a year (Spring and Summer) and the enrollment is approximately 15 to 20 students. The students are a mixture from the Curriculum and Instruction department and the Developmental and Adult Education department, both in the School of Education. Although traditionally an instructional design course, the main project has slowly evolved to use technology as the delivery method. Prior to the summer term, students had produced print based projects as well as HyperCard or HyperStudio projects.

In the Summer of 1995 (and again in the Spring of 1996), I decided to teach the creation of World Wide Web pages to the students so that they might create WWW sites for their project. I decided to teach the WWW page creation for several reasons:

1. Hot topic - Everywhere you look in the papers, magazines, and television, WWW is discussed and site addresses are given. One of the largest demands we have in the lab is the use of the web and how to search for information. Many of our graduate students have expressed interest in learning web page construction to use in their classrooms at schools or in the departments in which they work.
2. Instructional design (ID) skills - By creating a web site, I felt the students could put many of the instructional design principles to use, such as a thorough analysis of the users, task analysis, planning, revision, and evaluation. I feel the ID part of the course is an integral part of the designing of any project.
3. Computer skills - In addition to using ID skills, students would also learn many computer skills such as scanning, graphic programs, converting files, word processing, page layout, and Web page programs (HTML).
4. Real life situation - One of the main benefits of this approach was the ability to put students in a real life situation. In the real world instructional designers must work in groups with content specialists, graphic designers, and programmers to create a product. The students had to work for a client. The client was interviewed and consulted frequently by the groups for guidance and approval in each step of the design.
5. Needed projects - Another large factor in the decision was the fact that the web sites were needed and clients were readily available. The School of Education has its own web server and the Dean has encouraged all programs to have web pages. Thus, there is a high demand for people to work on the sites and I knew the projects would be put to immediate use.
6. Cooperative learning - It was important to me that we have group projects and I was eager to try "jigsawing" within the groups (Slavin, 1990). In the summer especially, group projects seemed to be the best way to accomplish a goal in a short period of time (four weeks).

The cooperative group learning method used for this project is referred to as Jigsaw II by Slavin (1990). In this modified version of Jigsaw II, teams are formed and each member of the team is given a unique assignment in which they are to become an expert. Students from the different teams with same assignments meet in "expert groups" to receive training, discuss, and work on learning their job. The experts then return to their teams and teach their teammates about the topic they have learned. The success of the whole group depends on the motivation of the students to learn in their expert groups so that the whole team can do well. The key to Jigsawing is the interdependence of the team members; the team depends on every teammate to provide training and information that every member of the team needs to succeed. The various assignments for this project are discussed in Week 3 below.

Teaching the Course

Weeks 1 and 2

During the first week and a half of the course (eight meetings), we discussed the chapters in the Dick and Carey (1996) book "The Systematic Design of Instruction." These discussions on the chapters would last about one half of the class period. The other half of the period, students were taught how to use the World Wide Web. Specifically, how to search for sites, find clip art, and to study sites which were graphically pleasing and content rich. We also spent several days learning the basics of HTML (HyperText Markup Language) so students would understand what a web page design program such as PageMill™ produces as output. Meanwhile, I was finalizing the clients for the projects.

The last several meetings of week two, the students were presented with the three project proposals. Students then divided into three teams according to interest in the topic. After the teams were chosen, the students further divided themselves into a specific job/title (expert groups).

Week 3

With teams and assignments given, the students were now ready to start learning their duties. The duties in each team were divided as follows:

Project Director. Works at scheduling, assigns tasks, calls group meetings and meetings with client. On the average, the teams met with the clients four times.

Programmer. Learns how to use PageMill™ to assemble text, graphics and links on the page. Since time was very limited in the summer, I tried to enlist persons with extremely good technology skills as the programmers.

Graphic Artist. Designs, selects, and scans graphics for pages. A large part of their training involved learning how to scan and clean up images as well as converting the PICT files into GIF files for the web.

Content Specialist. Collects content information and word processing of data. These persons spent an incredible amount of time hunting down word processed files already in existence as well as creating new ones.

Project Designer. Keeps all documentation of project and is responsible for overall design of project, an extremely important job so information could be passed on to the next person who might maintain or update the site.

Other. Any other job needed (example: contact book publishers for releases or publishers for permission to use copyrighted text, pictures, or graphics)

During the first two days of week three, I met with each expert group. For example, I met with all the graphic artists and made sure they knew how to operate the scanner and were aware of where the clip art files and graphic programs were located. By the middle of week three, the teams had formulated interview questions and were ready to meet with their clients (see below for sample of interview questions). After meeting with their clients, the teams roughed out the web site and met with clients again later in the week. Once the plans were approved, the site was ready for construction.

Sample of interview questions. The following questions are a sample of the questions students asked when interviewing their clients:

- What is the purpose of the Web page? Is it to inform, entertain, or convey an attitude or feeling?
- Who is your audience? What would the age, education level, and interest level of your prospective viewers be?
- What benefits would a person receive from visiting the Web site? Why would they wish to return?
- What kind of information would be presented at the site? Consider graphics, photos, documents, and links to other sites.
- How would you like the site to look? Bright and colorful or conservative and formal? Any special color preferences for text, backgrounds, etc.? Does the organization have a logo?
- Which is more important: 1) quick loading time of the page or 2) visually appealing but slower?
- How much information is already word processed and ready to use?

Week 4

To say week four was busy would be an understatement. All groups were simultaneously working on graphics, layout, and word processing and assembling the site as they went along. Some sites had to be scaled back due to the time factor, but most progressed nicely. The vital importance of jigsawing became apparent during this week. Each group member was responsible for advising all the other members about how their jobs were being performed.

At the end of the week, the projects were finished and presented to clients. If the projects met with approval, they were immediately posted on the server so the whole class could view them.

Results and Discussion

I feel the project was a success. All three clients were extremely happy with the web site and the three sites that were developed are still in use. One web project was for the Adult and Developmental Education Department at SWT, the second web project for Thomas Rivera Mexican-American Book Award, and the third a page for the School of Education Teacher Fellows program.

The students were pleased with their accomplishments. Most students felt they had learned a skill they could use again at their schools or businesses and had learned much about instructional design and using the World Wide Web. However, I feel some suggestions for implementing this plan should be considered:

1. Be sure to leave time for "jigsawing" to take place. The Summer schedule was so rushed many students did not get enough time learning the other roles. For example, many students felt they could have used much more practice in the role as programmer to learn how to make links and import text as well as graphics.
2. Make sure each person understands their role within the group. Confusion could result if duties overlap or duties are left out. Monitor very closely the various group dynamics and don't be afraid to step in to help the group reach decisions and clear up assignment problems. Rather than being territorial about their duties, some members were perhaps too deferential.
3. Don't put too much power in the hands of any one member. Even the project director did not have the authority to make a major decision but only to call a meeting to decide.
4. Try to match the clients with the group. One client wanted a very conservative instructional site while the other was open for a more modern graphic approach. I made an effort at the beginning of the team assignment process to make sure the students were given a general overview of what each client had in mind for a web site. The decision on the type of site was dependent on the type of information presented as well as the client's wishes.
5. Make sure clients are willing to spend time with the groups so groups will know what the clients want. One group wanted to replace the existing site (which they thought boring) with their own pages but the client resisted. The group was given a link on the original pages to present the content in their design.
6. Agree beforehand who will maintain the site once it is posted. This underscores the need for extensive documentation by the group so someone else can find the files to make updates.
7. Site organization is a must. All of the web pages of a site should go in one folder or directory. Contained within this folder should be a folder for all of the graphics for your site. If you don't follow this organizational scheme, total chaos will result on your web server. Others who post pages and graphics on the server with the same name can easily erase your work. Insist on organization!

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Preparing Teachers To Use Telecommunications as an Educational Tool

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Communication technologies are powerful, motivating tools that can actively engage students in thinking and learning. By making the journey onto the Internet, teachers and students can break down the walls of classrooms and open up new worlds and unlimited information. Technology and telecommunications activities carefully integrated into curricula areas provide students opportunities to develop the process skills, content area knowledge, literacy skills, and technology skills necessary for effective, lifelong learning. To realize technology and telecommunication's full potential, classroom teachers must be prepared to use technology and telecommunications as an educational tool.

Electronic networks are unparalleled teaching tools, making research findings, educational materials, experts, and original sources available to any teacher and any student. Interpretation, discovery and experimentation in the academic areas can be enormously quickened and expanded by electronic networks. Networks can facilitate scholarly collaboration, lowering barriers posed by geography and specialization. Web pages (searchable documents written in Hypertext Makeup Language), are becoming an even increasing means of providing information through this online effort. Not only is it important for teachers to be able to locate online information, but also to contribute to the knowledge available via the Internet (American Council of Learned Societies, 1994).

Significant changes in teaching and learning must accompany the integration of technology and telecommunications activities into teaching. It is one thing for a teacher to be able to navigate the Internet to find information, and quite another to incorporate technology and telecommunication into classroom activities in a meaningful ways. Using technology and telecommunications for instructional purposes has major implications for practicing teachers as well as students preparing to be teachers. Perhaps the most serious challenge for educators today is how to prepare technology-literate teachers to face the classrooms of today and the future. One possible solution to help meet this challenge is for universities to prepare preservice teachers and practicing teachers to use the technologies of the 21st century (Darling-Hammond, 1994).

The need for technology in education is well documented in the literature (Byrum & Cashman, 1993; Fox & Thompson, 1994; Levin & Waugh, 1995). Most universities preparing teachers have addressed this need and restructured their undergraduate teacher preparation programs to include the training of preservice teachers in technology. However, it is apparent that there is also a need for universities to offer innovative education programs to train practicing teachers to integrate technology and telecommunications into the schools. While many practicing teachers have access to the latest technology in their classrooms, they are often lost when it comes to integrating the technology and telecommunications activities into their teaching. There is little doubt that placing technology in classrooms calls for fundamental changes in teaching practices on the part of teachers. Perhaps the most serious challenge to teacher educators is to retrain innovative teachers to face the technology-rich classrooms in schools.

Despite the apparent awareness of the importance of technology in education, progress toward the integration of telecommunications into teaching has been very slow. The Office of Technology Assessment (OTA, 1995) identified the following as barriers to technology integration: 1) lack of teacher training, 2) inservice programs that focus on the mechanics of individual computer use rather than on designing instructional strategies that were enhanced by technology, and 3) teacher education programs that were not turning out graduates who could incorporate technology as a teaching tool in any meaningful way.

Building on findings from research literature, Our Lady of the Lake University's Education faculty have developed a unique program which trains teachers to create an innovative learning environment in their classrooms while integrating leading-edge technology and telecommunications activities. Through a cohort approach, teachers enrolled in this program earn a Master of Education in Curriculum and Instruction with an emphasis in Instructional Technology. This program strives to meet the literacy and technology needs of practicing teachers and to help overcome the barriers of technology integration in schools.

Goals of the Program

The primary goal of this new program is the preparation of professionals in the area of instructional technology. This exciting program avoids the current teacher training shortcomings through staff development and will produce a cadre of highly qualified , highly motivated teachers. Narrowly, this program will prepare professionals to teach information processing in K-12 settings. All participants completing the program will be eligible to apply for the Information Processing Technology Level Two endorsement for state certification. The program is also designed to be appropriate for teachers at all levels, including media specialists, computer educators, instructional technologists, curriculum developers, and classroom teachers. The academic objectives of this new program include:

1. Graduates will be able to teach information processing in the school setting.
2. Graduates will be able to create, design, and evaluate technology based delivery systems of instruction.
3. Graduates will be able to use computer programming for instructional purposes.

Program Description

The Master of Education program was designed to complement this mission of the Education Department at Our Lady of the Lake University: "Programs within the Education Department at Our Lake University are designed to prepare professional educators to understand and meet the educational needs of a diverse student population and to function in a global society which requires all students to be life long learners. The programs provide opportunities for participants to gain the skills and vision to be leaders in schools faced with challenges of the 21st century." This new master's program complements the mission of the Education Department in all of the four areas mentioned.

After many months of discussing the needs of schools with current teachers, the education faculty designed the new curriculum for the new master's program. While maintaining the integrity of the Master of Education in Curriculum degree, the new Master of Education in Curriculum and Instruction with an emphasis in instructional technology was designed to meet the current technology and telecommunications needs identified in the schools. Of central concern to the education faculty who developed the curriculum for this 36 hour program was the training of teachers to use technology as a catalyst for changing schools in ways that better support the integration of technology and telecommunications into the curriculum. Competencies that the teachers will develop include:

1. background information concerning information processing technologies and its use in education,
2. operational skills and familiarity with current information processing tools,
3. methodology for instruction in concepts and skills of information processing,
4. modern programming with experience in at least two languages,
5. technology-based delivery and management of instruction,
6. understanding of how the Internet works,
7. teaching of effective "surfing" on the Internet for instructional purposes, and
8. skills to create and design instructional software using a computer language.

All teachers enrolled in the program will complete the following professional education courses: Multicultural Foundations of Education, Research: Methods and Procedures, Applied Learning and Development, Individual Differences, Curriculum Development, Classroom Management and Classroom Assessment.

All teachers enrolled in the program will complete the following courses in instructional technology: Computers and Education, Teaching Computer Literacy, Computer Programming for Instructional Purposes, Instructional Media

If the potential benefits of the information revolution are to be realized, teacher educators will need to make vital contributions. With the dramatic advances in educational technology and the increasing availability of telecommunications, all teacher training programs will need to prepare their teachers for the new technologies that are transforming our world, both inside and outside the classroom. Children presently in elementary schools will need new skills to be the information workers of the 21st century. Clearly, Our Lady of the Lake University's new Master of Education program is a first step in addressing these needs.

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Models of Internet Use — Approaches from Various Disciplines

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The Internet has become an essential part of today's world—in education as well as in business, industry, arts, and sciences. Teachers and faculty from elementary schools to universities are using the Internet more and more to provide students with skills that will prepare them to access and use global resources of information, both in school and in their future careers. In order for teachers to effectively assist their students in understanding the use of the Internet, they themselves must be familiar with the Internet and must feel comfortable using the different Internet services available. This paper addresses some of the issues involved in preparing teachers to utilize Internet resources, and describes how education faculty can work with and learn from faculty in various disciplines to provide role models for their students.

The Internet and Education

According to Graphic, Visualization, and Usability Center's (GVU) Fifth WWW User Survey (1996), almost 30% of the millions of World Wide Web users have educational occupations. Instructors use the Internet to provide students with syllabi, lecture notes, presentations, and assignments designed to supplement the in-class experience, and in some cases, to replace it (Shotsberger, 1996). Other instructors use e-mail to communicate more efficiently with students, and to encourage collaboration and interaction among the students. Still others rely on the Internet as a powerful resource for finding current information that can be used in student assignments and research projects. While many educators have learned to utilize the Internet for instructional purposes, there are still numerous faculty members at colleges and universities who face barriers to using the Internet, including their own perceptions of the benefits (or lack of benefits) to students, the availability of necessary equipment, and their own lack of skills (Rutherford & Grana, 1995; Spotts & Bowman, 1993).

Education faculty are faced with the challenge of helping preservice and in-service teachers become comfortable with the Internet so that they will be able to integrate Internet activities into their teaching. However, according to Rutherford and Grana (1995), "Some faculty may resist [new teaching methods] because, never having had instruction in how to teach, they teach only as they themselves were taught (which for many means exclusively lecturing)" (p. 82). If some teachers "teach only as they themselves were taught," then we must overcome existing barriers to Internet utilization and learn to integrate Internet activities into our courses so that we will provide role models for our students to follow.

One member of an online discussion group dealing with issues related to educational uses of information technology made the following suggestion as part of her dissertation: "...an individual's decision to adopt a particular innovation is a function of available RESOURCES, the PERCEIVED VALUE the individual ascribes to the innovation, and whether the individual engages in COMMUNICATION WITH OTHER ADOPTERS" (Gilbert, 1995, p. 43). If this theory holds true, then in order to help education faculty further their use of the Internet as a supplement to teaching, we must address the issues of Internet access, the perceived value of integrating the Internet into existing courses, and the communication among faculty in all disciplines who are using the Internet.

Internet access varies across institutions, cities, and countries and is not directly addressed in this paper. However, we would encourage individual institutions that are striving to increase the utilization and benefits of using the Internet on campus to make this issue a priority.

The importance of the second issue, dealing with the perceived value of using the Internet, was affirmed in a study conducted at Western Michigan University (Spotts & Bowman, 1993). One of the primary conclusions of the study was that "...perhaps the single most important factor influencing university faculty's use of technology is their need to be certain that the technology will contribute to improved student learning" (p. 203). One method of identifying whether or not the use of the Internet contributes to improved student learning is to solicit feedback from educators who have already tested Internet integration. In this paper, we present some responses from a variety of university faculty who were asked whether or not using the Internet benefited their students.

The third issue, communication among faculty using the Internet, is a primary emphasis in this paper. Since future educators come from different disciplines and take courses from departments other than education, it is important to look at how faculty in various departments are incorporating the use of the Internet into their classes, and how they are encouraging or even requiring their students to learn essential Internet skills. Education faculty, as well as other faculty, can benefit greatly by discovering how the Internet is applied in other courses. By becoming aware of the types of Internet activities used in other departments, we will be able to build upon those experiences and incorporate them into our own education curriculum.

Models of Internet Use at One University

We conducted a survey at a regional state university during the Fall semester of 1996 to help determine how faculty from various disciplines were using the Internet to supplement their teaching. The questionnaire included requests for demographic data, questions about how the faculty members were using the Internet, and questions about how they were requiring, or at least encouraging, their students to use the Internet. The form also contained room for respondents to give feedback regarding perceived benefits of incorporating the Internet into their teaching, problems that they or their students had encountered along with solutions for overcoming these problems, and general comments about integrating the Internet into education.

The following discussion presents information gathered from participants in the study. Since the survey was completely voluntary, the results are not meant to be indicative of the entire university, or even of a specific college. The term "instructor" is frequently used to indicate a member of faculty regardless of whether or not that person is a Professor, Associate Professor, Assistant Professor, Instructor, Lecturer, or Adjunct.

Table 1.
Questionnaire Response Rates

College	Distributed	Completed	Response Rate
Arts and Sciences	179	37	20%
Business and Technology	48	14	29%
Education	139	27	19%
Total	366	78	21%

The Overall Picture

The questionnaires were distributed to 366 full-time and part-time faculty in the three distinct colleges at the university (listed in Table 1). Seventy-eight completed forms were returned for an overall response rate of 21%. The response rates for the three colleges as well as for the university are shown in Table 1.

When looking at the response rates of full-time versus part-time faculty, we see that 25% of the full-time faculty returned the questionnaires while only 10% of the part-time faculty participated in the survey.

Nearly one-third (32%) of the faculty responding to the survey claimed more than 10 years of prior computer experience, while only 6% had worked with computers for less than a year. Most of the respondents indicated that they used the Internet in some form to help them with their work. Nearly all (90%) of the respondents indicated that they could access the Internet from their offices, while 36% had access to the Internet from both their offices and their homes. Of those with Internet access, the majority used e-mail and the World Wide Web. Table 2 shows the rankings of the Internet services used by the faculty with Internet access, while Table 3 lists some of the reasons they used those services.

Table 2.
Internet Services Used by Faculty

Internet Service	Percent
E-mail	98%
World Wide Web	83%
Telnet	40%
Gopher	37%
FTP	33%
Web page development	29%
Usenet	26%
Listserv	17%
IRC/MUD/MOO	3%

Table 3.
Reasons Faculty Use Internet Services

Reason	Percent
Communicate with others in my field	83%
Keep up with current events in my field	71%
Find material for use in my class	64%
Communicate with my students	56%
Find material for research projects	50%
Provide students easy access to course material	26%

While most of the faculty had access to the Internet and were using it personally, less than one-third (32%) of the faculty required work from their students that involved the use of the Internet. More than half (54%) of the faculty encouraged their students to use the Internet without necessarily requiring that they do so. E-mail was the service required the most, while the web was the service encouraged the most. Table 4 lists the services required and/or encouraged by faculty, while Table 5 indicates reasons students use these services.

Table 4.
Internet Services Required or Encouraged

Internet Service	Required	Encouraged
E-mail	26%	30%
World Wide Web	24%	37%
FTP	9%	8%
Web page development	6%	5%
Telnet	4%	10%
Usenet	3%	5%
Gopher	0%	9%

Table 5.
Reasons Students Use Internet Services

Reason	Percent
Find material for research projects	35%
Communicate with the instructor	27%
Communicate with other students in their class	15%
Access course material	15%
Keep up with current events in their field	14%
Communicate with others in their field	9%

Survey respondents listed many benefits to incorporating the Internet into teaching, including the ability to quickly access current and relevant material, the availability of a broad range of materials, exposure to ideas and developments around the world, the learning of skills necessary in a technological world, and greatly improved communication between instructors and students. Reasons given for not requiring Internet use included the belief that not all students had access to the Internet and that the faculty member's own skills were not adequate. For example, one respondent stated that "...our limited facilities cause me to limit how much Internet participation I require," and another expressed that "I would use the Internet for various activities if I had the skills." In addition, not all instructors perceive much benefit from using the Internet in specific classes, such as the instructor who wrote that "benefits are minimal because material is often unreliable or, at least, requires verification."

Several problems concerning Internet usage were described by survey respondents. Two problems that were frequently mentioned were the students' lack of computer skills and the difficulty of accessing the Internet. These problems were summarized in this comment: "Many students are not computer literate enough to use the Internet. Many do not have access; that is, they do not have computers available at a time or place that makes it possible for them to use the Internet." Other problems included the lack of ability to determine quality of material, how to cite sources from the Internet, instability of campus network, lack of time to learn and to manage Internet activities, and lack of training and support for faculty.

Some of the respondents suggested ways of dealing with these problems. For example, one person recognized the need for better skills and stated, "I plan to further develop my skills, and then make greater use of the Internet in classes in subsequent years." Another expressed the need for "SPECIFIC training activities" for faculty. On the issue of Internet access, one respondent commented that "getting Internet access available in classrooms should really encourage instructors to use it." Another wrote, "I would like more money spent on computers for student use, better coordination/information about/between labs, more support for faculty developing courses around the Internet. Students also ask for more expanded lab hours!"

College of Arts and Sciences

The College of Arts and Sciences is the largest at the university, consisting of Agricultural Sciences, Art, Biological Sciences, Chemistry, Communication and Theatre, Computer Science, Earth Sciences, History, Journalism and Printing, Literature and Languages, Mathematics, Music, Physics, Political Science, and Sociology. One-fifth of the Arts and Sciences faculty (34 full-time and three part-time) participated in the survey (see Table 1).

Every respondent in this group had at least one year of prior computer experience, with 46% claiming more than 10 years of experience. All of the respondents indicated familiarity with word processing, while most indicated that they also had experience with e-mail and the web. Eighty-nine percent had access to the Internet and e-mail, 81% indicated that they used the web, and less than half used other Internet services. One respondent maintained a web site for a professional organization, while another used the Internet for accessing supercomputer centers in other locations.

Over one-fourth (27%) of the Arts and Sciences respondents required their students to use the Internet, while more than one-half (51%) encouraged Internet use. They required or encouraged the use of the web the most, followed by e-mail, then by FTP, telnet, gopher, Usenet, and web page development. Their students used the Internet primarily to find materials for research projects, and secondarily to communicate with the instructors. Students also used the Internet to access materials for classes, keep up with current events in their fields, and communicate with other students.

One English professor explained how students used Internet resources in a graduate course:

> I made my students search the Web for information about children's literature, I made them go to some specific Web sites, and I made them download two

books: *The Wizard of OZ* and *Alice in Wonderland*. The students use the etexts in their research.

A radio and television instructor also identified specific student activities by stating that students "view FCC and FTC materials" as well as "mass media web sites." This instructor found that the major benefits of students accessing these Internet resources included "familiarization with data sources and familiarization with data current in law and media." Two other instructors commented on the convenience of e-mail. According to one respondent, "students must use e-mail to submit work, communicate with me and others in the class." A computer science instructor wrote, "I don't give specific Internet assignments to students, but I do expect them to have e-mail accounts so that I can communicate with them or they with me. Many of them do send me e-mail questions or comments."

Several faculty members commented on the usefulness of the Internet in terms of providing resources for students. Some instructors mentioned that they provided information to their students on accessing and citing Internet sources along with discussions related to potential problems with determining quality and trustworthiness of material. One respondent commented on the problem of reliability and verification of Internet sources, stating that "slowly, it seems to be improving. Perhaps hope is out there: www.hope.com?"

College of Business and Technology

The College of Business and Technology is the smallest of the three colleges, and includes Accounting, Economics and Finance, General Business and Systems Management, Industrial and Engineering Technology, and Marketing and Management. Twenty-nine percent of the Business and Technology faculty (11 full-time and three part-time) responded to the survey (see Table 1).

As might be expected with business and technology professionals, this group of faculty appeared to be more experienced with computers than the faculty in the other two colleges. Half of the respondents from this group claimed more than 10 years of prior computer experience, including word processing, spreadsheets, databases, presentations, accounting/financial packages, programming, e-mail, and the web. All but one person had access to the Internet from the office and participated in e-mail, while 79% also used the web. Over one-fourth of the faculty used gopher, telnet, web page development, and FTP.

Forty-three percent of the business and technology respondents required their students to use some aspect of the Internet, while 64% at least encouraged the use of the Internet. One faculty member commented on the convenience of using e-mail : "They can send me a message and I can respond at any time." Others explained that the material on the Internet is "more current than that found in journals and MUCH more current than books" and that the Internet provides "fast access to a wide range of material, access to professionals in the field and professional association publications." Other faculty members indicated that they wanted their "students to be in touch with the world" and to benefit from greatly improved "communications from instructor to student and among students."

Some of the faculty provided specific examples of how they had integrated the Internet into their courses. One economics instructor asked students to "search out economic data, download it and then produce a graph." Students in this course also maintained a file of current economic indicators obtained from the Internet and used the Internet for performing basic research. The instructor indicated that, with the help of the Internet, students had "access to data and research" and "access to me."

Another general business instructor maintained a server that provided a local intranet in one of the computer labs. The instructor explained,

> Students are required to prepare a home page on the CBT lab intranet. A total of eight article reviews for each student are posted to the server and linked to the student's home page. The home page must also contain an e-mail link.

The instructor further explained that by using the intranet, "additional course material can be posted at any time, reducing handouts. Also, students learn skills in demand by industry."

College of Education

The College of Education includes the departments of Counseling, Educational Administration, Elementary Education, Health and Physical Education, Psychology and Special Education, and Secondary and Higher Education. The response rate for this college was 19%, which was the lowest of the three colleges (see Table 1). Respondents included 25 full-time faculty and two part-time faculty.

Education faculty appeared to be the least experienced with computers in general, with only 30% claiming more than 10 years of experience, and 11% indicating that they had worked with computers for less than a year. The faculty from this college had much more experience with word processing, e-mail, and the web than with any other type of computing.

All but three respondents had access to the Internet. Eighty-five percent of the faculty utilized e-mail services, 63% used the web, and 33% used gopher. Less than one-third used other Internet services. When asked the purpose of using the Internet services, one respondent wrote: "This is new for me. I am exploring (primarily)."

Thirty percent of the reported education courses required students to participate in Internet activities at least 20% of the time, which is more than what was reported for the other two colleges. One-third of the respondents required their students to use e-mail, the web, telnet, FTP, or web page development, while 52% encouraged the use of various Internet services.

Several faculty members described Internet activities assigned in their courses. One instructor assigned e-mail journals, had students demonstrate use of technology in their portfolios, and asked students to document the use of technology in teaching. Another instructor "had a class that used only Internet material for presentations" because the Internet "provides opportunity for very up-to-date material." Still another instructor had students "look for materials for teaching fields and write lesson plans integrating Internet activities into lessons" and "look for multicultural resources for presentations and use in the schools." Other instructors assigned research and group projects utilizing the Internet for long distance communication and collaboration, and had their students join a class listserv mailing list for class discussions.

One instructor, who was teaching one on-line course via the Internet and included the Internet as an integral part of all courses, described various activities involving students. Students "create web pages of resources for their schools, etc. throughout classes." The instructor set up a listserv mailing list "for each class to use for communication" and encouraged the use of "e-mail for working on joint projects." This instructor also set up a "web site for each class — for me to put information for students and for them to display their work (pages)."

Some of the respondents indicated that they planned to increase their use of the Internet. One wrote, "I plan to use e-mail as a required portion of my course next semester," and another added, "I am in the process of developing more usage for my classes." Another instructor stated,

> I am teaching one on-line course. I include the Internet as an integral part of all others. I emphasize appropriate use — not just what's there. I am designing a spring course to be half on-line and half face-to-face. I am planning a fall course that will incorporate the Internet and on-line components, supplemented by traditional distance education.

Summary

The Business and Technology faculty were the most experienced with computers, and they required their students to use the Internet more than the other faculty required its use. Though the Education faculty were the least experienced with computers, they were more involved than the Arts and Sciences faculty in the integration of the Internet into their courses. Arts and Sciences faculty appeared to require mostly research-oriented activities with the Internet, while faculty from the other colleges also emphasized the use of e-mail to improve communications among faculty and students. Faculty from all three colleges indicated a desire to continue improving their own Internet skills and to provide better access for their students so that they could all benefit from the resources and communication available through the Internet.

Conclusions

Faculty from all disciplines are working towards better utilization of the Internet in education. By examining how faculty are using the Internet and by becoming aware of different ideas, benefits, problems, and solutions, we can learn from each other and help one another to achieve this goal. The Internet will continue to grow, and education faculty must continue to be the kind of role models that their students need to follow in order to effectively use the Internet in their teaching careers.

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THE INTERNET AS GLOBAL CLASSROOM AND LEARNING CENTER

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The general public, and teachers in particular, are inundated with information about the Internet, the World Wide Web, and various other components of telecommunications. Unfortunately, the reaction by many schools, teachers, and departments of teacher education is to try to teach many of these components as content to students and teachers. There are at least two reasons why this approach is a mistake: (1) the software, methods, and content used will be antiquated by the time these students get into the work force, and (2) knowing "about" something does not in any way ensure that the individual can use the information. A more productive approach would involve an integration of telecommunications activities and skills that would supplement and enrich rather than supplant and replace the current curriculum and instructional activities in your classroom.

Although you and your students may need specific telecommunications skills before either of you can expect to be successful in integrating telecommunications into your curriculum, that does not mean that these skills should be the primary focus of instruction. Rather, students can learn and practice with the basic skills they need for an activity just prior to (just-in-time training) or along with their actual use in the curriculum. By initially viewing the Internet as a global classroom and learning center, teachers and students can begin using these resources immediately to enrich lessons. This approach to the resources available on the Internet has the advantage of using the known or familiar to approach the unknown, and increases the chances that teachers will pursue their exploration of the Internet as a source of instructional resources. One way to approach these resources is to view the Internet as a source of-

- Lessons and Lesson Plans
- Classroom and Curriculum Activities and Resources
- Content Area Resources
- Online Libraries, Museums, Field Trips, Tutorials, and Periodicals
- Assessment and Evaluation Resources
- Teacher Support and Information

Dyrli and Kinnaman (1996, p. 70) suggested the following approach to getting started:

- Review current curriculum and adapt learning experiences as online activities. Evaluate the content (concepts, principles) and the processes (observing, inferring, predicting, measuring, communicating) of current instructional units and determine what might be supplemented with online activities, experiences, or other resources. Examples might include using online research tools, visiting online locations for specific purposes, participating in collaborative projects with other students in various places around the world, or communicating online with experts.
- Join an education electronic list, discussion group, or newsgroup to ask for resource suggestions, locate online resources, seek keypals, and initiate your own cooperative activities.
- Visit education resource locations and explore the available offerings. Find an efficient and effective way, such as the use of bookmarks, to keep URL's and descriptions of the sites of most interest to you and your students. One way is to develop a database with fields for the name of the site, the URL, and a brief description of what is available at the site.
- Use Internet guides and search tools to locate curriculum and content materials and opportunities.
- Gradually move to more extensive projects and curriculum units.

My purpose in this presentation is to provide you with a perspective so that you can begin planning appropriate use of telecommunications resources in your classroom immediately. Following are examples (Land & Turner, 1997) of how you might supplement instruction with resources available on the Internet and with technology.

Have I Heard This Story Before?

Subject: Language Arts

Goal: To study common story themes such as Cinderella and compare variations of those stories.

Applications:

- word processing- Have students write their own modern-day Cinderella (or other) story.

- page layout- Have students write a newsletter article as it might appear in a local paper or newsmagazine describing differences in the same storyline.
- database- Prepare a database of as many variations of the Cinderella story as students can find with information on how they differ.
- telecommunications- Have students communicate by e-mail with other students in other countries about variations of the Cinderella or other common fairy tales.
  http://www.ucalgary.ca/~dkbrown/cinderella.html.

Anyone For a Piece of Pi (Math)?

Subject: Mathematics
Goal: To explore the characteristics and applications of pi.
Applications:

- word processing- One state purportedly considered passing a law that set the value of pi to 3 to make it easier for students to use. Have students write a one page reaction to this suggestion.
- page layout- Prepare a newsletter "selling" the virtues of pi as though it had just been discovered.
- spreadsheet- Have students discover pi either by giving them the circumference and radius of several circles or spheres, or have them measure the objects, and calculate the relationship between the circumference and the radius squared by dividing circumference by radius squared. Have students calculate the value of pi from 1 to 15 decimal places (the limits of ClarisWorks). Have them look for any apparent patterns.
- telecommunications-http://www.ncsa.uiuc.edu/Edu/RSE/RSEorange/buttons.html or http://daisy.uwaterloo.ca:80/~alopez-o/math-faq/node12.html

Watch Out For the Curves!

Subject: Mathematics
Goal: To explore various kinds of geometric curves.
Applications:

- graphics- Retrieve from the Internet site provided or chart with a spreadsheet.
- slide show- Prepare a slide show or presentation with the graphics in the student-prepared database.
- page layout- Class prepares a group newsletter describing something about their three or four favorite curves.
- database- Database of as many curves as there are students in class.
- spreadsheet- Enter formulas for and experiment with various curves and prepare graphs.
- telecommunications-http://www-groups.dcs.st-and.ac.uk/~history/Curves/Curves.html
  http://freeabel.geom.umn.edu/
  http://www.geom.umn.edu/apps/gallery.html
  http://www.mathpro.com/math/glossary/glossary.html

Comments: See file Curves database in the Tools folder (Ch_09) for a database slide show idea. You must use a special technique to place the graphics in the database. National Center for Genome Resources site (http://www.ncgr.org/)

The influence of telecommunications on education will not be as dramatic as some suggest, but will be more dramatic than others hope. Telecommunications will have an impact on schooling because it is an outside-of-the-schools force that is pervasive in our society, whether it be in business, in the military, in higher education, or in industry. It will also have a dramatic impact upon our culture. For instance, compare the current references to the Internet that you see or hear about in magazines, books, newspapers, television, radio, and movies to as recently as 1994. There is a revolution occurring in the telecommunications industry; education can't avoid this revolution even if it wanted to.

The traditional curriculum is typically not connected directly to the lives of most students, can become outdated quickly, and is seldom individualized. Conversely, telecommunications brings immediacy and individualization to the curriculum; up-to-date materials including articles, databases, maps, reports, surveys, diagrams, film clips, photographs, and sound bites; and has the potential to transform the curriculum (Dyril & Kinnaman, 1996, p. 65).

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Teaching Online—Lessons Learned the Fourth Time Around

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For many of us, the Internet is revolutionizing the way we live, relax, work, learn, and/or teach. Computer conferencing, e-mail, World Wide Web, Internet—these are just some of the terms that are heard more and more both in and out of today's classrooms. This paper describes how teachers enrolled in graduate courses are entering this exciting online world, and acquiring skills and knowledge that they then use to enhance their teaching and professional activities, and to help others learn to integrate these new resources into the educational arena.

We truly are living in a global society, where students from a small rural school district can visit schools and classes on the other side of the world without even leaving their classrooms; where we can travel worldwide while sitting in our homes and offices; and where increasing numbers of employers are looking for persons with Internet experience and expertise. E-mail is changing the way we communicate, as individuals are able to correspond with more immediacy than by traditional mail, with lower costs than by phone, and with greater access to people and opinions via discussion lists. The World Wide Web brings pictures, sound, and limitless information to us wherever our computers are located. Internet Service Providers abound, and many students come from homes where the Internet is as common as the telephone or television. In fact, some of these students may have more skills and knowledge about online activities than their teachers.

The Challenge

The challenge, then, to teacher education programs is multifaceted: to prepare preservice and inservice teachers to use online communications and Internet tools as resources, to provide opportunities for these teachers to learn to integrate online activities into their classrooms, to help educators acquire skills and knowledge with which to prepare their students to participate in these online activities, to encourage educators to participate online by communicating with other educators and by sharing their materials on web pages, and to model appropriate online activities and behavior. How universities approach these challenges is varied, from denial, to Internet units in computer courses, to supplementary activities in traditional courses, to integration of online activities into content areas, to courses offered totally (or primarily) online. Additional challenges in each of these areas include availability of appropriate technologies, faculty with skills and knowledge to incorporate Internet activities into their lessons, and the widely varying computer and Internet knowledge and skills of students of all ages. How do we, as teacher education faculty, help our departments address these challenges?

The Literature

Literature describing the theory and practice of integrating online activities into instruction is growing rapidly. E-mail has been discussed from a variety of perspectives, from that of a teaching supplement (Poling, 1994) to an instructional strategy (Lowry, Koneman, Osman-Jouchoux, & Wilson, 1994). In an article with the appropriate title "Revolution@Alma Mater.edu" (1996), it is suggested that e-mail "enables students and faculty to communicate conveniently at any time of the day or night—even if the faculty member is traveling or the student is at a remote campus or another off-campus location" (p. 41). Partee (1996), though, emphasized the fact that online activities provide more:

Not simply an alternative to personal interaction of instructor and student, communication technology can serve as an extension of traditional classroom instruction. A computer network can enhance the three major activities of all teachers: to counsel students individually, to deliver general information (a lecture), and to encourage class discussion. (p. 79)

Considering more than e-mail, he also advocates the use of newsgroups for discussion, and of the Web to distribute class materials. Examples of the latter may be found at the World Lecture Hall (http://www.utexas.edu/world/lecture/), where visitors are told, "[t]he World Lecture Hall (WLH) contains links to pages created by faculty worldwide who are using the Web to deliver class materials. For example, you will find course syllabi, assignments, lecture notes, exams, class calendars, multimedia textbooks, etc." Print publications and online sites promoting online educational activities are appearing with a regularity that emphasizes the expanding nature of Internet integration into higher (and other) education.

Meeting the Challenges

Colleges of Education are taking note of the emergence of the Internet, and are employing a variety of approaches to meet the challenges of preparing preservice and inservice teachers to use the rapidly expanding resources with which we are surrounded. A basic step is to find faculty knowledgeable about, and willing to teach about and with the Internet, often beginning with e-mail. With at least one such faculty member in place, a suggested method employs a dual approach: modeling online course activity, and using a *train-the-trainer* approach. This is especially effective in graduate educational technology courses, where the students (who are teachers in various school districts) become excited about online resources and share that excitement with university faculty in their other courses, and also with the other teachers in their districts. As their enthusiasm and growing skills are observed, they often find themselves conducting inservice sessions in their local school districts and/or other areas.

Beginning Online

For the past several years, teachers taking graduate educational computing courses at a regional state university have participated in online activities as part of their class assignments, and some have taken an online course that has *evolved* as has the technology. It all began five years ago, when students were strongly urged to obtain and use e-mail accounts (available free for all students on the university network, and for $5 to teachers on the statewide network), and to use those accounts to communicate with their instructor and classmates. Few students participated, though, probably because of the 'unfriendly' university VM computer system, and the lack of access to computers with modems.

During the summer of 1993, graduate students enrolled in *Microcomputer Educational Applications* were required to obtain and use e-mail for some class assignments and for basic communication outside of class hours. It became evident from the beginning that having available appropriate assistance was a must, especially with the university system. As one student said,

> Hello, I found my way to the library and am on the computer e-mail. I only had to ask for help twice. The lab person does not understand that I am a beginner. He kept telling me things I did not need to know and not telling me what I needed to know. Maybe I will survive this.

Two years later we finally had Internet access in the lab where our students worked on assignments, and where the lab assistants were graduate ETEC students whose duties included tutorial assistance, along with the more traditional lab duties. Just knowing that there was help available, seemed to build confidence as students learned to maneuver through the ever-expanding variety of Internet tools and activities.

Students used e-mail to submit reflections on articles they had read, and this was especially challenging since students were just learning the online system. A main thrust, though, was to get the students to communicate, so messages like the following (saying an assignment would be coming) were not infrequent.

> I will respond to the article later after I have had a chance to read it more thoroughly. I did want you to know that I have finally learned enough about e-mail to at least read my mail and respond to you.

As students became more comfortable with their new-found communications skills, they sought more, sending requests to both instructor and other students. (Students were required to send a specified number of messages each week, and to get credit they had to send a copy to the instructor, enabling her to monitor activities, addressing potential difficulties as appropriate. The monitoring is a must, and continues to this day in all courses.) One student wrote:

> I wanted to forward something to you that I sent to Mike but I don't know how. Can you respond to me with the proper instructions? Thanks!

Another sent the following comment to a classmate:

> Wouldn't it be lovely to have time to play with all this stuff at our leisure?

Still another offered to share his skills with the class:

> I know how to upload files to ACADEMIC accounts. I will demonstrate it sometime this week if you want. Thanks.

And then there was the student who expressed the feelings of many:

> I hope that you-a'll are having a lovely day. I don't know if any of you received this message but if you did I'm Excited!

After two weeks of class, the student who had sent the message after getting help in the library, sent the following (referring to the community college where she was on faculty):

> [Our college] does not have an Internet connection. I am going to talk to my Dean about getting us online some way. We do have a local bulletin board with e-mail. If I cannot get on anything else I am going to have my students go on this.

Students communicated with each other, reacting to what they had heard in our class and in others. For example, this same student wrote to a classmate:

> The book about children's learning styles and computer use looks like a good idea. Some of our community college students need this kind of learning environment. I would like to see the book and see what it says.

As students became more comfortable communicating online, they created distribution lists in their online address books, and the amount of mail increased drastically. In response to a comment about the increasing incoming mail, one student sent the following message to the class:

> Overload is possible through the e-mail system; however, I would rather be overloaded with the opportunity to respond than to have never had the chance to begin with. Keep sending those messages my way.

Another student did not feel as positive about the use of e-mail, and her comments reveal an internal dialog:

> I was going to say no, graduate students should not have to learn e-mail. My reasoning was going to be if you are in a field which wouldn't utilize e-mail, then you would only learn it for a grade in the class and promptly forget most of what you learned. But I couldn't think of any professional fields where the opportunity to use electronic mail might not exist. So I suppose graduate students should learn it.

During the last two weeks of class, an interesting dialog occurred online, when several students discussed the possibility of having a course taught online the following semester. (By this time, messages written to other students often included comments directed to the instructor. As still happens, this may appear to be a check to see if the instructor is actually reading the messages, but sometimes it's an indirect request for assistance.) The students were not successful in their campaign for an online course at that time, but many of them signed up for and participated in a course that was piloted as a traditional course (with required online activities) during Fall, 1993, but has been taught online ever since.

Actually, this summer experience with e-mail as a course requirement laid the foundation, for both instructor and students, for future online courses, as well as for incorporating online activities into non-online courses. Lessons learned included the need for (a) tutorial support, which improved when we had Internet access in our lab; (b) a user-friendly system, which the university VM system was not, but later we moved to the UNIX machines, where students felt more successful with less frustration; (c) requiring specific online messages, and monitoring, via copies sent to the instructor; and (d) encouraging discussion and reflection, to help students realize and verbalize their evolving ideas, as with the student's statement about the importance of e-mail. A potential problem is that of having some students dominate online, flooding everyone's mailbox with e-mail. Three students became quite active, and it was necessary to have private discussions to redirect some of their activities to help others and to not appear overwhelming (in response to students who were dismayed with the amount of mail they were receiving). These students are now all active Internet users, and have difficulty remembering what life was like without online access.

Going Online

During the fall of 1993, *Computer Research Applications* was first taught, and it became the Internet Course. Although it was not taught online that first time (as the students had requested that summer) it has been each year since then. Although students were required to be online to complete assignments, only six computers in the lab were connected to the university network, and thus the Internet. (There were other labs that had more Internet connectivity, but were unavailable to entire classes of students; students sometimes used these if they were on campus outside class time.) The six computers on which students could access the Internet were slow, and the VM system that many students were using was still not user-friendly. As one of the students who had also been in the previous class, and who is now using e-mail and teaching his students to use the Internet, said:

> I understand your approach to this. E-mail is extremely useful when the system is not overloaded. It is difficult for a new learner when expected responses are so excruciatingly slow that you assume you've done it wrong.

As was true in the previous class, some students were subscribed to TENET, the state educational network, on which all accounts were UNIX-based, and Pine was the mail program. Comments from a student who had just received TENET account and who had not been in the previous class illustrates one of the fundamental differences in outlook:

> Dr. E- I've been faithfully logging on each day. Each time, I get a little braver and explore more and more options. Yesterday I got on the Gopher and searched the national network for Internet subscribers that I might know. None of them were on the Internet. I plan to use the Internet to find a periodical for the upcoming ETEC 625 assignment. I'm trying to get more familiar with this networking thing!! (I'ts (sic) hard to teach an old dog new tricks, but once he learns them— it's for good!!)

A week later, the same student wrote:

Dr. E- I'm getting more comfortable with e-mail as we move along. I really look forward to checking it to see if anyone wrote.

Another student on TENET had a concern about the lack of personal contact that accompanied e-mail. She said:

I have mixed feelings about corresponding over computers because I am a people person and like to see who I am talking to. I learn a lot about a person from his/her body english (sic) also, (and I know this is weird) but I see an aura around people and it tells me a lot about them as far as personality anyway. So therefore I guess I prefer real life conversations. But this does have it's (sic) purpose. See you tomorrow night.

Discussions of netiquette and appropriate communications methods, as well as ways of conveying feelings online resulted from this comment, and students began using (and creating) emoticons. This issue has been brought up in each succeeding semester — from the students who missed the face-to-face interaction, to a student who would not participate on the class list because of a comment she had received that she felt had been insensitive.

Students telnetted to libraries, gophered to varied sites, and subscribed to lists, to name but a few of their activities. E-mail was still a prime activity, and was made somewhat easier as students began to change their accounts from the VM to the university's UNIX machines. This was actually a breakthrough because all students could then use Pine for mail and could use similar procedures for both gopher and telnet access. All of us learned the value of having a similar type of access for all students. Frustration was reduced, and voluntary use increased. Unfortunately, lessons learned are not always lessons followed, and explosion of Internet Service Providers has led to more types of Internet access than we could have ever anticipated. However, for about two years, we had the advantage of most students using UNIX systems, and this greatly facilitated the incorporation of online activities into coursework. Other lessons learned that semester and that are still reflected in our current courses include the importance of: (a) developing a sense of community to alleviate the sense of isolation students may feel; (b) using a flexible mail program to keep and organize course-related mail; and (c) knowing what software and hardware students are using, to facilitate troubleshooting, and to be able to refer students to others with the same set-up.

Two additional lessons learned resulted from two events (same student for each) that came to light in the computer lab. Shortly before class one day, the quiet lab atmosphere was shattered by a shriek, as a student catapulted out of her chair. She had recently read *The Cuckoo's Egg* (Stoll, 1990), had e-mailed the author to share her comments with him, and on this day a reply arrived! The excitement and its effect on class attitudes and activities was a lesson to us all, as it reinforced the importance of sharing our excitement as a means of motivating our students and colleagues at all levels. The second lesson, learned from the same student's activities, was the potential problem of a full mail-box. One of the class assignments required students to subscribe to lists, and this student chose to subscribe to the Star-Trek list. After being away from the computer for a few days, she found that she was unable to send mail because of the amount of mail that had come from the list. As quickly as she attempted to delete mail, more arrived. She stopped the flow by unsubscribing to the list, but this mishap actually resulted in three lessons for everyone: (a) do not stay on lists which generate more mail that can be handled; (b) do not go out of town without setting lists to nomail; and (c) be sure to exercise the proper mail-handling techniques to minimize the possibility of exceeding the allotted disk space for mail.

Teaching Online

In the Fall of 1994, while other courses continued to incorporate e-mail and other Internet activities, *Computer Research Applications* became an online course—presented completely online except for three face-to-face meetings—and has continued that way each fall. Other courses are incorporating the Internet as essential components, and a question has arisen about whether a course must be one or the other — online or in class. Is three the magic number for face-to-face meetings? Are any needed? What about having five, or eight? What about combining a variety of types of course delivery methods — in-class, Internet, and 2-way interactive video? Upcoming semesters will try out these ideas, but for now, the emphasis is on lessons that will promote more effective educational experiences for both students and instructors participating in online courses delivered via e-mail and the Internet.

The world appears to often forget the early implementation of technologies, not realizing how much these early efforts have taught us, and how lessons learned remain valid and may often be generalized. Numerous changes have required constant revision of course content and treatment: students' knowledge levels have increased for some, but not for others, increasing the disparity between the two extremes; type of access has diversified, from VM to UNIX through direct connect, making it necessary to offer multiple instructions and still not always meeting all needs, because of other connectivity issues; Internet tools/activities have expanded, and instructions for use may differ based on the type of access; and management techniques for e-mail and the web are needed by all.

The lessons learned that first year have been invaluable, and additional lessons have been added to the list on a regular basis. During Fall 1995, Internet access in the lab increased, with full capabilities (including Netscape) available on twenty 486 computers. This has helped with the tutorial assistance aspect, and some students come to the lab to seek advice from the lab assistants (who are not allowed to touch the keyboards when helping students), although they do not come to campus for classes. The time when all students had the same type of access (when everyone was on UNIX) has passed, and confusion again complicates the access issue, as many students are subscribing to a variety of Internet Service Providers, not all of which offer the same services. The university now offers PPP access to all students and faculty, which means that all students who are within local dialing distance can use Netscape and other client Internet software. The difficulty comes when students need to set up their home computers, and each situation seems to have its eccentricities. So with progress (Netscape) comes potential difficulty, but once it's working, students quickly discover that getting online is definitely worth it. One student brought me an article titled "Superintendents in Cyberspace" (1995) that she was taking to share with her school—she hoped it would give people at her school ideas.

Graduate students in these classes have become a part of a new breed of educators who use the resources available online, and then create their own contributions that are now available for others to use. A Curriculum Resource Guide (Espinoza, 1996) and a Research Resource Guide (Espinoza, 1996) are among the products that they have published on the web, and they are using to support the education of today's students.

Summary

The Internet has opened up vast resources to support the education of both today's students of all ages and those who just want to continue learning. Teacher education programs can take the lead in providing preservice and current teachers with skills that will help them find, evaluate, and use these resources, but only if the programs are provided with the appropriate technology, support, and training for both faculty and students. We have come a long way since that first course when it was recommended that students get e-mail accounts, but few did. Lessons learned by both the instructor and students will form the foundation for future classes and learning opportunities. We will remember the importance of training, of community, of reflection, and of avoiding a full mailbox. Most important, though, is to remember that lessons learned and heeded lead to growth, which leads to lessons learned, and so forth. While writing this, a message arrived from a student in the Fall 1996 online *Computer Research Applications* course — he, too, had been thinking about lessons learned, and was submitting his list of ten to the class list. Lessons learned provide the foundation upon which teaching and learning with technology rests.

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Technology Training Model for Inservice Teachers to Integrate Information Technologies

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Information technologies are increasingly being used by teachers in educating students in the K-12 arena as evidenced by the wealth of information exchange in areas of pedagogy, curriculum, resources, policy and teaching philosophies among teachers on the Internet. Teachers themselves are reporting increased use of the Internet in their classrooms in professional publications (Quinlan, 1996, Carlson, 1996, Edinger, 1994, McGlinn, 1995, Graves, 1995, Somers, 1995). In the past, adoption of technology into the daily practices of teaching and learning has been relatively slow; in stark contrast, information technologies are being adopted and actively embraced at an unprecedented rate by teachers and students, causing quite a revolution in the field of K-12 education. These technologies, with easy-to-use interfaces, allow teachers and students to access, consume and contribute to a wealth of relevant information, communicate with peers, collaborate with colleagues worldwide and break away from the previously isolating and physically contained experience of a classroom. These technologies empower the teacher to create a "global classroom," a virtual educational setting that electronically transcends traditional boundaries. Teachers now have a treasure chest of information tools, experiences and resources with which to reinvigorate the educational process for themselves and their students. They can now use contemporary resources and technologies and engage the students in the learning process by making them active partners.

The President's initiatives, Challenge Grants from the NSF and the revolution caused by the Internet are providing the much needed impetus for large scale technology implementation into schools. National and local initiatives are calling for the infusion of information technologies into the classroom by offering funding opportunities and reduced costs specifically for connecting schools, libraries and public institutions. The immediate challenge to school districts, once connected, will be to train teachers, in a short period of time, to effectively use these technologies. Placing technology into schools without emphasizing associated changes in methodology and curriculum , is a futile venture that will not propel schools into the 21st century but freeze them in current practices. Inservice staff development programs need to be comprehensive, immersive and effective to cause the social and knowledge changes needed to produce creative adoption of information technologies in the schools of tomorrow.

Iterative Design Process

This paper will discuss a two and four week immersive summer training model that has been developed through an iterative design process to empower teachers to take advantage of information technologies. The model has been effectively used to train teachers to become savvy users of the Internet and demonstrate the integration of these technologies into everyday teaching activities. Teachers were trained to be informed consumers and inventive producers of learning experiences on the Internet. Surveys indicate high satisfaction with the content and the intensiveness of the training model.

Training models need to reduce the learning curve by creating immersive environments for computing and emphasizing the application and retention of skills gained in training. These issues, that are of increasing importance as more school districts move toward integration of information technologies, will be the primary focus of the paper. The training model discussed in this paper was initially implemented in the GirlTECH project described below and then further compressed through an iterative design process for implementation in the OWLink project. Specific training documents and schedules are available online.

GirlTECH Project

www.crpc.rice.edu/CRPC/Women/GirlTECH

Funded by the NSF, in 1994, this project provided the initial need for a training model to train twenty Mathematics and Science teachers, to integrate the Internet into their classrooms, in a four week program. Teachers were provided with personal laptop computers, space on a UNIX server and access to the Internet. Most teachers returned to classrooms where their computer was the only one available for students. Three of these teachers have since implemented the 1995 GirlTECH project, the following year.

Project OWLink

www.rice.edu/armadillo/Owlink

The OWLink project is a tele-distance project that links teachers and students from five diverse schools in the Texas area in project oriented work with each other and with Rice University staff and faculty. A revised version of the training program used in GirlTECH was implemented in the OWLink project in the summer of 1995 with thirteen Mathematics and English teachers from the Houston area. Teachers return to their schools and use the advanced computing facilities of the OWLink rooms which are equipped with twelve high-end multimedia computers, fiber-optic based teledistance equipment and high bandwidth Internet connections where teachers implement the processes of teaching with technology on a daily basis.

The Training Philosophy

More often than not, technology training emphasizes and concentrates on discrete skill development, vastly ignoring application or practices that enable users to gain an understanding of the relation between the training and use in the classroom. Kinnaman (1993) advocates new avenues in teacher training: "Teachers don't need to be 'trained.' They need activities that engage them with the process of teaching- activities that encourage them to explore, create and reflect upon the benefits and limitations of teaching with technology" (pp. 258). Training is often usually in the form of providing information that may or may not have relevance to the end user. In contrast to traditional training programs, this program was conceived with the intention of making the training highly meaningful and personalized to the individual teacher. This paper describes critical components of the model used to train teachers and encourage implementation of skills in meaningful end-products that can be readily implemented in the classroom. The intent is to enable teachers to consciously think beyond adopting the new skills to simplify, automate or duplicate current teaching practices and instead to rethink, re-envision teaching and learning in light of the new skills and produce original learning activities that showcase these qualities. Gorry (1996) challenges teachers and schools to rethink current practices:

> Schools and universities need to view information technology both as an aid to current practice and as a new conception of the world - to balance concern for today's business with invention of the future. In its expressive use of technology, the system-after-next complements planning with envisioning-trying to see, not from the present to the future, but from the future to the present. Without envisioning, information technology in schools and universities will only rigidify the past.

This philosophical orientation succinctly exemplifies the spirit of the training programs described here and has greatly influenced the training model. Emphasizing the learning process and the end-products rather than the discrete skills and shrouding the training in an environment of experimentation and innovation has resulted in teachers successfully producing interesting learning activities that are customized for the Web and engage students in the production of knowledge rather than mere consumption of information.

Technological competency

A nationwide survey conducted by *Electronic Learning* in conjunction with its sister publication *Instructor and Middle Years* discovered the following: 66% of the respondents said they gave straight workshops on specific software titles or hardware, rather than on how to use the technology as a tool to expand curriculum. (Siegel, 1995).

In stark contrast to the results described above, this model uses the skill training as simply a means by which the teacher can integrate Information Technologies into teaching and learning. Teachers are given direct instruction in specific skills required to become savvy users of the Internet. They are taught the skills necessary to navigate the Internet, understand its functioning and the user interface. They are taught effective and efficient search techniques and encounter issues regarding relevancy of resources and validity of information. They are taught the use of other Internet related tools: ftp, telnet, e-mail, UNIX space maintenance and HTML (Hyper Text Markup Language). Every step of the way, however, teachers are allowed ample opportunities to practice their skills in meaningful activities that will assist them in accomplishing the larger goals: a project that shows evidence of the teacher having rethought a lesson in light of these technologies.

Progressively, the skill level is increased, mastery of one set of skills leads to an introduction of the next set of skills. This progression is derived through an Instructional Systems Design model: deriving objectives for the training, the delineation of content, creation of activities for practice, reward system for learning and evaluation.

Technological Empowerment

Using UNIX accounts sponsored through Rice University, teachers create and maintain WWW pages retaining control over their data, the ability to maintain, modify and to add to their products, which gives them an immense sense of responsibility in their learning, ownership of their productions and motivation to continue to engage in follow-up activities. Teachers maintain their WWW pages and lesson plans in their accounts and these are reported to be very appealing activities. The instantaneous ability to publish to a worldwide audience has an energizing effect on the response to training and the ensuing motivation to learn new skills.

Collegiality and Collaboration

Key to liberating the teacher from the physical confines of the classroom and encouraging a sense of collegiality and collaboration are an introduction to the principles, nature, roles and responsibilities of electronic collaboration. Teachers are introduced to newsgroups, listservs and other means by which they can collaborate and communicate with colleagues near and far. They are encouraged to think of themselves as both initiators and participators of collaborative online projects. They are introduced to online resources and the means of connecting and contributing to them.

Professional Development

Teachers in the training program are brought into a professional environment within which they are challenged to think of new ways of teaching and learning with information technologies. Through a multi-dimensional and multi-modal approach, teachers are introduced to professional literature from practitioners, from revolutionary thinkers in the field of education and information technology, and from experts in pedagogy. They are asked to conduct group discussion of articles and state opinions. Frank discussions of the pros and cons of teaching with technology provide a venue for teachers to vent fears, participate in a learning and experimenting community and elevates the group to a higher level of thinking within which to formulate their opinions and situate their experimentation. These communal discussions allow the teachers across disciplines to communicate problems and practices unique to their content, understand other subject areas, modify practices to suit their peers' needs and more importantly, modify student activities to encourage conceptual connections across the different disciplines.

Reflective Practices

Teachers are asked to maintain journals of their thoughts during the training. Taking time out during intensive training to reflect on the process allows the teacher to be aware of the change processes, modify and focus on the end goals of the training. The reflection also helps the teacher to take advantage of the increased technological competence and make necessary pedagogical shifts.

Constructivistic Projects

White (1987) talks about the changing world of technology and its implications for curriculum and the need to rethink curriculum.

> The technologies should be viewed as the instruments for change that they are, but we as educators should be thinking more about their impact on learning and society.
>
> Education,...K-12,...would require us to rethink the heart of education itself. Instead, education is treating the technologies as just another triad of textbook, teacher and test.
>
> In my view, these changes we are undergoing are so significant for how we learn, how we remember, and how we form judgments that I believe education needs to develop a curriculum designed to educate for these changes. (p.41).

Teachers are given the freedom to create their own meaning or construct their products while implementing the skills they learned. It is clearly communicated that the trainer's role is to provide the training but that creative implementation of skills is their responsibility. The end products that resulted reside on the World Wide Web (WWW). Created in 1994, some of these lesson plans have been widely publicized as models on the Web since there was very little teacher created material online at the time to emulate or improve upon.

An analysis of these lesson plans reveals that a varied set of teaching philosophies are applied when creating online lessons(Kumari, 1996). Each of these lesson plans, though, make excellent uses of the Web. Some require the student to mine the Web, gather relevant data and present the analysis to peers. Yet others require students to make calculations using the data gathered from the Web and suggest the most productive uses of resources. Some require students and teachers to use information processing skills in creative ways to learn new concepts or relearn old concepts with new interdisciplinary connections.

Paradigm Shift

Teachers express excitement when given the opportunity to be collaborators, and pioneer the creation of online curriculum. The short term training program brings a sense of fulfillment and accomplishment. Having the ability to learn, implement and work at home with their computing to practice seem to help enormously. Teachers seem to undergo a change in thought processes; they view teaching with the Internet as a collaborative learning adventure that they undertake with their students. Technologically empowered teachers are invigorated with new ideas about teaching with technology and excited about the endless opportunities that the Internet and tele-distance present for teaching and learning environments.

Drawbacks in Practice

After undergoing intensive training in the summer and having ample time to reflect, create and practice, teachers return to schools with intensive workloads and little time for training or the implementation of new skills. Remedies to this major impediment, a barrier to succesful retention, implementation and extension of skills, have been suggested to school principals. Providing teachers with time during school to participate in training and continue the maintenance of practices created in the summer will increase the chances for implementation and skill retention. Experimenting with technology and advocating the use of technology takes time, and the administrators need to make changes and create reward structures for teachers pioneering within their schools. Teachers also need to be given opportunities to showcase their technological skills within the school by being provided with scheduled times where they make presentations to the other staff.

Conclusion

Teachers were taught not only how to use the web but to contribute back to it. Teachers were shown how to author for the web, integrate graphics, create links and produce content for the Web. To do so, however, teachers themselves must be intimately familiar with the technology; they need time to understand the medium and experiment. They need immediate feedback and the chance to implement. Simultaneously, they need to be introduced to complementing and new philosophical orientations. Providing articles for the teachers to read incorporates collegiality and stimulates philosophical discussions, making this a learning and experimenting community. Feedback from other teachers and the WWW audience provide additional incentives. Most teachers find the web by in and of itself to be an exciting medium with which to teach and learn.

Students need to be able to be information literate in the 21st century, and these teachers are leading the way. They are conscious of their responsibilities to other members of the teaching community on the Internet and form an operational and practicing group within which to exchange ideas, collaborate and experiment, conduct mediated conversations with stimulating discussions and exchange of ideas and notions. They critique each others lesson plans, suggest new ideas, look for inter-disciplinary ties and sustain experimentation. This brings a sense of collaboration and collegiality to the training process.

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Mentoring Graduate Students with Online Tools

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The teacher-to-student aspect of course delivery is readily facilitated with a number of electronic communications tools that will be described in this article. The student-to-student aspect of graduate learning, something we deem essential to professional growth, becomes a challenge for students whose "classroom" exists within their computers. Learning to master new and challenging environments with unreliable hardware, operating systems, and software can be tedious and frustrating; people need peers to provide encouragement, laughter, and advice.

Introduction by Gertrude (Trudy) Abramson

For many years, I have taught courses in authoring systems and courseware design and development to teachers at Universities in face-to-face classes, once a week for 150 minutes. The general format was to begin by allowing students to "vent their spleens" for about 5 minutes and then present a 15 minutes mini-lecture ; classes typically ended with 20 minutes of questions, reflections and discussion. The remaining 110 minutes were spent in hands-on exploration in small groups. For the most part, students felt very positive about the shared, "guided discovery" process.

At the School of Computer and Information Sciences (SCIS), Nova Southeastern University (NSU), doctoral distance education requires students to come to campus for an intensive week, or two weekends, of classes each term. After that, each student works independently, at home, and all further instruction and communication is electronic. At the discretion of the professor, assignments may be submitted electronically or through the U.S. mail. Successful functioning of our virtual campus depends on an effective SCIS - network including the WWW, the Electronic Library, and the campus bookstore. Of course, our remote students must have state-of-the-art multimedia computers, fast modems, and software required by their coursework.

This panel addresses a variety of issues in graduate and inservice courses that rely largely on distance education for instructional delivery. Many of us gathered here are grappling with the problem of retaining the best of traditional classroom learning using the tools that permit synchronous, asynchronous and remote communications. At the same time, we are developing new paradigms for learning that meet the needs of technology-based society. The panelists are colleagues and doctoral students in the Doctoral Computing Technology in Education (DCTE) program. Here, we discuss successes, failures, and new, largely untested, emerging solutions. Several of our panelists have sent remarks for reader edification.

Online Tools at SCIS by George Fornshell

The graduate education process at SCIS makes use of asynchronous online electronic mail, general topic online bulletin boards, and multi-thread online bulletin boards for course and peer group communication and instruction. A structured Electronic ClassRoom (ECR) enables more formal communication in real time. New WWW form-based tools using Common Gateway Interfaces (CGI-scripting) allow professors and students to gather data related to self -assessment and provide automated responses.

Electronic mail (e-mail) is the heart of online education. This tool is used to convey ideas, to exchange questions-and-answers, to spark and guide research, and to provide assignment feedback. E-mail may be sent to a single person, to several people, or to a large group simultaneously. It may be sent to a bulletin board where it is posted automatically.

General topic bulletin boards provide a common forum for the posting of mini-lectures and issues of general interest to the class. Dialogues may be initiated by both students and professors and every reader may respond (post). Entries may be deleted only by the owner. This venue permits professors to share significant student contributions with the entire class. Entries are posted in a single list with the newest at the top.

It is also possible to establish a thread-based bulletin board. This tool allows the professor to set up topics. Users may post their responses to a given topic. For example, topics may be entered as Assignment One, Assignment Two, etc.

The ECR is an NSU virtual classroom. It was developed long before distance education became popular and is text-only communication in real time. It is a screen-based simulation of a classroom where the top half of the screen is the "speaker" and the bottom half are the "students-at-their-desks." Students may "speak" when the teachers "calls on them"; they "raise their hands" to signal an interest in participating. Online sessions held in the ECR may be recorded and replayed on a delayed time basis.

On the emerging front, World Wide Web (WWW) pages provide opportunities to experience courses designed for Web presentations. These course make use of multimedia and interactive form data-gathering tools. Analysis of course evaluations and examinations may be automated, providing students with almost immediate assessment of their work.

Computer Mediated Communication by Lisa Deziel-Evans

From my perspective, one of the most difficult aspects of being a distant student is the isolation that can occur, especially when a question (problem) arises. This is particularly troublesome for the more introverted student who is unlikely to pick up the telephone and ask for help. In a traditional setting, these problems are often addressed through the use of student-to-student interactions outside of the classroom.

Over the course of my study, I have relied heavily on ongoing communication with a group of students in the DCTE program with whom I clarified assignments and shared support and encouragement. Many ideas were formulated and developed as they traveled back and forth over the network. Fellow students were more than willing to take the time to provide feedback and to help explain troublesome concepts. In this regard, the use of e-mail was invaluable but it provided feedback from a self-limited group of people.

The use of electronic bulletin boards (BBS) provide a forum for a more widespread audience. While it becomes a little more intimidating for some students than the use of e-mail since the messages are read by the entire class, the social distance makes it easier than using the telephone or speaking up in class. A bbs is an efficient and easy way to post information for everyone to see and it ties up fewer computer resources than would sending mass, individual e-mail messages.

The students in the classroom become more real to one another as they contribute ideas and comments that allow other students to formulate pictures of them as people. Common interests are noted and communication is initiated. The BBS helps lessen the isolation and helps students sense they are not alone, that others are going through the same hardships, problems, enlightenment, etc. It also helps prevent duplication of responses by faculty members since, once a question is answered, it is posted for everyone to read.

I believe that most graduate students welcome the opportunity for "non-graded intellectual growth." The sharing that occurs through online communications is an invaluable and necessary part of graduate school. The informality that appears to be a part of the online culture may stimulate communications that emulate grad school hallway and late night discussions, but add the benefits of having the ideas maintained in an archive and allowing asynchronous input from people who were not at the initial discussion.

Rationale for Obtaining a Doctoral Degree through Distance Education by Robert Lipton

The DCTE program allows me to be gainfully employed and involved in a quality education program simultaneously. Requiring physical residency in an age of e-mail, web-page access, fax, telephone, and postal mail seems passe. Two distance factors are essential: professors who can deliver quality coursework electronically and a well-equipped electronic library that provides rapid service. SCIS's Cluster format requires four on-campus weekends each year. These intensive meetings enable easy-access to faculty and administrative staff and allow student interaction and the formation of peer support bonds. I have made friends through this program as I have not done since my undergraduate live-on-campus days.

The instructional format, although quite rigorous, allows a degree of autonomy that is conducive to my lifestyle. In addition to my heavy duty schedule at the district level, I am adjunct faculty at Penn State and have family responsibilities. The professors in my program provide the appropriate guidance and understanding that has made it possible for me to balance my life and to perform well as a professional, a father-and-husband, and as a doctoral student.

Electronic Learning at SCIS by Margaret Marston

The electronic library (EL) service at NSU is very valuable as I pursue my doctoral studies. It provides access to many databases that are otherwise very difficult to locate and use. For example, through EL research, I have found standardized tests to use in my research class. I accessed ERIC, FastTrak, and WorldCat from my home computer. Many resources that I use are not available on a commercial Internet server. NSU uses Lynx through Unix, a menu-based environment that allows fast retrieval of information.

Interpersonal communication works well using e-mail. Some professors send mini-lessons online, others have online web pages. These pages may contain assignments, discussion forums, links to relevant databases, and/or lecture notes. Grades are transmitted online with the electronic student (ES) system. Depending on the professor and the nature of the assignments, work is submitted online or through the postal system. The Cluster meetings are invaluable as they help students and professors to form bonds that personalize the electronic communications.

Learning Communications in the Age of Technology by Mitchell Pratt

Communication, or the flow of information between teachers and students, is a hallmark of the educational process. Today's technology facilitates the process. Thornburg, in Betts (1994), states that we "are seeing tools of the Communications Age starting to change the face of the Information Age" (p.20). Our professors at SCIS communicate with us electronically without regard to time or distance. Negroponte (1995) points out that we are evolving in our communication from atoms to bits; that is, we are becoming a society where we communicate increasingly with digital technology rather than paper.

Because time and distance are no longer factors in interpersonal communication, the look-and-feel of higher education is changing accordingly. We, at SCIS, are working largely in a distance but highly-personalized environment. New and emerging online tools will continue to impact and improve distance learning communications.

A Distance Student Becomes A Distance Teacher by Crystal Sandiago

I took my first distance learning class, the subject of which was the Internet, at the University of South Florida at Tampa, with media specialists in Dade County in 1992.

At that time, I learned the joys of using Veronica to search gopher space and the ready access made possible by the Virtual Reference Desk. The first and last classes were on-campus and all other communication was e-mail-based. This allowed me to devote my time to classwork rather than invest it in travel. The DCTE program makes it possible for me to work full-time while I pursue my degree. Every course I take is job-related in some way, has sharpened my technology skills and has made me more employable. The project courses have inspired me to undertake many technology projects that I have presented at conferences where I show teachers and media specialists how to merge new technologies into their curricula.

I am preparing to offer my own distance learning course, "The World Wide Web for Educators," which I developed using Netscape and e-mail and is based on a program that I developed for my courseware course given by Drs. Abramson and Fornshell. Following are elements I plan to integrate into my course:

- There will be a first meeting to introduce the students to one another and to me, and a final meeting to hand in and demo final projects.
- E-mail addresses for all class participants will be distributed for online peer support.
- A bulletin board will be set up on the university server for message posting, requests for help, and comments.
- Assignments may be uploaded for submission.
- Messages will be sent to students in advance of assignment deadlines.
- Performance will be assessed through a project to be shown to the group at the last meeting of the course.

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Design and Development of Teacher Education Materials on the Web

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This paper focuses on the design and development of Web-based instructional materials for teacher education. The *Teacher's Guide to the Holocaust* and the *Teacher's Guide to School Networks* were developed at the Florida Center for Instructional Technology, and they are available for teacher education programs throughout the world. Design and implementation features of these programs are outlined as examples of the effectiveness of disseminating instruction via the World Wide Web.

Advantages of Web-based Delivery

The World Wide Web offers many advantages for the delivery of teacher education materials. No other medium can offer such broad, inexpensive delivery as the World Wide Web. Delivering instruction through the World Wide Web is much more economical than traditional delivery methods because you do not have to purchase diskettes and there are no postal delivery charges. In addition, if instruction is disseminated via the Web, it can be updated continuously simply by revising the files stored on the computer server.

Another benefit of delivering instruction on the Web is the cross-platform capability. In other words, when the text, graphics, audio, and video files for the project are placed on a Web server, they can be accessed by Macintosh, MS-DOS, and UNIX computers. This compatibility eliminates the need to develop two or three versions of the same program for different computer platforms.

Another advantage of disseminating teacher education materials on the Web is that they can contain links to other resources. This allows the integration of a tremendous amount of information from other sites that are appropriate to the content area. For example, the *Teacher's Guide to the Holocaust* contains active links to the National Holocaust Memorial Museum and the Cybrary; the *Teacher's Guide to School Networks* provides links to other network-related sites such as Novell.

The Teacher's Guide to the Holocaust

The *Teacher's Guide to the Holocaust* is a Web-based instructional program that was designed by students in the Instructional Technology program at the University of South Florida to meet the Florida mandate for Holocaust education in K-12. Graphic artists, editors, and programmers were provided by the Florida Center for Instructional Technology to produce the program.

The *Teacher's Guide to the Holocaust* approaches the humanitarian issues of the Holocaust through a multimedia, interdisciplinary approach and provides a clear, concise, and accurate account of the Holocaust. The program is divided into six main sections: People, Timeline, The Arts, Society, Teacher Resources, and Classroom Activities (see Figure 1).

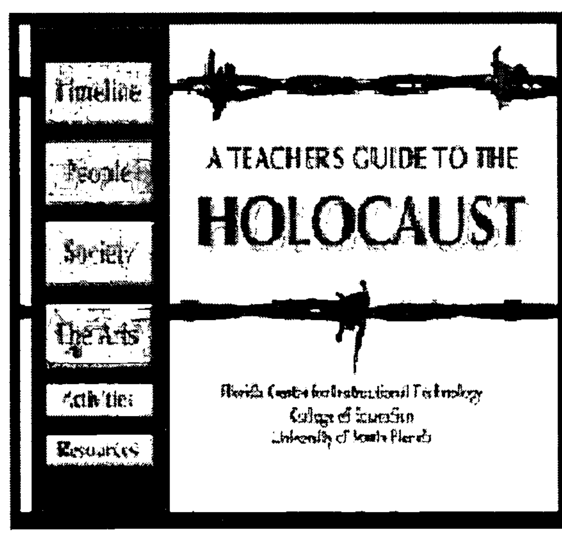

Figure 1. Main Menu for Teacher's Guide to the Holocaust

People

The *People* section exhibits the behaviorist categories of people in time of war. In this section, the focus is not only on victims, but also on bystanders, perpetrators and collaborators. On a more positive note, *People* also celebrates the resisters and rescuers of the Holocaust, with a special dedication to the Righteous Gentiles who placed their lives in danger to save Jewish people from destruction. The *Survivor section* includes numerous firsthand stories of survivors and personalizes the Holocaust by making connections between the historical aspects of the Holocaust and actual people.

Timeline

The *Timeline* section presents the story of the Holocaust chronologically along a detailed timeline of history. This section focuses on The Rise of the Nazi Power, Hitler's Final Solution, the Rescue and Liberation of Nazi death camps, and the Nuremberg Trials. Topics are supported with QuickTime movies from the National Archives (such as a movie of Hitler at the 1939 Olympics), historical photographs of Europe at war, and copies of transcripts and documents from the Nuremberg Trials. This section is designed to serve as a concise point of reference for teachers. Links are included to other Web sites for those teachers who want to further investigate the Holocaust from a historical perspective.

The Arts

The *Arts* section demonstrates that despite the Nazi's attempts at dehumanization, victims and survivors of the Holocaust held onto the parts of themselves that made them most human. This section is a gallery of the Arts—literature, photography, fine arts, music, drama, and film. In *Music*, teachers and students have the ability to hear traditional Jewish music and songs written during the Holocaust in both the camps and ghettos. *Drama* includes the works of playwrights, Ronald Vierling and Alina Kentof—materials that teachers can incorporate into their study of the Holocaust. The *Fine Arts* section contains the works of David O'lere, a surviving artist of the Holocaust. Permission to use sixteen of David O'lere's paintings for this project has been obtained through a copyright release statement signed by O'lere's son and the manager of the O'lere paintings.

Society

The *Society* section focuses on the interaction of people and places — Society. The history of anti-Semitism provides teachers with background information about Jewish persecution. This section describes Poland, Germany, and other parts of Europe that were directly affected by or involved in the Holocaust. Anticipated links in this area include a virtual tour of Dachau concentration camp, and the journal writings of several young adults from the Patch American High School in Germany who recently visited the Dachau museum and wrote about their experiences.

Teacher Resources

The *Teacher Resources* section provides teachers with a bank of reference materials, including annotated bibliographies for books, articles in the ERIC database (Educational Resources Information Center), related web Sites, and software programs that might enrich both teachers' and students' learning experiences when investigating the Holocaust. The section also lists various Holocaust Memorials and Museums in the United States and provide detailed descriptions of the resources available at each center. Teachers may contact these museums to obtain more information or materials to include in their curriculum.

Classroom Activities

The *Classroom Activities* section presents a series of lesson plans and integrated units that may be used across the disciplines. Arranged according to Gardner's Multiple Intelligence Theory, the Activities Section is divided into categories of students' individual strengths, such as Musical, Bodily/Kinesthetic, Intrapersonal, Linguistic, etc. Each lesson describes the learning objective, appropriate grade level, materials needed, and procedure. Moreover, this section contains "Submit an Activity" and "Send us your Comments" segments, where teachers may send their own lesson plans or submit suggestions for revisions of the lesson plans in the database. All lesson plans are edited and evaluated by experts in the field prior to being added to the *Classroom Activities* section.

The Teacher's Guide to School Networks

The *Teacher's Guide to School Networks* is designed to provide basic information about local area networks for teachers, administrators, and media specialists. Through text, graphics, and hyperlinks, teachers can learn the terminology and basic concepts of installing and maintaining a local area network. Topics in the program include: hardware, software, protocols, topology, and cables.

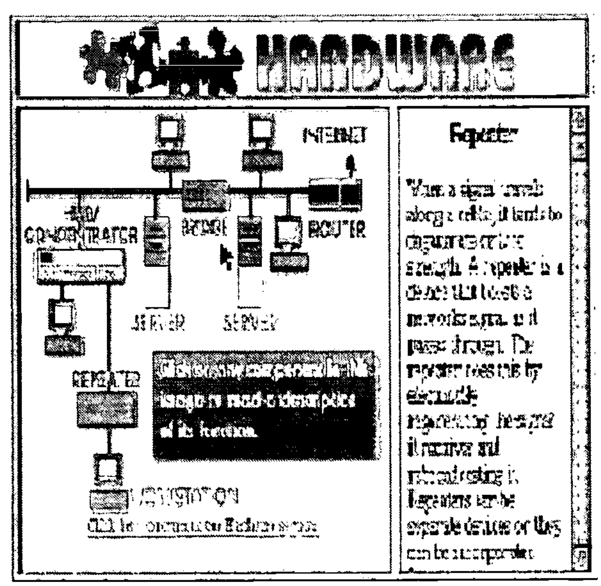

Figure 2. Imagemap in Hardware section.

Hardware

The *Hardware* section includes information and diagrams about file servers, workstations, network interface cards, concentrators, repeaters, bridges, and routers. A summary section is included that uses HTML frames to allow the user to click on an imagemap and review information about various aspects of a network (see Figure 2).

Software

The *Software* section includes advantages and disadvantages of various network operating systems, including peer-to-peer and client/server. Links are included to other Web sites that offer more information on AppleShare, LANtastic, Microsoft Windows for Workgroups, Windows NT, and Novell Netware.

Cables

The *Cabling* section includes diagrams and information about unshielded twisted pair, shielded twisted pair, coaxial cable, fiber optic cable, and wireless transmissions. Guidelines for installing cables are also included.

Topology

The *Topology* section focuses on the physical topology alternatives for networks. Advantages, disadvantages, and diagrams are presented for linear bus, star, star-wired ring, and tree topologies. A table is included that summarizes the topologies and correlates information about common cables and protocols.

Protocols

The *Protocol* section includes information about the most common protocols used in school networks, including Ethernet, LocalTalk, Token Ring, and FDDI. A summary chart is included that correlates the protocols with speed, cables, and possible physical topologies.

Game

A Jeopardy style game is included in the *Teacher's Guide to School Networks* that allow users to review the information in the program. Using a Perl script, the game keeps score of the user's answers and reveals pieces of a puzzle if the questions are answered correctly.

Issues in the Design and Development of Web-based Instruction

Numerous issues arose in the design and development of these Web-based courses. Each graphic had to be carefully evaluated to determine if it was relevant to the program and whether or not it justified the transfer time. A "rule-of-thumb" guideline was to attempt to keep each page to less than 50K. Because of this constraint, special efforts were taken to compress the graphics as much as possible or to use thumbnail graphics with links to another page. Copyright issues with graphics were carefully researched; substantial time and effort were required to obtain the proper clearances.

Navigation issues, such as links, image maps, headers, and footers, had to be designed and tested with the target audience. Whenever possible, icons were added to make it clear to the users whether they were branching to a glossary, internal link, or external link. Text was rewritten and edited continuously to ensure that it was accurate and presented in a logical manner.

Creating content for delivery on the Web is an extremely time-consuming task. The rewards, however, can be worth the effort. Within days of the release of these programs, feedback arrived from all over the world, complementing the efforts and requesting permission to use the programs in teacher education courses and inservice programs.

Relevant Sites

- Teacher's Guide to the Holocaust: http://fcit.coedu.usf.edu/holocaust
- Teacher's Guide to School Networks: http://fcit.coedu.usf.edu/network
- Florida Center for Instructional Technology: http://fcit.coedu.usf.edu

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TELECOMMUNICATIONS: PRESERVICE APPLICATIONS

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The online world is rapidly becoming a part of everyday life, with references to e-mail and web addresses all around us. As growing numbers of homes and schools acquire the resources needed for access to the Internet, more and more students of all ages are coming into our classrooms with at least an introductory knowledge of how to use e-mail. the web, and other Internet tools. Telecommunications is no longer a rarity in the schools — the number of schools with no Internet access in place, or in the planning or wishing stages, is diminishing. Access, though, is not enough. Training must be provided, and this is where it is essential for Colleges of Education to step forward. The papers in this section illustrate a variety of approaches to this task.

Many teacher education programs have been responding to this challenge by developing ways to integrate telecommunications activities into the teacher preparation curriculum. George Davis and Rhonda Ficek, of Moorhead State University, describe one example of how they have redesigned the introductory education course so that "students will use technology to access a significant amount of the information used in these courses." Davis and Ficek describe how students use e-mail, the web, listservs, and newsgroups as essential components, while investigating the major course topics and completing projects. Students also have online access to course mentors—area principals and teachers available to answer questions from these preservice teachers.

Telementoring is recognized as an effective means of providing support for preservice teachers, as shown in the next two papers. In the first, Henry Dobson describes the Great Lakes Collaborative Telementoring Project, which "relies on computer-mediated learning supported by technology, and provides a mechanism for dialoging and sharing pedagogical practices constructed from experiences from the real-world." The online environment provides time- and distance-independent learning situations, with an emphasis on real-time learning in the area of elementary mathematics. In the second paper, Kathleen Weiss describes a telementoring project implemented in her reading class at the University of Houston, where preservice teachers were matched with content area mentors. Weiss also used a listserv to help link classmates, and found that students used it to continue discussions from the classroom.

Technology is no longer restricted to computer (or technology) classes—the Dobson and Weiss papers are but two examples. Carol Long, Mary Ito Dennison, and Sue Reehm describe a project in a Special Education course—Characteristics of Students with Mild Disabilities. Graduate and undergraduate students learn to use the Internet by locating, gathering, organizing content while refining and building upon the previously created web pages. The course emphasis is on the content, rather than the technology. Rick Seaman provides another example of Internet activities in content areas. He describes five activities carried out by preservice mathematics education teachers at the University of Regina. His students participate in a variety of activities at different levels, from observing through creating, to presenting their projects at a mathematics conference. Seaman's paper concludes with a group reflection statement, prepared by the preservice teachers, about their experiences.

Leslee Francis-Pelton and Ted Riecken describe the integration of telecommunications activities into four different courses. In social studies, the Camelot Project united preservice teachers and middle school students in an online activity to learn about the Middle Ages. Students assumed e-mail aliases as they participated in an online historical narrative. Francis-Pelton and Riecken also describe the use of telecommunications "as a tool to manage three courses for preservice math majors—a technology course, a mathematics methods course, and a mathematics content course." They compare the intent, the extent, and the results of the use of technology (e-mail, listservs, web use, and web construction) in each of these courses. In all classes, communication between teachers and students was increased by the use of e-mail.

Cynthia Hutchinson and Jerry Gardner describe the use of e-mail to "establish and maintain communication between student teachers and university professors." Students submit a variety of reports, as well as their reflection journals online, and faculty are able to respond immediately, as needed. The goal is for these students to continue using timely communication throughout their educational careers after this start.

Hutchinson, along with Gay Staats, Marjorie Adamczyk, Christine Scheer, Rebecca Boggs, and Darrae Norling, describes a partnership between a college of education and a K-5 school, who were joint recipients of an Apple Partners in Education Grant. University students participated in a field experience, where they worked with the elementary students to create web pages. Jackie Stokes describes a different type of collaboration between preservice teachers and elementary students. Most of the interaction takes place via e-mail, as students focus on the information processing that occurs while creating presentations, as well as on metacognitive aspects related to the task. The *school buddies* concept was used to pair students from the two different institutions, and the buddies communicated with each other about class assignments.

Another type of communication involves the use of listservs or newsgroups. Both of these allow for communication from one person to many, rather than the one-to-one relationship of the more traditional personal e-mail. The next two papers describe student use of listservs and newsgroups. Susan Powers and Karen Dutt-Doner used a newsgroup for communication with one class, and used a listserv for the same class the following semester. They saved all messages from both semesters, categorized and analyzed them, and report on the numbers and types of messages from each semester. The same five themes were evident each semester, although the emphasis differed. Mark Roddy also describes the use of a mailing list—he found eight broad areas of use. He illustrates the use of the list by providing examples of messages from one particular thread of conversation initiated by a student teacher. Roddy suggests that this method of communication is one way "to reconnect the theory held by the larger academic community to the particulars of the daily experience in the classroom."

Sandy Jean Hicks and Betty Young explain a unique approach to providing Internet training—a series of summer NetShop workshops. They describe the structure of the NetShops and the instruction, and present an analysis of pre- and post- surveys, to illustrate the concept. Unlike the other papers in this section, this was not conducted as part of a university course, although it was possible to get university credit for participation.

The final paper in this section is also unique. Sandra Atkins and Jacqueline Peck describe a project that, as in other papers, utilized e-mail as a communication mode. However, the communication was between preservice teachers at universities in two different states "to provide opportunities for preservice teachers to examine their own views of teaching diverse populations." Atkins and Peck have used examples of student e-mail to illustrate some of the understandings and knowledge gained by students at each location.

In his paper, Mark Roddy stated that "the electronic mailing list constitutes a powerful tool in the service of teacher education." We might generalize that statement to include the variety of online telecommunications resources, from e-mail to the web, and everything in between — the papers in this section support that concept.

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Using Project Teams with Internet Access in Preservice Teacher Preparation

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Moorhead State University's teacher education program, like many other programs, is working to incorporate technology into the preparation of its education majors. MSU has decided that the best way to do this is to redesign existing courses in teacher education is such a way that students will use technology to access a significant amount of the information used in these courses.

Introduction to Education is a three semester hour required course taken by all education majors as their first course in teacher education and has been so redesigned by the authors. The outcomes of the course are to:

- explore the profession of elementary and secondary teaching as practiced in the United States.
- understand the current re-invention of elementary and secondary education in the United States.
- gain an in-depth understanding of the Minnesota Graduation Standards currently being implemented K-12 statewide.
- begin to think like an elementary or secondary teacher.

A one semester hour (40 contact hours) field experience is a co-requirement of this course.

The four major assignments of the course take the students from a historical review of the U.S. industrial model school as an integral part of the industrial age to the current age of information which requires a new educational paradigm. Students explore this new educational paradigm as it has been defined by the national standards documents and the Minnesota Graduation Standards. Students also explore the growing diversity of learners in K-12 classrooms through a study of student exceptionalities. The course's final assignment requires students to examine several best practice examples of this new educational paradigm and contrast it with the current practice found in many U.S. K-12 classrooms today.

Teachers designing instruction based on the national and state standards recognize student exceptionalities as a key determiner of appropriate instruction and understand that all students process information as they construct their own knowledge of concepts taught. In the classrooms of these teachers, the use of technology as a way to access a wide range of information is a natural fit. In these classrooms students actively seek out information while the teacher functions as more of an instructional manager than a main source of information. The textbook is replaced as the other main source of information in favor of more primary sources of information including, but not limited to, those sources accessed by technology.

These concepts are not just talked about during Introduction to Education. The course is designed to deliver instruction based upon the use of primary texts, library sources, and information on the Internet combined with the 40 hours of field experience. All of this has replaced teacher lectures and a traditional textbook as main sources of information. In this manner the course gives teacher education majors experience using technology in the process of achieving the course outcomes, instead of having them just talk about how to use technology in instruction.

Redesigning the Course

The redesigning of the Introduction to Education course involved constructing the online environment, selecting appropriate support technologies, and finding relevant online materials for course content. The desired instructional content and outcomes were the primary guiding principle throughout. The temptation to include many of the latest technology tools was avoided in the interests of remaining committed to the goals set out for delivery of this course.

The online environment was constructed to provide access to the course syllabus, assignments, related readings, online information sources, and course mentors (practicing teachers and principals). In addition to the typical content on the course syllabus, links to e-mail addresses were provided for both instructors to facilitate student/teacher interaction. The mentor page contains pictures of the principals and teachers from area schools who agreed to answer questions from the preservice teachers in this course. Links to their biographical information and e-mail addresses were provided to encourage communication with experts in the teaching field. The assignments contained links to relevant online materials along with suggested traditional readings.

Selection of appropriate support technologies was more difficult. Our vision for the course suggested the following possibilities:

- Electronic mail to facilitate student/student and student/ teacher interaction
- Graphical web browser to provide access to online materials in both textual and graphical format
- Presentation software for use during group presentations to the class
- Groupware for collaborative group work on a single electronic document
- Listserv / newsgroups / web conferencing software to enhance communication between all members of the class

Electronic mail using the UNIX-based Pine software was one of the easier components to establish, since all students are encouraged to request an e-mail account as soon as they enter the university setting. Nearly all of the student labs on campus provide access to a graphical web browser (in most cases, it is Netscape). In addition, most student labs also provide access to PowerPoint as a presentation tool for preparing slides and transparencies. However, finding affordable tools for document sharing was not an easy task. After exploring the possibilities in Microsoft Word (which were complex and undependable in our lab setup) and discovering the expense of site licensing for other commercial groupware products, the decision was made to encourage collaboration on the group's research paper using electronic mail for the present. Finally, listservs and related technologies were examined to enhance communication between all class members. Web conferencing software seemed to be the best fit for the course objectives, since messages are threaded by topic, as opposed to a class listserv setting. No conferencing software existed on the campus web server, but a departmental web server running Microsoft's Front Page was suggested, and permission was secured to use that web server for this aspect of the course.

Current Course Operation

Introduction to Education is team taught by Drs. Davis and Ficek. Dr. Davis is the teacher educator for the course and leads instruction on the educational content (theory and practice) for the course. Dr. Ficek provides instruction in the skills required to use the web browser, electronic mail, presentation software, and web conferencing software. She also supervised the design of the course homepage and its maintenance.

The course has 40 students organized into ten four-person cooperative learning groups. Each group is responsible for three major papers and one multimedia presentation during the semester. Individual assignments are also required. The use of the Internet in this course includes regular e-mail among team members and course instructors. E-mail is both initiated by the student and sent in response to specific assignments made by the instructors. A news group is also maintained for the course.

All instruction pertaining to the use of software is conducted in a computer lab setting to provide all students with hands-on training. Several periods of instruction were devoted to the use of e-mail to send basic messages as well as attached documents. Students were introduced to a graphical web browser (Netscape) and were given a set of educational sites to visit. Instruction in organization of electronic findings using bookmarks with folders was followed by an assignment requiring students to organize their bookmarks into several pre-defined categories. In addition, online search strategies were explored.

The course then turned to more educational content as the students investigated the four major course topics. Each topic's assignment called for students, working as teams, to collect information on the topic by using the MSU library (searches are conducted using the university's computer PALS system), several articles on reserve, one of the course's required primary texts and several web sites. As the students progressed through the course, the number of information sources provided by the instructors declined and student teams were required to find their own information sources using the Internet and the MSU library.

During the latter part of the semester, instruction in the use of presentation software (using PowerPoint) is provided. The final team project is a multimedia presentation by each group for the entire class.

Future Course Enhancements

Now that the course has been offered in the redesigned format, several enhancements are planned for the next offering. The web conferencing environment will be integrated into all four group assignments. This will allow students to more effectively interact with their cooperative learning group outside of class. This should address student concerns about finding time to meet together as a group outside of class. Similarly, group assignments will be modified to make better use of the online mentors. This will give students the opportunity to interact with experts in the field when face-to-face interaction is not feasible.

Along these lines, encouraging students to become active in existing national online discussions pertaining to instructional issues, such as KidSphere, is an important goal. Many such discussion groups (listservs) are readily available, and an assignment is planned which will require students to participate in at least one listserv related to education.

Groupware is becoming more prevalent and affordable. As these products mature, the course will utilize this software to enhance online collaboration on research papers. Since four group members will provide input on the content of the papers, this software will make the job of the "senior editor" much easier, since contributors can annotate their suggested changes before actual incorporation into the document.

Additional web materials such as group pictures with e-mail addresses will be added to the course web environment. This online environment provides a rich opportunity to create a non-static set of materials which can be continually updated and enhanced.

Evaluating the Innovation

Since we are carrying out an instructional innovation (using the Internet to find information), we are monitoring our effectiveness in preparing students to succeed by using two instruments. At the beginning of the semester, a technology skills survey was distributed to each student. The information collected in this survey was used to tailor the technology instruction for the group, based on their past experiences with the various technologies.

The second instrument we are using is the Concerns Based Adoption Model (CBAM) Stages of Concern Questionnaire (Hall, George, & Rutherford, 1986). This instrument is given twice, before and after instruction, and is designed to measure the relative intensity of seven types of concerns people exhibit when faced with adopting an innovation. By determining the relative intensity of each type of concern for each student we are better able to adjust our instruction to address the higher intensity concerns of our students and therefore insure a greater level of student success.

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Telementoring: Training Preservice Teachers In The Next Millennium

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Changes in computer technology are changing the way future teachers are being trained. The advances in informa tion technology have significantly affected the way future educators will experience the process of becoming effective teachers. Teacher educators now possess the ability to become intellectual coaches, engaging their protégés as active learners through the use of computer-mediated communication, diverse databases of academic resources, and online/real-time telecommunication dialog. This new generation of preservice teachers is able to connect with learning projects related to real-life experiences in different educational environments. They are able to share similar and not so similar experiences with mentors, peers, and educational specialists. This new process is not text-bound in a college classroom filled with columns and rows of students, but is a dynamic medium interwoven with a collaboration of professionals at all levels.

Collaboration

The *Great Lakes Collaborative (GLC) Telementoring Project* was developed to improve the effectiveness of training preservice teachers, especially in the area of elementary mathematics. It involves a collaboration of those individuals who have significant impacts on teacher education: the preservice teachers, teacher educators or educational specialists, and the inservice or cooperating teachers. This telementoring project relies on computer-mediated learning supported by technology and provides a mechanism for dialoguing and sharing pedagogical practices constructed from experiences from the real-world. These practices can be shared, discussed, and evaluated at different times and at different locations. This scenario is entirely different from the traditional teacher training classrooms of textbook experiences, where everyone receives the same information at the same time and in the same place. With the telementoring project, preservice teachers are able to dialog with one or more teacher educators who act as consultants, or with other inservice or preservice teachers.

The GLC Telementoring Project is a distance-independent learning situation for preservice teachers. It can be on-site, in an elementary classroom, or in the living quarters of the preservice teacher. This type of learning is definitely time-independent and can be conducted in real-time or at different times. The technology supports dialog with or among teacher educators, other preservice teachers, inservice cooperating teachers, and educational specialists. This communication mode can be conducted with individuals or as a group using the conferencing software. It provides an effective way of addressing the individual needs of the preservice teachers. Computer-mediated, multi-modal communication is predominantly written communication and requires all participants to engage in the process if it is to be successful in training a new generation of preservice teachers. This type of format requires increased levels of maturity and motivation, as well as the ability to work independently on classroom projects. These developed or acquired attributes of time-independent learning are benchmarks of an effective teacher.

Real-Time Learning

The GLC Telementoring Project provides real-time learning that is independent of time, place, and distance. It uses online chat mode with real-time discussion groups promoting conferencing on special topics related to pedagogical skills or subject matter content areas. This type of learning must be coordinated with participants so that the preservice teachers can interact with other preservice teachers, educational specialists, and cooperating teachers.

Preservice teachers can benefit from the independent learning mode of the GLC Telementoring Project. They can work alone, using the academic resources available from the GLC Explorer Database of Academic Resources in Mathematics and Science. These academic resources include curriculum materials, appropriate software, and videos in tape and laser disc formats. In addition, the Explorer Database contains unit and lesson plans in mathematics and science. These lessons have been reviewed by experts in the field and are rated to be effective, correct in content and matched with various curricula and instructional levels. The teacher educator's role in this mode is one of being a human resource when needed to support the acquisition of pedagogical skills or comprehension of math or science concepts. Also, the teacher educator functions as an educational counselor, supporting, nurturing, and guiding the preservice teachers into successful careers as professional educators.

Life-Long Learners

The GLC Telementoring Project is well-suited to the development of the professional educator, an educator who will always be a *life-long learner*. An educator of the 21st century is one who will use technology to create a community of learners, not bound by textbooks, distance, time, or professional status.

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TELEMENTORING: PRESERVICE TEACHERS TO INSERVICE TEACHERS

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After surveying the literature on information technology and teacher education, Willis and Mehlinger (1996), concluded that "preservice teachers know very little about effective use of technology in education" (p. 978). Furthermore, teacher education is indicted for "not preparing educators to work in a technology enriched classroom" (p. 978). According to the Office of Technology Assessment [OTA] (1995), graduates of teacher education programs in the United States do not think of using technology as a "teaching tool." Even though students are taking computer literacy courses for teacher certification, they are not incorporating computers into their lessons when they become certified as teachers (OTA, 1995).

Technology in Teacher Education Programs

It is not enough for students to take a computer literacy course. Integration of technology must be modeled by the faculty in the college of education (OTA, 1995). The problem lies in the fact that present day faculty did not receive training in technology. This gap in training is part of the cause of technology not being modeled in teacher education programs (OTA).

Furthermore, technology needs to be incorporated into content area methods courses (Fullan, 1991; Novak, 1991; OTA, 1995). An introductory approach would be for students to communicate with content area professors by e-mail or on a listserv set up for the specific class.

Telecommunications

Findings from the *1995 Survey of Advance Telecommunications in U.S. Public Schools, K-12* (National Center for Education Statistics, 1996), reveal that 50% of U.S. public schools now have Internet capabilities, compared to 35% of the schools a year ago. Because there is an influx of telecommunications abilities in our schools, our preservice teachers need to know how to incorporate this into their teaching curriculum. Telecommunications is an easy first step for collaboration of faculty and students (Bishop-Clark & Huston, 1993).

Telecommunications Projects

An example of an on-going telecommunications project involves biology students at the University of Illinois (Levin, Levin, & Boehmer, 1994). Freshman biology students are involved in a model called teaching apprenticeship. Students are apprenticed by a community of educators through e-mail.

The Internet-based *Electronic Emissary Project* (Jones & Harris, 1995) is still another example of an on-going telecommunications project. It matches teachers with subject matter experts. One of the benefits of this program is the promotion of collaborative learning.

Telementoring: Preservice to Inservice Teachers

The modeling of these and other electronic projects that fill the literature has influenced this author to venture out on her own. Preservice teachers from the author's *Reading in the Content Area* methods class were chosen for this research project. As previously mentioned, the literature supports modeling of the integration of technology in methods courses.

Mentor teachers from all over the USA and Australia volunteered by way of an educational listserv. The mentors had a plethora of teaching experience. Many of the mentors hold master's degrees and have their own web pages. One mentor has recently published an article about her own online experience in the classroom.

The preservice teachers, prior to being matched with content area mentors, were administered the *Computer Attitude Measure* (Kay, 1989). The measure consists of Likert type questions in the behavioral, affective, and cognitive areas. The survey can easily be completed in fifteen minutes.

Next, the instructor modeled the creation and sending of a short e-mail message for the preservice teachers. At that time, a computer technologist was not available. For some students, this demonstration was enough. However, for the students who had not obtained their university e-mail address, this was a more cumbersome task.

Originally the preservice teachers were asked to communicate with their mentors six times in the semester. Later in the semester the instructor revised the number of communications to four. The quality of the messages was more important than the quantity.

The author originally was looking at the effectiveness of implementing electronic mentoring in a methods course. It soon became clear that other components of technology could influence preservice implementation of technology in these students' classrooms.

Setting up a listserv for this class was another way to model technology. The listserv was aptly named *scaffold*. The listserv was one mode of communication linking the classmates. Students had the option of sharing valuable teaching tips from their mentors. This was also a way for students to continue discussions from the classroom.

The instructor was also able to communicate with the students without having to wait until the following week. In examining the end of the semester reflections, students who did not feel as comfortable with an electronic mentor were more comfortable communicating on the listserv. On the other hand, some of the students who had a working relationship with their mentor were not as impressed with the listserv. The instructor was able to see patterns emerge on the listserv. In the beginning, it was viewed as a place to socialize, even share jokes. As the semester progressed students shared information from their mentor regarding discipline, first year teacher anxieties, lesson plans. Late in the semester the students were sharing web sites they found on the Internet and recommending technology articles they read!

The majority of the class was excited to receive an electronic mentor. Matching each preservice teacher with a mentor in the appropriate content area was a definite challenge. The biggest problem was the inordinate amount of all level music majors. None of my original volunteers were music teachers, so I had to rely on local mentors for the music preservice teachers.

Reflections

Within a week after receiving the mentor, students began to share their successes. As an instructor it was a good feeling to share in students' successes. The honeymoon was short lived. My e-mail soon became a complaint department! Fullan's (1991) comment that "conflict is essential to any successful change effort" became my solace (p. 27). Some of the students had unrealistic expectations as far as how rapidly a mentor could answer their myriad of questions. They somehow forgot that these dedicated men and women were teachers with other responsibilities as well.

Logistics was another problem for some of the students. Not all students owned a home computer. It depended on their class schedules as far as how often they were able to check their e-mail messages. One of my students suggested that in future that a few minutes out of class time be allotted to check and send e-mail messages. This might be a practical suggestion worth pursuing.

Preservice teachers that felt a kinship with their mentors remarked: "We have the same philosophy of teaching, we are so alike in our thinking, we are passionate about teaching."

The preservice teachers that developed a nurturing bond with their mentors were able to be open to suggestions from these mentors.

Even though some students were reticent in the beginning about having an e-mail mentor, most of the students felt it was a beneficial project by the end of the semester. Many of the students plan to continue to communicate with their e-mail mentor. The students especially look forward to communicating with their mentor when they are involved with student teaching.

Implications for Future Research

This research project was an initial attempt of a college of education methods instructor to model the integration of technology. The rationale was based on a review of the literature. This is just one way to model technology in teacher education programs. More in depth research needs to be conducted in the area of technology in methods courses. This semester our class has only scratched the surface. It is a first start.

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An Ongoing Project to Teach Content through WWW Publishing

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To enhance learning and the acquisition of technological skills, preservice teachers at Winona State University enrolled in a Special Education course have been involved in an ongoing project. The project encompasses the development and revision of interactive web pages connecting content, recent research, and local, state, national and online resources pertaining to learning disabilities and mental retardation (Long, Dennison, & Reehm, 1996).

The Project

Winter quarter of 1996, students taking the Characteristics of Students with Mild Disabilities course created 15 web pages which were linked to the Department of Special Education home page. The pages provided definitions for the two disability categories and reflected national and state interpretations. Lists of common characteristics of children with learning disabilities and children with mild mental retardation, a bibliography of recent research, and resources for locating further information and assistance were published.

The class was organized so that graduate students enrolled in the course were leaders for undergraduates team members. The graduate students were evenly distributed among the teams and were instructed in HTML and web page design. The responsibility of the graduate students was to program the pages and to supervise the undergraduate students who researched information for page content. In subsequent quarters, students enrolled in the course have revised and added to the web pages using the same organizational structure.

As the project has evolved, the role of the students has changed. The first class that participated in the project had the primary goal of publishing on the World Wide Web, and a great deal of effort was put into programming as opposed to focusing on content. Later classes have had the advantage of being in the position to refine and build upon what already exists. Now the emphasis is on evaluating and critiquing what has been published, revising, reorganizing, and providing additional material.

To date, the students have made several major changes. For example, the research bibliography was annotated, expanded and categorized. Student generated definitions for learning disabilities and mental retardation were included along with formal definitions and e-mail addresses and web sites were linked to agencies listed in the resource directories.

Project Evaluation

Evaluation of the project has been conducted in three parts each quarter. First a pretest was administered to determine attitudes toward technology and perceived Internet competence. Second, the same survey was given as a section of a posttest at the end of the quarter and, third, the posttest also contained a portion asking the students to compare their knowledge gained from this project to projects in other classes.

In comparing the results of the pretest questions, the students have consistently reported the following personal perceptions. They considered it very important for teachers to know how to use a computer, acknowledged the need for computers to be used in every classroom, and reported they were comfortable working with computers.

Analysis has found significant increases in the students' knowledge levels for locating information on the Internet—using Netscape, gopher, telnet, listservs, e-mail, and FAQs; defining search engines, URLs, and home page; and publishing home pages. None of this information has related to skills directly taught during the course. The students learned how to use the Internet by locating information on the web and gathering and organizing the information to create and expand the web pages (Long, Dennison, & Reehm, 1996).

Upon completing the web pages, the students have reported they felt the project was worthwhile with graduates rating it more so than undergraduates. The students have rated their learning greater from this project in the areas of content knowledge and working as a team, than projects in other classes. Students thought the project was superior in several ways to projects assigned for other classes but that it required more effort, more time, and more organizational skills on their part. An overwhelming majority indicated they would like to do a similar project for another class with all of the graduate students wanting to do so.

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WEB SITES AND TEACHING WITH THE INTERNET FOR PRESERVICE TEACHERS

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This paper describes how preservice mathematics education teachers at the University of Regina became familiar with the Internet during their pre-internship year. The preservice teachers participated in a math project that required use of the Internet, became involved in a web site, developed their own mathematics Internet projects, presented their projects at a mathematics conference, and reflected upon their mathematics Internet project.

The web site chosen was Math Central, which became an Internet site in September 1995 and is maintained by faculty and students in mathematics and mathematics education at the University of Regina in Regina, Saskatchewan, Canada (http://MathCentral.uregina.ca). Math Central is a place for teachers to share resources, have mathematical questions answered, and carry on a dialogue amongst themselves. The site is presently administered by Drs. Denis Hanson, Vi Maeers and Harley Weston. The description of activities in which the preservice teachers were involved will include a more complete description of Math Central.

Activity One: Involvement in and Development of a Mathematics Internet Project

For one of the activities, the preservice teachers set up potential mathematics Internet projects for their internship. To gain a better understanding of this process, the preservice teachers were informed at the beginning of September, about a high school mathematics Internet project found on a listserv, and were asked if they were interested in becoming involved. They agreed to participate and, at the conclusion of the project, to describe their feelings about being part of such a project. The project entailed responding to a survey prepared by high school students in an eastern United States high school. The responses, gathered by e-mail, would help the high school students learn the survey research process, including sampling designs, questionnaire design, data collection, and data analysis. The high school students would then determine whether any two groups of participating students differed significantly in their responses to the survey. Some of the countries that responded to the survey were Hong Kong, Canada, United Kingdom, Mexico, Australia, Germany, and Spain.

Since many diverse countries responded to the survey, it was possible that several questions in the survey might be misinterpreted due to differences in culture. As a pilot, the teachers of participating schools were asked to review the survey's questions and suggest changes before the actual administration of the survey. Even though the preservice teachers were high school graduates, they were allowed to participate in the survey that was constructed for 14 to 18 year old students. By the end of September the survey had been piloted and final changes made to its questions. Some of the questions requested respondent information about language(s) spoken, how many people were resided with, how many hours per week were spent watching television (doing homework), age of the respondent, and gender. Participants were asked to e-mail the completed forms to the high school students by mid-October. On October 23 we received the raw data concerning other participating groups and a thank you for helping out with the project. We were told the high school students were presently analyzing the data and were to complete a report by October 28.

Looking back at their involvement in the Internet project, there was an appreciation of all the work the high school students had gone through. However, the preservice teachers concluded that it is valuable to show the final results of projects that people have participated in, not merely provide raw data. They also decided that such a survey could have its origins and analysis in mathematics but also have an impact on other subjects such as Health, Social Studies, History, and Geography. The preservice teachers were beginning to understand what it takes to develop a mathematics Internet project properly. It was now time for them to develop their own mathematics Internet projects.

The preservice teachers divided themselves into three groups of either five or six people. The first group considered sports team web pages on the Internet because they are plentiful and easily accessible. These pages were found to contain the past and present statistics for teams and players. Using the information on these pages helped demonstrate the applicability of mathematics in some of the areas that students enjoy, but which are not ordinarily considered as areas involving mathematics. An objective was to have students learn different ways to represent and statistically analyze the data of a particular team, in addition to working on problems dealing with proportional reasoning. Their project concluded with some questions that students might be asked and a list of other possible sites.

The second group developed their version of how they would run a survey on the Internet. They would have a group of students pick a topic from a given list (e.g., school, family, personal, geography etc.) and then brainstorm for possible survey questions. A ceiling on the number of questions that could be asked within each topic would then be decided upon. They would then find schools that were willing to participate through web sites, listservs, etc. Data collected would be prominently displayed in their classroom and their students would be involved in collecting and disseminating the results to the participating schools. To facilitate this process the students would use various statistical methods to represent and analyze the results much like the survey in which they had been involved. In contrast, they would get the comparisons out to each participating school as soon as possible, so that a discussion of the results using e-mail could follow. The objective was to have other subjects such as Health, Social Studies, History and Geography become involved in what was initially only a mathematics topic .

Group Three's project involved developing a list and description of sites on the Internet that might benefit teachers, students, and parents concerning mathematics. Addresses and brief summaries of some sites were included along with downloaded examples. They also included a sample lesson so that the reader could see how an Internet site might be included in a lesson plan.

Activity One was an ongoing project from September to November. During this time period the preservice teachers were also familiarizing themselves with other Internet resources, in particular, Math Central.

Activity Two: Joining and Involvement in a Web Site

The site chosen in which to become involved was Math Central. Other sites could also have been chosen but this site was selected because it was located at the University of Regina. Math Central has a discussion forum for teachers of mathematics (Teacher Talk), a question and answer area for students and teachers (Quandaries and Queries), and a sharing place for mathematics resources (Resource Room). In September the preservice teachers subscribed to Teacher Talk and began their interaction with the web site.

The preservice teachers received e-mail daily from Teacher Talk while preparing questions to be submitted to Quandaries and Queries for discussion on Teacher Talk. Some of the questions asked dealt with the memorization of formulae, use of calculators in the classroom, assessing group work, the value of grade 12 calculus, Internet math lessons, and how to teach the composition of functions. They received replies, from all over the world, that were enriched with teachers' experiences and research.. One preservice teacher was able to make contact with a teacher in the field that resulted in the two of them planning to set up a project between their classes in the fall during the preservice teacher's internship. Another response caused a preservice teacher's position to 'soften' on the use of calculators in the classroom. Some would have liked to have had more responses to their queries, and as a result joined other listservs to get more responses. Overall, the preservice teachers found the experience worthwhile and found new ideas that would help them during their internship. They also said they would use this service again.

Activity Three: Contributing to the Resource Room

Math Central has a place where mathematics educators can share resources—the Resource Room. The preservice teachers were to send to the Resource Room three ideas (one from each group) concerning the teaching of mathematics. The contributions made were a game to help in the teaching of adding and subtracting integers, ideas for teaching the Pythagorean Theorem, and a short comment concerning the Babylonian number system. These contributions will be placed into the appropriate educational level and curriculum strand at Math Central.

Activity Four: Identification and Critique of Mathematics Sites

Each group of preservice teachers was asked to identify and critique three sites that would help them during their internship. Each student identified specific locations, and each group came to a consensus on which three they felt would be the best. The sites chosen offered the preservice teachers resources, sources of problems, ways to apply mathematics, data sources for math projects, lesson plans, and a site that helps new teachers make the transition to their new profession. The initial screen of each site was downloaded to assist in the identification and selection process of the sites by each group.

Activity Five: Presentation of Internet Projects at a Mathematics Conference

At the end of October, the preservice teachers were given an hour and a half to present their mathematics Internet Projects at a K-12 mathematics conference that included math educators from all over the province of Saskatchewan. The preservice teachers not only discussed what they were doing, but also talked to teachers 'in the halls' about what use they were making of the Internet. Although their presentations went fairly well, they had high expectations and would have liked to have seen a better turnout. However, they felt it was an excellent experience and enjoyed talking with those teachers who had the Internet in their classroom. Overall, the experience of being at their first mathematics conference was an educational one–from their presentation to others' presentations and from the workshops to the displays.

Preservice Teachers' Reflections

The preservice teachers submitted a *group reflection* concerning their mathematics Internet project experiences. The following is their statement.

This project was not only an educational experience but also a practical exercise that we will be able to use in the future when we are teaching. Through this project, we became familiar with the Internet and learned how to use it to our advantage. At the beginning of the project, many of us were not comfortable with using the Internet but this project took away the fear of technology. The Internet gave us ideas on lesson planning, evaluation, making adaptations, and projects for the students. We also discovered that the Internet is not only a place for resources but it also serves as a means of communicating through e-mail and listservs. These allow teachers from all over the world to share their ideas. The Internet seems to 'shrink' the world.

This project also taught us the importance of working with other people. Group work involves cooperation and management skills. It is important that as future teachers we recognize how important it is to work effectively in groups. Students need to be exposed to group work and teachers also must learn how to work together. People have a lot to learn by working with each other.

Even though there are many advantages to working with the Internet, there are also disadvantages. We thought that it was hard to find original things to do with the Internet. Sometimes working with the Internet is a time consuming experience because you have to sort through a lot of 'garbage' before you find something worthwhile. It is important that as teachers we are aware of the 'garbage'. It is important that we are able to judge whether or not the information we are receiving is accurate and reliable.

Overall, this project was a real eye opener for all of us. It showed us the power of technology and how to make use of it in our classrooms. It is important that we became familiar with the Internet because it is going to be a big part of everyone's lives in the future. By learning how to use the Internet in educational settings, we have taken a step ahead of current teachers who have limited computer experience. We can now use our knowledge of this new technology to teach them and bring them up to speed with the world of technology.

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Preservice Teachers' Use of Telecommunications in Mathematics and Social Studies

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The Internet is the most rapidly expanding means of mass communication in the world today. As of 1995, there were over seven million computers on the Internet and a new network was being connected every 30 minutes (Cerf, 1995). With an almost 100% annual growth rate, these figures should now be double those amounts. Over half of this growth is in countries outside the United States, making the Internet a veritable library of worldwide resources.

The rapid rise of popularity and accessibility of Internet resources has implications for education and the training of teachers. As more schools become connected to the Internet, schools need teachers with Internet skills among their repertoire of computer skills. Although many universities now require students to complete a course on using computer technology as part of their teacher education programs, most such courses do not provide enough time to cover the scope of technology use in the classroom (Bruder, 1989). Students are often given only a limited exposure to the resources and possible classroom uses of the Internet, as it is only one topic out of many.

Studies over the last seven years have consistently indicated that less than one-third of students leaving teacher education programs felt adequately prepared to teach using computers (Fulton, 1989; Handler, 1993; Scrogan, 1992). Barker (1994) noted that teachers show great enthusiasm for using computers, but often find it difficult to integrate technology into the curriculum. Preservice teachers rating the importance of a variety of computer skills rated as highest those skills with which they were most familiar and confident in usage (Francis-Pelton & Pelton, 1996).

If we wish teachers to use the resources of the Internet in their classes, we need to provide experiences beyond short segments of a technology course. Internet usage should be woven throughout the teachers' education program in such a way that they gain confidence, skill in Internet usage, and models of how the Internet can be used to enhance education. This paper will highlight two projects that used telecommunications in preservice teacher education settings as a tool for learning rather than as the subject to be learned.

The Camelot Project: Interactive Electronic Storying

The Camelot Project was a joint school-university initiative in which preservice teachers and middle school students used e-mail to learn about the Middle Ages. The project was conceived by Dr. Ted Riecken of the Faculty of Education at the University of Victoria and Jordan Tinney, Vice-Principal of Bayside Middle School in Brentwood Bay, British Columbia, and was implemented in the 1994-95 school year. Sixteen preservice teachers enrolled in a senior level social studies methodology class used e-mail to work with a group of 15 middle school students to create two virtual communities which then engaged in a dramatic role play about life in medieval times. Built upon Egan's (1989, 1990) theories about teaching as storytelling and the role of imagination in learning, the Camelot Project explored the potential of electronic mail as a vehicle for engaging students in interactive learning about social studies topics. Project students at the university and the middle school each assumed an e-mail alias and sent messages back and forth between their virtual communities to develop a living and interactive historical narrative which explored different aspects of life in the Middle Ages. Topics that students explored included treachery and intrigue in medieval politics, the role of women in medieval society and the tension between pagan and emerging Christian belief systems in the Middle Ages.

Structuring the Interactions

The original vision for the project was to create a kind of multi-user domain (MUD) using a beta version of an e-mail package being developed by the British Columbia Ministry of Education. The software, known as OnRamp, was designed for use in a Macintosh environment and supported the inclusion of sounds and graphics along with e-mail messages. A sophisticated drag and drop addressing system made the system very easy for students and novice users to use. We discovered very early in the life of the project that we would not be able to achieve our intention of guiding the middle school students' learning about the Middle Ages through involving them in a carefully crafted storyline. We discovered there is a strong incompatibility between predetermined educational outcomes and the kind of free-flowing dialogue and plot twists that characterize a living interactive story created via group interaction. With more than 30 individuals involved in the interactive dialogue, the task of maintaining a coherent storyline proved to be impossible. The combinations and permutations of different individuals sending messages back and forth was so great that it proved impossible to manage the overall plot that was to give structure to the interaction. What we opted for instead, was to put students at each setting into groups of four or five with each set of paired groupings having their own storyline and themes. Thus, each group of four or five students from the middle school interacted with a similarly sized group at the university.

Developing Students' Historical Understanding

From a social studies perspective, one of the goals of the project was to help the middle school students develop what social studies researchers refer to as "historical understanding" (Downey & Levstik, 1989). Such an understanding involves recognizing that people living in time periods other than our own, usually had a different set of material resources, values, customs and beliefs than those which characterize our own time period. For example, the following segment of e-mail correspondence between Jordan Tinney, in his role as King Arthur, and a middle school student who was involved in the project, reflects a distinct lack of historical understanding on the part of the student.

King Arthur: (Jordan Tinney)

> Welcome to the Middle Ages. A time of Kings and a time of wizards.... I am King Arthur and I welcome you to the Court of Camelot. You have each been selected from a large group of people to join me in my court, and as such you will be given a room in my castle. I would like you to decide what you would like placed in your room and I will have the servants attend to your every need.
>
> Student reply
>
> In my room I want to have a bed, a bookshelf, a Power PC like yours, a matter transporter pad, a replicator, a trap door that is in front of the door, and an electronic steel door with voice password. [Electronic mail, Bayside Middle School, November, 1994]

As indicated in the student's reply there is a clear lack of understanding about what life was like in the Middle Ages. Some of the devices the student requests are from our own historical era and others, such as a matter transporter pad, do not even exist except in the realm of science fiction. Over the course of the project, the middle school students appeared to develop a richer and deeper understanding of what life may have been like in the Middle Ages.

The Development of Voice

A significant, but unintended outcome of the project was the way the interactive electronic storying allowed some of the middle school students to express themselves in a manner not usually available to them in a regular classroom setting. When, at the end of the project, the two groups removed their aliases and revealed who they "really" were, it turned out that the keenest middle school participants were girls who were normally very quiet and reserved in class settings. This finding is significant because although computer technologies are still perceived to be more of a male domain, in this case, the technologies appeared to enhance and increase the educational involvement of a number of normally very reserved adolescent girls. What was especially startling about this discovery was the depth and sentiment of the involvement of the young female participants from the middle school. One of them, masked from gender based preconceptions through her genderless alias of "The Labyrinth" made particularly powerful contributions to her group's interactive story. The following excerpt, although presented out of context, shows the creativity and depth of involvement that the project elicited from one of the girls.

Dearest Vivien,

> If you seek haven you may come to my castle to the east of Camelot...Journey to the top of the mountain and speak my name three times. I will appear and take you to my castle. I have offered Eleanor and Piedmont the same offer, and if you know of any others who need a safe haven, speak to me. You must trust them completely before you offer them haven. I will be away for the next ten days on a mission which I will tell you about when I return. I sincerely hope that nothing fatal happens to Camelot or UVicshire, for I know many have seen visions and felt the evil coming upon us. Lord Dudley is angry and mightier than he appears.
>
> If life is so dear or peace so sweet, is it to be purchased at the price of chains and slavery? Forbid it, Almighty God! I know not what course others may take; but as for me, give me liberty or give me death.
>
> Signed Labyrinth [Electronic mail, Bayside Middle School, March 1995]

That this e-mail based project was able to allow for the involvement of the girls in this manner points to some interesting research directions for those who study the gendered dimensions of computing. Pipher's (1995) recent work on the drop in self-esteem experienced by adolescent girls points to the importance of voice and self expression for teenaged girls. Whether the use of computer technologies and e-mail exchanges such as the one described here can promote positive self image for adolescent females is an important research question that needs further investigation.

What Was Learned From The Camelot Project

The Camelot Project provided evidence of the strong potential that electronic exchanges have for teaching and learning. Over the duration of the project, the middle school students' responses indicated a growth in understanding of the subject area even though content was explored through imaginary and fictional settings. As a medium for involving students in their learning, electronic mail appeared to offer a number of girls opportunities to express themselves in a manner not normally available to them in regular classroom interactions.

Managing Courses Through Telecommunications

Telecommunications was used as a tool to manage three different courses for preservice mathematics teachers - a technology course, a mathematics methods course, and a mathematics content course. Although very different in focus, each course had a World Wide Web home page which included a course syllabus, readings, assignments, and links to Internet resources useful for that particular course. Use of these resources varied widely due to the varying nature of the courses and the extent to which technology was a course focus.

The Technology Course

The technology course began with a three week instructional segment on the use of the Internet, e-mail, and web page construction using the Hypertext Markup Language (HTML). By the end of their first week in the course students were required to send an e-mail message to someone and to reply to any message they received. They were also to choose a listserv of interest to them, sign up, and participate in it.

Students' first major assignment was an on-going assignment involving construction and regular updates of their own home page, which was then linked to the course home page. Students were required to include appropriate links of their choice to a variety of educational resources in predefined categories. Required resources included:

- a source for lesson plans useful in teaching their subjects
- a source for shareware/freeware which could be downloaded
- a resource such as a database or graphics
- their favorite search engine
- an electronic journal that would be a useful resource for them as teachers
- a company/products
- information available through the Internet that could be used in a class project or problem solving activity.

Home pages could be further personalized by including color and graphics and any additional links of interest to the student.

All students were expected to participate at least weekly in a course newsgroup accessible from the course home page. The first assignment for the newsgroup was to sign in and introduce themselves to others. In subsequent weeks students were expected to comment on reading assignments or respond to questions posted for discussion purposes. A log was kept of all postings to the newsgroups.

Course readings were links from a readings page to appropriate articles or resources selected to coordinate with the current topic. Some were links to resources at other locations throughout the world, while others were links to pages assembled by the course instructor.

Assignments were also managed via the Internet. Descriptions and grading criteria were given on an assignments page. Assignments consisted of preparing classroom activities utilizing the following applications:

- Spreadsheet or database
- Geometer's Sketchpad
- A graphics package of their choice
- HyperCard
- A symbol manipulator, graphing utility, or graphing calculator.

Assignments were sent to the instructor as e-mail attachments. Feedback from the teacher was also sent to the students as an e-mail message.

The Mathematics Methods Course

The mathematics methods course began, like the technology course, with an instructional segment on use of the Internet. However, as technology was not the focus of this course, only one week of instruction was given on use of the Internet and HTML. All but one student entering the course were already using e-mail, so no class time was devoted to this topic.

As with the technology course, the first major assignment was constructing a personal home page, with updates throughout the semester to add links and resources to the page. Required resources were the same as those required in the technology course. Again, all home pages were linked to the class home page and readings consisted of both links to teacher generated pages and other resources on the World Wide Web.

By contrast, class communication for this course was conducted via a class mailing list. There was no direct requirement to participate in discussions through the class list, but students could use this list as a convenient way of disseminating information to other students in the class.

Assignments for the course were described on the course home page and primarily involved developing teaching materials for use in the practicum the following semester. No assignment other than the construction of a personal home page directly required students to use technology. All students were required to share the materials they had developed with other students. Many chose to do this using technology. Students' most frequent use of the course mailing list was for this purpose. Feedback for any assignments submitted electronically to the instructor was by personal e-mail messages to the student.

The Geometry Course

The mathematics course was a traditional third year geometry course, focusing on axioms, proofs and geometric relationships. Instruction focused on the mathematical content. No direct instruction on the Internet was provided, but course materials and related resources were provided through a course home page. The software program, Geometer's Sketchpad, was frequently used for both instruction and student assignments.

E-mail accounts were provided to enable students to submit assignments completed with Geometer's Sketchpad electronically. A course mailing list was also available, but was used very little by the students. Most telecommunications use was limited to submission of assignments or asking questions of the instructor.

Findings Related to the Three Groups

In course end surveys, students rated exposure to the Internet, e-mail, and making personal home pages among the most useful topics in the technology course and the math methods course. Not only did computer use increase for course related work, but students also reported an average of five hours/week of computer use unrelated to the courses. The geometry course, by contrast, made little mention of the Internet as playing an important role in the course. Although the students did appreciate the benefits of technology, they focused on the mathematical content rather than the technology tools of the course.

All three groups appreciated the ability to communicate and update course materials on the WWW. The ease of editing and changing web pages allowed announcements, modifications, or additions to be made as needed. Record keeping and management of assignments was enhanced as all e-mail messages and attachments were automatically logged and saved. Comments could be easily typed in an e-mail message while marking the assignments and the length and detail of the feedback to students increased.

Drawbacks to electronic transmission of assignments were also noticed. In the technology and geometry courses, attachments worked very well, as students were completing assignments using a common software package. However, in the math methods course students were mainly using word processing to complete assignments. Assignments were not submitted in a standard format using a standard package, and often there were difficulties retrieving and reading the assignments. Students frequently had to resubmit assignments as text files. This limited the ability to include graphics, formatting, and other enhancements. Some students chose to resubmit assignments by printing them out. If assignments are to be submitted electronically, guidelines need to be established early to define acceptable formats for submission to avoid student frustration.

E-mail increased teacher-student communication in all three courses. Many students took the opportunity to write the instructor to ask questions, comment on the assignments or courses in general. The Usenet group was less effective for mass communication than the mailing lists, as most students participated only as a class requirement and did not take the time to read comments posted by others in the class. Mailing lists were preferred by students, as they could check their e-mail from home without needing to use a browser.

Using the Internet to manage a course allows students to learn valuable skills through experience. Confidence increases because skills are continually reinforced, and they transfer more easily to other tasks. As the Internet continues to grow, more resources will be available and teachers and students alike can benefit from improved access to more current resources and the flexibility and efficiency offered by the Internet.

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Using the Internet to Improve the Student Teaching Experience

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At The University of Central Florida a group of faculty members was frustrated by the limited number of contacts we typically had with each student teacher. The reasons for this included budgetary restrictions on travel to each school site, the number of students supervised, and the time available for supervision. A review of literature suggested that there might be a solution to our frustration right at our fingertips - when seated at our computers, that is. Electronic mail could be used to establish and maintain communication between student teachers and university professors (Casey, 1994; Casey & Vogt, 1994; Hoover, 1994; Lowe, 1993; Thompson & Hamilton, 1991).

To facilitate the transition of student teachers to experienced professionals, *Teacher Net* (Casey, 1994) in California and *Dial-a-Teacher* (Lowe, 1993) in Texas were implemented. Both were computer networks that used electronic mail (e-mail) to provide contact and support between student teachers and education professors. This idea of a 911 for student teachers was very appealing to professors seeking ways to improve student teacher morale and confidence (Lowe, 1993).

In the fall semester of 1996 a group of junior and senior student teachers at The University of Central Florida was asked to use the university-wide e-mail system, called Pegasus, to keep in contact with the college coordinators who would supervise their internships. The University had just begun a more active use of its e-mail system, striving to have a "paperless" system of communication. The faculty involved were all familiar users of the system, having been introduced to e-mail and its uses through professional development activities. The students, however, were at various levels of familiarity with e-mail.

How Student Teachers Get Connected

All students are given a computer account with e-mail and Internet access when they enroll in classes at the university. Students can access this account on campus at any computer lab or at home via a modem. Some students in the pilot project were active users of the system, others were surprised that they had such accounts.

In addition, all teachers in the state of Florida have free access to the Florida Information Resource Network (FIRN), for e-mail and Internet access. Student teachers in schools with Internet access could use FIRN to connect to the Pegasus server.

How Email is Used

Every student teacher has a variety of reports and an application to complete prior to and during the internship period. In this pilot project these reports were e-mailed to the college coordinator. For example, first day reports, daily schedules, first impression papers and the reflection journal/continuous log were e-mailed regularly to the college coordinator. These documents could be saved, printed, and responded to immediately. The college coordinator no longer had to wait for the next visit to the site school to review these documents.

Reflection Journals/Continuous Logs

The use of e-mail has been most successful with the reflection journal/continuous log. Previously, some of the journal/log entries seemed to be written the night before the due date. The reflections often lacked depth or true feeling. Now, the college coordinator receives weekly, and in some cases daily, e-mail messages which reflect greater credibility and opportune reactions. A response to the reflections can be given immediately. Responses could include strategies for improvement, ideas for content enhancement, or approaches to classroom management.

Communication with Supervising Teachers

College coordinators could also use e-mail to communicate with the supervising teachers. Prior to accepting a student teacher, supervising teachers are required by the state of Florida to complete clinical supervision training. This shared responsibility gives the college coordinator more time to work with the school on curriculum development, technology implementation, or other projects. E-mail was a very efficient way to keep in touch during the supervision process and to share information related to the other projects. Some of the e-mail communication included a listing of possible Internet sites and announcements of university workshops and presentations.

What We Are Learning

We have learned that there are advantages and disadvantages to using e-mail with student teachers. The advantages of using e-mail for journals and other forms of communication are numerous. Both students and college coordinators attest to the ease over the traditional forms of telephone and regular mail. The junior year student teachers are usually on campus only two or three days per week so students feel it is easier to contact the college coordinator using e-mail. When college coordinators are available, their schedules do not usually coincide with the student teacher's for personal consultation. With teaching loads being two to four classes at the university, office hours are usually at times when student teachers are in the public schools.

When student teachers were surveyed, they made the following comments about the advantages of using e-mail:

> I don't have to worry about how I'm going to get it (journal) to you since I'm not on campus very much. I like the fact that I HAVE to get used to using the Internet. Now I'm more willing to use e-mail to communicate with friends at other schools.

> It is neat to talk about a problem on a given day and to have suggestions from you concerning an alternate approach to fixing classroom management or a particular teaching strategy.

> It is good for me to organize my thoughts using Microsoft Works, use the spell-checker, and then copy/paste it to e-mail.

The disadvantages seem to be mostly centered around the problem of computer accessibility. The following are comments made about the disadvantages:

> I have to remember to check my e-mail which I am not used to doing yet.

> I don't have the time to write about everything I do everyday I intern.

> E-mail is always busy when I try to connect from my home computer.

> Sometimes it's hard to get online from off campus.

> It's a drag waiting in line to use a computer lab on campus.

> A computer lab for interns only would be nice and make it more easily usable.

Conclusion

A professional teacher communicates in a timely manner with students, colleagues, and administration. As a result of this pilot project, it is our hope that these student teachers will consider clear, timely communication a top priority. This will enable them to comply with all deadlines for information exchange with the university during their student teaching and, it is hoped, that there will be some carry-over into their future careers.

While we have found both advantages and disadvantages to our use of e-mail, we need to improve the system in the following ways:

1. Provide a clear list of expectations concerning the e-mail process for the student teachers at the beginning of the internship (See E-mail Procedures for Internship I)
2. Provide a listing of alternative computer labs to enable the student teachers to solve the problem of accessibility
3. Distribute additional questionnaires to determine the suitability of the project both during and after the internship is completed
4. Expand the use of e-mail for communication between the college coordinators and the cooperating teachers
5. Encourage student teachers to use e-mail to communicate with other student teachers.

Using e-mail during student teaching allowed for success for all concerned. Problems with classroom management, lesson plans, subject matter, and teaching strategies could be addressed in a timely manner which resulted in the student teacher's progression at a much faster and substantial rate. We look forward to a new semester with the improvements suggested.

Appendix: E-mail Procedures for Internship I

A professional teacher reflects upon/evaluates the lesson content, his/her delivery of instruction and the students' responses, and revises/improves lessons as necessary. Student teachers will reflect on and discuss with their supervisors the effectiveness of their lessons, their presentation, and the student responses. They will then revise written lessons accordingly, and re-teach the lesson, if possible.

1. Communication with Mr. Gardner, Dr. Kassner and Dr. Scott-Kassner is an important part of your success in assuming the role of a professional. If you do not have access to a computer, problem solve so that you can use one at least twice a week (all public schools have computers).
2. E-mail addresses: jgardner@pegasus.cc.ucf.edu and kassnerk@aol.com
3. Phone numbers: Gardner 823-2864 (w) 629-8228 (h) and Kassner 823-6493 (w) 426-7134 (h)

4. You can copy word processing documents and paste into your e-mail.
5. Keep all hard copies for your portfolio.
6. Daily reflections should include lesson plans and reflections of how the class progressed. If you are reflecting on an observation, include an outline of the lesson and your evaluation of the teaching/learning process.
7. You will be asked to submit your schedule and data during the semester. You will be evaluated on how well you adhere to administrative/communication detail.
8. Format for e-mail is as follows: Student X, at School X, Week X, Day X.
9. Obtain the listing of other student teacher's e-mail addresses and communicate regularly. You will probably find that you are having similar concerns.
10. E-mails must be received at least weekly by the college coordinator.

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Dream Links to the World: Together on the Web

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The popularity of the Internet is exploding. The World Wide Web has literally opened the world to computer users with access to the Internet (Winner, 1995). The proverbial playing field is finally leveling off as K-12 students across the nation are gaining access to resources available on the Web.

Educators from around the state of Florida have attended workshops on "Creating Your Own Web Page" at the Center for Multimedia Research and Training which is operated by the Florida Department of Education and housed at the University of Central Florida. K-12 educators are customizing Web documents for classroom use (Quinlan, 1996). College and university faculty are creating Web documents to enhance their unique course requirements. In 1995, 600 four-year colleges in the United States had Web pages on the Internet (DeLoughry, 1995). Today the listing of faculty and students at the University of Central Florida alone who have Web pages is quickly approaching that number.

This paper will describe how the students in the College of Education at The University of Central Florida partnered with students at Altamonte Elementary, a K-5 school in Seminole County, Florida, to experience firsthand the role technology can play in school reform and to gain a global perspective through web publishing.

Background

The partnership between the elementary school and the college of education came about as the result of an Apple Partners in Education Grant, PIE-2, awarded in 1995. The grant was one of ten awarded to teacher training institutions and K-12 schools to enable educators to develop and implement innovative projects that incorporate Apple technology. Each site received a variety of technologies including the Power Macintosh LC 5200's, Newton Message Pads, QuickTake cameras, color scanners and limited free time on eWorld, Apple's online service. A variety of software was also donated. A team of five representatives from both sites joined educators from each of the ten partnerships at an Apple-hosted two week professional development retreat in California. Teams tackled issues ranging from using computers as tools to support restructuring efforts to modeling ways to integrate technology into student-centered learning experiences.

Elementary School Partner

During the 1995-96 school year, the elementary school began implementing a major restructuring of their K-5 program to prepare all students to become successful adults, while realizing the necessity of meeting the developmental ability levels of a culturally diverse population. Learning communities were created. One community, called the Vision Center, was comprised of 120 third, fourth and fifth grade students combined in multi-age classes to create a "school within a school." The students rotated among four teachers who specialized in math, science, language arts, and technology. One classroom became a technology lab with sixteen LC 5200's provided by the PIE-2 grant. During the first year, several major technology projects were completed including an interactive map of the central Florida area and electronic field trips across the United States.

Wanting to incorporate technology into all areas of the curriculum, the hardware was reconfigured during the second year of the grant. Four computers were placed in each classroom and the 120 students were divided into two groups of 60 multi-age students. Each group of third, fourth and fifth grade students rotated between two teachers each day; one teacher for math and science and a second teacher for language arts and social studies.

University Partner

The college of education had been making a concerted effort to incorporate technology into all of its classes since a stand-alone technology course was dropped from the undergraduate program in the early 1990's. The hardware received from the Apple PIE-2 grant was placed in a Curriculum Materials Center, then moved to a computer lab for college of education students. In the first general methods class, Teaching Strategies I, students are introduced to E-mail, the Internet, a grade management program and HyperStudio.

During the 1995-96 school year students in a Teaching Strategies I class which met weekly on the elementary school campus, participated in a field experience in the Vision Center helping to create the interactive map and the electronic field trips. The joint project for the second year of the grant is the creation of a home page.

Training and Software

The classroom teachers and the university students were provided with training to use Claris Home Page, a software program which allows the user to develop customized web pages without having to learn Hypertext Markup Language (HTML). A site license was donated by the Claris Corporation to the university for training purposes.

The Process

Each university student was teamed with four intermediate students, a Dream Team, to help create the home page for the elementary school. The Dream Teams met throughout the semester to research Internet sites, to critique previously created HyperStudio stacks for inclusion on the home page, to storyboard ideas, and to help create the home page. In addition each university student was required to create a personal home page as a course requirement.

Goals of the Experience

A major goal of the partnership between the College of Education and the Vision Center of helping students and teachers collaborate on technology projects is being realized. Teachers, professors, university students, and elementary students are sharing the roles of learner and coach. The motto "each one teach one" is lived day by day.

A second goal of the project was to introduce the university and elementary students to the Internet in a meaningful way and to have them experience how Web sites are created. Each Dream Team learned how to plan, design, build and publish its own Web site. The Web pages are colorful and exciting, and contain valuable information. Publishing allowed the Dream Teams to put their ideas and interests in front of a global audience. The students' awareness of this became dramatically real during a class when the Vision Center students were participating in peer editing of some HyperStudio stacks to include on the home page. When the author of the stack being edited was asked if she wished to make the suggested correction, she responded, "Absolutely, if the whole world is going to see it!" The Dream Teams learned that Web pages can be a bridge to new interests and new friends. The friends may be at a neighboring school or around the world.

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Using Telecommunications to Aid Reflection in Preservice Elementary Teacher Education

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The increased use of computers in schools has brought about new possibilities and new problems for teachers. Access to greater amounts of information, much of it electronically published, means that it is important for teachers to develop students' literacy skills. The skills of defining, locating, selecting, organizing and presenting information creatively can be facilitated by a range of presentation software. Various software packages have different capabilities which allow students to incorporate different media for expressing their understandings of the relationships between parts of the concepts they are exploring. As part of a unit of work investigating software for the curriculum, students at Queensland University of Technology (QUT) create a slideshow in *KidPix* to explore how this presentation software can be used to enhance student information processing skills in the elementary classroom. During this time they deconstruct slideshows created by primary students, and then correspond with them by e-mail, outlining their creation of a similar slideshow. The culmination of this interaction is the sending of the tertiary students' slideshows to the elementary students.

There is much literature about the role of teacher education in preparing students for the use of information technology in elementary classrooms (Downes, 1993; Handler, 1993; Oliver, 1994a; Wild, 1995). At QUT this has been addressed in the newly structured Bachelor of Education (Primary) course by the introduction of two units to develop skills and understandings of the uses of computers in the classroom, and in society in general. The foundations unit considers global issues involving technological progress and societal change whilst developing students' skills in the use of information technology. The second unit, which introduces students to software for the curriculum, is based around three 4-week modules. Students are then called on to reflect on the value of these 4-week modules in implementing the goals and objectives of the Department of Education, Queensland, (1995) *Guidelines for the Use of Computers in Learning*.

The second unit, *Using information technologies in the primary curriculum*, is designed to introduce students to ways in which software can be used in the elementary curriculum. The lecture program provides a framework for understanding the students' experiences in the four modules. The cohort of 300 first year students rotates through the modules, so that at any time 100 students are undertaking any one module. In the first week, students choose one out of two of the six themes (each group of 100 students has a different set of two themes from which to choose). This becomes the basis for a compendium of activities that can be implemented into a classroom to enhance student understanding of this topic. Besides the three 4-week modules—the problem solving module using *Microworlds*, the *KidPix* module on creative publishing, and evaluation of the ways in which four pieces of software can enhance delivery of the elementary curriculum—students are to locate two Internet sites that can support activities around their topics.

Creative Publishing with KidPix Studio

The *Creative Publishing* module is partially designed to introduce the students to the Macintosh operating system. Whilst approximately half of the computers in use in elementary classrooms in Queensland are Macintosh the majority of student laboratory work at QUT is on Windows machines. Although the two hardware platforms are becoming increasingly similar it is felt important that students be required to operate in both before they leave the university. The activity chosen for this experience is the creation of a slideshow in *KidPix Studio* which is significantly easier, at QUT, on Macintosh computers. However, the main focus of the activity is not on the technical aspects of working within the Macintosh environment, but on the information processing that the students go through in the construction of their presentation and the metacognitive aspects of planning, monitoring, evaluation and reflection.

It has been proposed that one reason that beginning teachers do not use computers in their classrooms is the lack of role models presented to them during their course of training (Oliver, 1994b). Not only are the steps in the creation of a slideshow demonstrated to the students by their lecturers, they also deconstruct the work of elementary students and mark their work by the same criteria by which their own slideshows will be assessed. This provides the students with a sound understanding of both the outcome of their activity and the capabilities of elementary students to use these media. This understanding is aided by e-mail communication with these elementary students.

Partially due to limited resources, students work in pairs to complete this assessment item. This gives students an understanding of group dynamics, building on the understandings from their foundation unit of the necessity of ensuring equitable access to information technology in the classroom. It is believed that such understanding is vital, as much work within elementary classrooms is undertaken as collaborative activities.

Structure of the Creative Publishing Module

The 4-week modules consist of an hour demonstration and an hour computer workshop each week. The demonstration is facilitated by use of a video projector. Students are required to spend up to nine additional hours per week on further activities associated with this unit. In the first week tutorial students are introduced to the software, the concept of a slideshow and examples of an effective animation and an ineffective animation. Students discuss the features of two elementary student slideshows in terms of the clarity of the purpose of the slideshow, clarity of the message conveyed, and effectiveness of the animation sequence. Students build on this knowledge in their computer workshop session by deconstructing an elementary student's slideshow using the same criteria by which their own will be assessed. After this the students are encouraged to play with both the KidPix and Moopies sections of the software.

This week is vital to successful time management of the project. Student pairs are to plan their slideshow together out of class time. They need to work out which aspect of their topic can be presented in a slideshow format, what the purpose of the slideshow will be, and what message the slideshow will convey. They also need to decide what aspect of their presentation is best suited to an animation. Once these decisions are made they are then to e-mail their elementary school buddies telling them of the processes that they have been through and how the decisions were made. They are also to comment (favorably) on their buddy's slideshow.

The second week tutorial is a demonstration of scanning images, image manipulation and animation techniques. Those students who are prepared, can create their animation in the computer workshop time. However, true to form, many pairs have not completed their planning at this stage. During the second week all slides and the animation sequence are to be completed.

The third week tutorial deals with adding sound, both in the form of sound files from the *KidPix Studio* CD and voice-overs. Students are expected to complete their slideshows for presentation at the next tutorial.

In the tutorial in week four students are to load one slide and discuss a design problem that they encountered and how they overcame this problem. In the workshop session students load their slideshows, run them continuously and evaluate the slideshows of their classmates.

Reflection

Reflection is an essential part of effective learning and teaching. It has been built into this module in a number of ways. Students reflect on their information processing when they discuss how decisions were made in their pair whilst writing to their school buddies. They reflect on design decisions and problem solving when they present to their peers in their oral. As part of their assessment, their reflection journal is to discuss how decision making took place within their pair, the value of the interaction with the school students, and how the use of *KidPix Studio* software enhanced information processing. They are also required to demonstrate how their experiences aided an understanding of the three readings (Pacey, 1993; Sallay & Naftel, 1996; Taylor & Stuhlmann, 1995) that formed the background for this module.

Further to this students are to show how activities such as they have undertaken in the creative publishing module can be used to implement the goals and objectives as outlined in the Guidelines document in the first section of their fourth assignment. This assignment is a synthesis of the lecture program, the tutorials and computer workshops, and the set readings.

Results

As with any undergraduate unit, the rate of success was varied. Although a strict timetable of activities was prescribed in the student handbook, this involved student interaction outside of classtime. The short timespan of the activity meant that students had to establish these meeting times in their first week. Whilst it was possible to achieve well without adhering to the suggested timeframe, this meant that the experience was not as enjoyable as it could have been. For instance, students did not take opportunity to play—to investigate the capabilities of the software—in the first week. This learning to operate in the environment is an essential part of the learning strategy in engaging with any new software environment. These comments are taken from the student reflection documents accompanying their creative publishing slideshows.

Timeframe

A three week timeframe for the completion of a slideshow causes some problems. This is especially true when students do not sufficiently plan in their first week.

However we did not have time to play. In the second week we were expected to dive straight in and create our animation.

Attitude

As with all things the attitude of the individual students had an enormous impact on how they enjoyed their experiences.

My partner came to grips with operating KidPix but I just sat there wondering when this whole KidPix experience would be over.

Interaction with School Buddies

The interaction with the school buddies cannot be too highly overrated. Having the elementary students' texts to deconstruct in the first week enabled the tertiary students to see the standard of work that is possible by elementary students of the age capable of completing the unit of work that is planned for the tertiary students. Having e-mail contact with these students was an added bonus. The quality of the exchange was not great. The tertiary students expected long replies to their initial responses but the logistics of including the contact within the elementary school when the use of *KidPix Studio* was no longer the main focus of the curriculum was difficult, as was getting elementary students to type long messages!

However, the tertiary students made three main comments about the interaction. First, they said that when they first deconstructed the student slideshows they were quite critical of them. (This criticism was confined to their assessment sheet and not conveyed to the students.) There were obvious things like spelling errors, lack of information in the slideshows and more obtuse aspects such as very few cohesive design features being used. But by the end of their experiences of constructing a similar slideshow the tertiary students were amazed that the students had managed to do such a good job. It was easy to be critical from the outside!

Second, students said that the fact that they had a real audience to present to had spurred them on to produce more effective work than they would have purely for a piece of university assessment. Their understandings of the effective aspects of their buddies' slideshows and the fact that the buddies were going to view their work were constantly thoughts as they created their work. Third, students said that they were conscious of the younger students as they constructed the slideshow and composed their e-mail messages. It helped them to focus on the task.

At the time of this writing, response to the tertiary students' slideshows has not been forthcoming. It is planned to video the elementary students' reactions on viewing the slideshows. They will be set the task of assessing the slideshows from the criteria that were used to assess their own work.

Building on Previous Knowledge

Many aspects of this unit have built on the skills and knowledge developed in the foundations unit. An understanding of file format has been extended by the use of the scanner and graphics manipulation software. The necessity of naming disks and keeping track of files-in-process-of-creation and files-in-final-format and the necessity of making backups also builds on skills developed in the foundation module. The naming of disks has added significance when working in the Macintosh environment as students are quick to discover! Skills in the use of e-mail was extended in the communication with the elementary school students.

One disappointing feature was the lack of transfer of the need to reference from the foundations unit to the curriculum unit. This was a major skill and understanding, underpinning the work that the students undertook in the foundation unit. However very few students saw the need to reference the images that they scanned or to provide a reference list at the end of their slideshow. This will need to be incorporated into the teaching of the module in future.

Learning From Peers

Although the skills needed to construct a slideshow are demonstrated to the students and written in a manual for them, the translation of these modes into the construction of the slideshow often leads to errors of understanding. Students commented that having a partner with whom to work through problems was valuable as was the camaraderie that developed in the computer laboratory as the students worked together in their own time. Errors that often occurred were students trying to incorporate sound into their animations, trying to include wrongly formatted Moopies into a slideshow, trying to incorporate large graphics into a slide and the constant swapping of untitled disks!!

Information Processing and *KidPix Studio*

The reflection documents that the students provided with their slideshows were limited in their acknowledgment of the ability of software such as *KidPix Studio* to enhance the information processing skills of students. Their evaluation comments related to Pacey's (1993) remarks on the use of different media as being applicable for 'the video age child.' However, explicit examples of how they made decisions to use different media in their slideshows as examples of this process were infrequent. One of the few pairs of students to discuss this, commented on the age of the students with whom they were corresponding and the aspects of those students' slideshow that they had found most effective. They therefore decided to use visual aspects as the main focus of their slideshow with voice-overs, rather than written information, to deliver their message.

It was pleasing to note that students were able to interpret the experiences that they had in the creative publishing module in terms of the Department of Education, Queensland, (1995) *Guidelines for the Use of Computers in Learning*. Students were able to identify when activities that they had undertaken aided in learning about computers (e.g. in the adoption of file management strategies - Students will develop skills in information management, Department of Education, Queensland, p. 7) and when they were learning with computers as with the selection of appropriate material and use of language to convey their message to their identified audience (Students will use computers for a range of purposes, to communicate (using text, sound, images, numbers and combinations of these - Department of Education, Queensland, p. 6).

Conclusions

The reactions of the students to the creative publishing module have not all been favorable. Those students who prefer to read and regurgitate are challenged to adopt another learning style. Although the skills necessary for the completion of the slideshow are demonstrated to them, their application of these skills requires a great deal of self-directed learning to occur. The quality of the slideshows varied but all student slideshows have demonstrated student mastery of both *KidPix Studio* and the Macintosh platform, and some outstanding work has been achieved. In terms of addressing the metacognitive underpinnings of this unit, student reflection documents have revealed that the writing for three audiences, the discussion in pairs and the discussion with peers and elementary students, have all aided in their ability to monitor and evaluate their work and understandings. Students have demonstrated that they have understood how *KidPix Studio* can be used to support the elementary curriculum in an integrated curriculum approach.

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Enhancing the Preservice Teacher Experience through Electronic Discussions

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As an experiment, an electronic newsgroup was introduced to three sections of a sophomore-level elementary education course during the Spring semester of 1996. The goal of the newsgroup was simply to introduce these students to different forms of information technology. Within two weeks, it became apparent that the newsgroup was fulfilling the above need of alternative communication. With student permission, the researchers began to save the messages for future content analysis. By the end of the semester, 66 students had made 856 postings and replies on the newsgroup. Five major themes emerged from the over 800 messages posted. Students used the newsgroup as a means to support each other either during stressful points in the semester, or with just general words of encouragement. This was a means to share teaching information and ideas — students would post ideas they gathered from other teachers, professional journals, or the Internet. The newsgroup was also used a great deal by students to reflect on their field experience in the elementary schools and to receive feedback from peers about performance in the field. Students also reported that they felt the newsgroup was a safe place to discuss controversial issues related to education. Finally, the students willingly used the newsgroup to discuss issues related to the class itself; issues such as the merit of various homework assignments or the timing of field experiences were openly discussed even though it was known that the instructor was a participant on the newsgroup.

With over 800 messages posted by the end of the semester, the researchers were pleased that the newsgroup had been so successful for a majority of the students. However, several issues remained to be resolved. First, not all students participated at all or to a great degree in the newsgroup. Their reasons ranged from a lack of interest to technical difficulties in using the newsgroup. In order to combat both issues, the decision was made to switch the newsgroup over to a listserv format for the following semester. The students reported being more comfortable with the use of their e-mail, thereby eliminating many of the technical difficulties. Additionally, with the listserv messages appearing directly in front of the students via e-mail, those students with a potential lack of interest might have their interest piqued when a message appears in front of them.

Second, and perhaps more important, it was unknown if the level of participation on the newsgroup was simply an aberration. The researchers wanted to know how to replicate, if not improve, the level of participation in the electronic discussion. Experience with other courses demonstrated a definite lack of interest on the part of the majority of students to participate. By determining the elements that made this listserv successful, the researchers might be able to develop a formula to ensure success on an ongoing basis in future elementary education courses, as well as throughout the school.

A listserv was instituted during the Fall, 1996 semester. By the end of that semester, approximately 680 messages had been posted by 56 individuals. Individual messages were again content-analyzed, as well as the reflections of the instructor over the course of the two semesters. The same five themes were again apparent. However, this group of students placed different emphases on these categories, as will be discussed below.

Themes

The same five themes emerged for each semester the electronic discussion was implemented. What is interesting for this study is not the particular themes themselves, but rather the differences in the way the issues were addressed by the two different cohorts of students.

Peer Support and Encouragement

In the first semester, a large number of the messages (approximately 18%) focused on students supporting each other in some form or fashion. The students using the listserv during Fall, 1996 posted far fewer messages that could be designated as peer support and encouragement (less than 8%), but when these messages appeared, they contained the same subthemes. There were a number of ways students utilized the newsgroup to ask for support and give support. First, students used the newsgroup as a way of communicating with classmates and professors to get answers to questions about course requirements, the National Teacher Exam, other courses and degree requirements. The newsgroup meant they did not have to wait until the next time class met to get needed answers. Related to degree requirements one student asked the following:

> I was interested in getting a reading endorsement, but my counselor advised me against it. She said people are having a real hard time getting the classes that are required for it. I would really like to pursue this endorsement, do you have any hope?

Another student responded to this query with information as to why s/he was seeking the reading endorsement.

Second, students used the newsgroup as a way of sharing concerns, fears, and feelings in an effort to gain affirmation. One student put the following message on the newsgroup:

> ... a woman came and spoke to (one of my) classes from the career center today. She talked about some of the openings she was receiving from school districts...But then she started talking about alternate careers you could do with an Elementary Education degree. Now maybe I am wrong, but when I decided I wanted to be an elementary teacher I did it because it is a field I could get more than monetary rewards from. I thought this was quite strange because if we come to college for a particular degree, shouldn't we look for jobs pertaining to the degree? ... Listening to her speak today really made me think about looking for a job. What are your opinions on the career center focusing on alternate career choices?

Even though the students may not have solutions to each problem or concern, the students begin to understand that they are not alone in their feelings. In this way, students used the discussion as a way to relieve stress and to support each other during stressful times in the semester. Students found the newsgroup to be a safe place to share their honest feelings. With time, they learned that it was also a place to find common ground. Additionally, the instructor was better able to monitor students' feelings — some students appeared to be comfortable sharing things on the newsgroup even though they were not willing to share the same feelings with the same people out loud in class. Thus, students are given a forum in which they feel comfortable sharing things they would not otherwise.

Sharing Information with Each Other

Approximately 35% of the messages posted during the Spring of 1996 involved students sharing ideas or information about teaching with each other; an equivalent percentage was posted during the following semester. Students shared information about teaching magazines/books, teaching materials, teaching strategies, and effective teaching tips. Among the most popular topics were special needs children, classroom management issues, teaching tips for your classroom, and web sites of interest. In all cases it became apparent that students were sharing their ideas in order to help each other become better and support the professional development of each other. In some cases students simply used the newsgroup as a way to share information they had read or learned in another class.

> Hey everyone! I was searching the Internet the other day, and I read a neat idea that we could use in our own classrooms. Many children have trouble with fractions. As the teacher, you could have each student bring in some family pictures or cutouts of a magazine. Have the students examine the pictures and then give them a worksheet that asks some of the following questions: What fraction of the people have brown hair? blonde? red? are wearing striped shirts? jeans? are smiling? The questions can go on and on! You can be creative with them or make them straight forward. I thought this was an interesting and fun way for children to practice fractions. What do you think?

Students utilized the electronic discussion as a means to share ideas, elaborate on each other's ideas, and integrate ideas into their own teaching philosophy. The students were also able to expand on the information shared in class. Instructors are limited in the amount of information that can be shared during class sessions. The newsgroups allowed for an opportunity to expand the amount of information that can be shared related to course topics. It became clear that students were trying to make sense of what kind of teachers they wanted to be. Even more so, they began to understand that their teaching practices needed to be linked to their beliefs about teaching.

Reflecting on the Field Experience

Approximately 20% of the messages posted to the discussion each semester related to the field experiences students completed in local professional development school sites. The field experience assignments include observation tasks, as well as teaching three lesson plans. Students were assigned to a classroom in pairs and teaching included team as well as individual lessons.

Each semester, students indicate that the field experience is one of the most beneficial. At the same time, it is one of the most anxiety-laden ones for them, too. While there is always time for debriefing and reflecting about the field experience during class time, there can never really be enough of it. "Sharing of experiences" often happens after the fact instead of immediately following the experience. Many times situations experienced in the field have such an influence on the students that they are eager to share them right away and the electronic discussion provided a vehicle for such immediacy. Some students shared good as well as bad experiences. One student wrote about this experience:

> One of my lessons that I taught started out well but ended in disaster!!! The lesson was on how to count to 10 in Japanese. ... Like I said, it started out good ... Then after we learned the numbers and their symbols I put them into groups of two by distributing cards... After they got into their groups it was all down hill!! I felt like I had no control at all. After I was done... I started to leave. Joan, the teacher, walked me out and started talking to me. Then I started crying. Joan made me feel so much better. She asked me what I would have done differently and I told her. Her eyes got big and a smile came on her face and she said "you have grown today and because of today you are going to be a better teacher." I was amazed!! The next day I did another Japan unit and we had to discuss what we had learned so far about Japan. 4 out of the 8 things that they said they had learned were from that one lesson that I thought I had bombed. So even if you mess up a lesson - look at it in a positive way and learn from it.

> A student responded in the following:
> I'm glad to see that I wasn't the only one who felt the same way you did. I didn't really think that my lesson was a disaster, but I did feel really uncomfortable when I was explaining to the children the directions to the lesson that I was about to teach. Just when I was about finished, my partner and the teacher were lost on what the children were suppose to do. So, the teacher corrected me and did I feel like the idiot! But after all, what is this field experience suppose to be about anyway! LEARNING FROM YOUR MISTAKES!!! Thanks for sharing your story.

What is so interesting about these messages is that students are willing to share negative experiences and that students responded to each other in very sympathetic, caring ways. Students seem to be more willing to share these types of stories on the newsgroup than in class. Once again, the students are learning to support each other as they learn and make mistakes. The responses allow students to see things with different perspectives.

The key difference between messages posted during the two different semesters related to the depth of discussion that took place. The messages posted above where completed during the Spring, 1996 semester. Students engaged in far more analysis of the teaching and reflection of their next progressive steps. Conversely, messages posted during the Fall semester, 1996 were more cursory and less introspective.

> I experience with my teacher at Dixie Bee has been great so far. The only problem I have is the way they departmentalize. I usually observe in the morning. The only problem is Mrs. Hicks is teaching someone else's classes in the morning. So, I only have limited time with her students. I am trying to make time to observe in the afternoon, so I can become better acquainted with the students. I went to Dixie Bee in the afternoon last Wednesday, and I had the opportunity to help one of the students take a test. When I came back on Thursday, Mrs. Hicks asked him if he had anything to say to me. He told me thank you because he received an 'A-' and shook my hand. I thought that was really polite for a fifth grader.

The students are able to share their frustrations with their field assignments, their enthusiasm for what they get to do, as well as reporting some of their experiences. However, what did not occur was student reflection on their personal performance. They were more apt to report on the performance of those they observed.

Debating Controversial Issues

During the first use of electronic discussion, there were approximately 60 messages on the newsgroup in which the students debated educational issues such as: inclusion, using the Internet to teach, teachers that are too physical with their students, showing videos in your classroom, open classrooms, and home education. This theme became the dominant theme during the second cohort's use of electronic discussion (slightly less than half of the messages) discussing issues such as: sexual harassment among elementary school children, corporal punishment, abortion, elections, and drinking among school personnel. Many of the debates began by a student having read or heard something and then posting the issue on the newsgroup. For the students during the fall semester, most of the issues were first raised in the popular press. More often than not, students responded back with a variety of perspectives. A small excerpt of the sexual harassment issue follows:

> Did anybody hear about the six year old boy from Lexington, NC? He kissed a playmate on the cheek and the administration called it sexual harassment! The boy was placed in a type of detention, he was at school all day but didn't participate. Does anyone else think this is absolutely crazy? A six year old doesn't even know what sexual harassment is! Kids that age still do not know when to and not to display affection and who they should or

shouldn't display it to. I think the administration should have taken different tactics. This might go along with our future discussion about discipline with dignity.

One such response was:
I totally agree. A six year old is not going to think that kissing a girl is wrong. They usually get oohs and ahhs from parents and others whenever that happens. I always thought it was cute because usually six year olds think those of the opposite sex are icky.

With this particular issue, students did not disagree with each other, but were able to build on each others' ideas, debate the issue from a knowledgeable standpoint, and offer multiple perspectives. Other issues, such as election-related topics and the abortion topic elicited more disagreement, although these were not necessarily counter-productive. Even though not all students participated in the debate, they had the opportunity to learn about an educational issue that was never discussed in class. Thus, the learning that takes place during a semester can be extended through discussions on the newsgroup. All students involved in the debate leave with a better understanding of the issue because they have opened up their ideas to discussion.

Discussing the Course

One of the things we learned quickly is that if you empower students with a vehicle of communication, students will use it. We learned that the newsgroup was a safe place where students felt comfortable sharing positive feedback as well as criticisms about the course and how it was progressing. The instructor encouraged students to share their feedback about class sessions, course readings, class assignments, etc. on the newsgroup. Any feedback that could be given as the course was moving along could be helpful in modifying the course. During both semester, students shared at least 7% of messages on the electronic discussion about the course and class sessions. In most cases, students would comment about particularly impacting activities, videos, or class discussions. Other students commented on a simulation assignment the students completed called *Creating and Maintaining a Positive Learning Environment.*

...it was a great sense of accomplishment to get the simulations done. I learned so much from the simulations. I feel like I am really getting into my major alot more than last semester.... I really had fun working with my group also. Everyone had great ideas which made the project more exciting. I'm glad that we didn't have to do this project by ourselves, because I think it would have taken me forever to get it done. I feel a lot more confident in what I want to do for the rest of my life after doing this project.

The instructor can have a better sense of the impact of an assignment when students provide feedback. Students also have the opportunity to synthesize what it is they learned from an activity.

There were a number of messages that the students put on the newsgroup to generally evaluate their experience in the course. These messages tended to be on the positive side–we can understand why the students would not want to put their names to negative comments about the course. These comments proved invaluable for the instructor because she could bring an issue posted on the newsgroup to the whole class. Students, in turn, felt their concerns were addressed throughout the semester.

Conclusions

It is clear from our data that an electronic discussion provides a vehicle for teaching and learning that may not be possible to achieve in the classroom setting. The students who actively participated in the discussions flourished and grew through their discussions. However, a major focus of the research was not only to determine how the newsgroup was used, but also to determine how such positive results could be continued and built upon each semester. By switching to a listserv accessed through e-mail from the newsgroup accessed through the World-Wide Web, many of the technical issues were solved for the students. Students during the second semester of use never reported an inability to access the discussion information. However, the hope that by placing the discussion directly in front of them by using e-mail only worked to the degree that the student was an active e-mail user. For example, those students who used e-mail for more than the electronic discussion (i.e. talked to friends, other faculty members, other classmates, etc.) were more apt to check their mail on a regular basis and therefore see the listserv messages. Approximately five to ten e-mail messages accumulated per day on the listserv - manageable if the person checked e-mail multiple times per week. However, for those students who checked their e-mail less than once a week, the resulting backlog of messages could be discouraging. Therefore, although technical issues were resolved, the issue of how to inspire the desire to regularly participate in the listserv still remained.

Second, the sheer number of messages posted from the second cohort was substantially fewer than the first electronic discussion (using the newsgroup), although with about the same number of students participating. Messages in the theme category of controversial issues sparked a great deal of interest and debate among students, more so than the previous semester; however, that could be attributable to the attention paid to most of these issues in the news media. Other themes received less attention, or at least more cursory attention, most notably discussion about field experiences and peer support/encouragement. Upon reflection, several factors are thought to have possibly contributed to this: first, the instructor had several life experiences which necessitated her absence from the class for periods of time (including marriage and deaths in the family); and second, two of the three class sections never seemed to bond as cohesive groups, perhaps affecting their willingness to discuss issues whether electronically or face-to-face. It is known that these two sections have a large number of off-campus students enrolled and these students have been vocal in their difficulty and inconvenience in accessing e-mail, and therefore the listserv. Further analysis would be needed to determine what other demographic factors might have impacted online discussion, but is beyond the scope of this paper.

In conclusion, the researchers continue to be pleased with the use and potential of electronic discussion as a means to enhance to the experiences of preservice teachers. The electronic discussion provide a window on student thought and discussion that may not be available through more traditional instruction. Removing technical boundaries is apparently helpful, but not enough to encourage enhanced discussions. However, the issue of how to facilitate and ensure that such vital discussion occurs for all, or at least the vast majority of students, remains.

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Using the Internet to Unite Student Teaching and Teacher Education

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In this paper, some of the challenges associated with and criticisms leveled against teacher education are introduced and discussed. Specifically, the perceived disconnection between theory and practice during the student teaching phase of the teacher education program is briefly examined both in the literature and in the specific context of teacher education as it is conducted in the Master in Teaching program at Seattle University. In this program, an electronic mailing list has been employed for the past two years to facilitate communication between students, faculty, and others concerned with the task of teacher education. Assuming a framework of constructivist learning theory, the power of the mailing list to reconnect student teachers with the learning community they have established is investigated. An example of this process, drawn from an archive of messages addressed to the list, is offered. The conclusion is that the mailing list can serve as a useful tool, allowing students to construct their understanding in concert with the larger community of learners in the teacher education program.

The Context

Teaching is a difficult and demanding profession. The process of transforming a concept so that individuals within a diverse group construct understanding that will persist and enable the learner to solve the problems encountered in life, is profoundly complex. Each student arrives at the classroom with a different constellation of abilities, interests, background experiences, and learning needs. Yet teachers are charged with the responsibility for enabling *all* students to learn. In order to accomplish this they must manage many tasks simultaneously. At the macro level, they must construct a social, academic, and emotional environment where a group of individuals is likely to construct the target understanding. At the micro level, they must take attendance, call parents, help children put on their boots, accommodate frequent interruptions, and deal with short supplies and things that break. Good teachers are extraordinary people. Feiman-Nemser and Buchmann (1987) put it this way: "Teaching, in sum, requires knowledge of subject matter, persons, and pedagogy. It demands principled and strategic thinking about ends, means, and their consequences. Most important, it requires interactive skills and serious commitment to foster student learning" (pp. 256-257).

Learning to teach is no less complicated or demanding than teaching itself. At Seattle University, in the Department of Teacher Education, the conceptual framework that guides the Master in Teaching program states that: "The teacher is an ethical, knowledgeable, and reflective decision-maker who teaches all learners to function effectively in a global and pluralistic society." The task that is joined each day by this department and more than a thousand others across the country is to enable people with an increasingly diverse set of qualifications, expectations, and experiences, to become teachers.

The program at Seattle University enrolls fifty graduate students in the Fall quarter and fifty more in the Spring. Each group proceeds through the four-quarter program as a very tightly knit cohort. The courses are primarily extensive (12 credit), integrated, and team taught. They include periodic forays into the schools and encourage reflection on the integration of experience and theory in the context of the learning communities that are formed within the cohort. While the program is unique in many ways in terms of its structure and content (see Roddy, 1996), it shares with most other teacher education programs around the country an extended period of student teaching. The student teaching takes place during the third quarter of the program, rather than the fourth, and is followed by a quarter of research and reflection, but it is, in other ways, a typical student teaching assignment.

The Problem

From a constructivist point of view, this period of student teaching is a uniquely powerful opportunity to construct understanding about teaching. Student teachers have richly textured and detailed impressions, built up over at least 16 years of experience, of what happens in schools. Indeed, one of the criticisms leveled against student teaching is that it is not sufficient to overcome this "apprenticeship of observation" (Lortie, 1975). On the other hand, they have been introduced during the foundations and methods courses (the first two quarters of the program) to a host of ideas about students, learning, teaching, and schools—ideas that may contradict many of *their* ideas and impressions. Given the array of concepts, generalizations, and models to which student teachers have been exposed, the potential for the construction of meaning as a result of experience, communication, and reflection is great. Ideally, student teachers have built their understanding of the best of what research has to offer concerning effective methods of teaching. They now have an opportunity to try these notions out in a real classroom under the guidance of an experienced teacher. Their motivation to learn about teaching and to succeed in the classroom is high. Yet student teaching is roundly criticized as being ineffectual (e.g., Feiman-Nemser & Buchmann, 1987; Goodlad, 1990; Zeichner, 1981).

Goodlad (1991), in his research on teacher education, points out the separation between the theory developed in the university and the reality student teachers encounter in the schools. Students who have studied cooperative learning, for example, and who are frustrated in their attempts to implement cooperative groups because they may not recognize the proper conditions for the application of this technique, may conclude, unless they are well coached by their cooperating teacher, that cooperative learning does not work and that the theory is wrong. In the relative isolation of the K-12 classroom, deprived of the support of the learning community they have grown accustomed to in the university classroom, they revert to the understanding developed over their years as students—an understanding that is based not on research and models but on idiosyncratic experiences and hunches.

In situations such as this, the only readily available source of experience and assistance in the field setting is the cooperating teacher. As noted, however, by Richardson-Koehler (1988),

> ...concern has been expressed about their influence. Because cooperating teachers are more oriented toward the practical and particular rather than toward theory and generalizations, student teachers may not learn the more general principles from their experience that would allow them to adjust to different classroom situations (p. 28).

Richardson-Koehler goes on to point out that in her research, a participant observation study of fourteen elementary student teachers, the norms of the school culture related to individualism, egalitarianism, and learning from experience strongly affected the feedback offered to student teachers by their cooperating teachers. She states that student teachers concluded from their experiences that

> ...each classroom and teacher is unique, that each teacher has to rely on trial and error, and that the criterion for success is 'what feels right to the individual teacher'. Thus, the student teachers were not exposed in the schools to a model of learning to teach that relied on rigorous analysis of teaching and collegiality (p. 33).

Other researchers have questioned the efficacy of student teaching that does not incorporate an intentional focus on the quality of the feedback offered to student teachers in the field.

> Though many applied skills must ultimately be learned in practice, it is clear that unsupervised on-the-job experience is, in and of itself, insufficient to support teacher learning and teacher effectiveness, as it can lead as frequently to the adoption of regressive and ineffective methods as to the acquisition of appropriate strategies (Darling-Hammond, 1990).

Kennedy (1991) noted that, in general, cooperating teachers, because they are so close to the practical side of teaching, have difficulties relating specific instances to larger, more generative principles. Zeichner's (1981) earlier research drew similar conclusions, noting that by concentrating on how to teach, cooperating teachers often missed the opportunities to consider what to teach and why to teach it. University supervisors are said to be similarly ineffective, for different reasons, at raising the level of the conversation (Richardson-Koehler, 1988).

These are some of the general problems that surround student teaching. In Seattle University's Master in Teaching program, because of the tightly integrated and cohesive nature of the program, individuals become accustomed to the support of the learning community that develops through daily close association and shared challenges. They have employed and consciously followed the constructivist learning cycle again and again through experience, reflection, conversation, and revision of understanding. Once they are out in the field, however, they are no longer supported in this cycle. In the setting that is richest in the important factors that provide essential feedback and clues about the effectiveness of the decisions they make and the understanding they construct, they are largely deprived of the support that could help them formulate solid generalizable understanding.

Part of the Solution

Various researchers have recently described efforts to address this problem and to improve teacher education generally through the use of the Internet (Merseth, 1991; Roddy, 1996; Schlagal, Trathen, & Blanton, 1996; Thomas, Clift, & Sugimoto, 1996). At Seattle University, Master in Teaching students are given computer accounts and e-mail addresses as soon as they enter the program. At present, they are allowed to keep these accounts as they begin their professional teaching careers. They have nearly full-time access to a computer classroom equipped with 32 Power Macintosh computers, all networked and connected to the Internet and the World Wide Web. At the beginning of the program they are introduced to telecommunications and to the Internet as a tool that can assist them in the teaching process.

Early in the first quarter of the program, they are invited to join a mailing list created for their cohort. The list is often joined by faculty members, support staff, and others concerned with the work and well being of the cohort (e.g., the program placement officer, the program secretary, an AmeriCorps volunteer who alerts students to service learning possibilities, etc.). The list, however, is rarely used to conduct university business. That is, unlike most instances in the literature (e.g., Thomas, Clift, & Sugimoto, 1996), faculty very seldom use the list to conduct course assignments, etc. Students, therefore, use the list in ways that make sense to them and in the rhythms that suit their needs.

The messages that have been addressed to the list have been reviewed, analyzed, and categorized in a preliminary fashion (Roddy, 1996) and are undergoing a more thorough analysis at present. The preliminary analysis, however, indicated eight broad areas of use. Of these, the messages that fit the category, *substantive reflections*, are of most import in this context. These messages often contain the threads of conversations that arise as a direct result of significant events in the field. Students describe their experiences, their frustrations, their thoughts and their questions. Other students and faculty members read these messages, consider them in light of their own understanding, and offer responses that sometimes serve to shed new light on the general meaning and implications of the events described. An example of a particular thread is given below.

The Whole Language Thread

In the Fall of 1995, students in the integrated 12 credit methods course (second quarter of the program) had been engaged by one of the professors in classroom discussions regarding the use of the "whole language" approach to reading. One of the students had encountered opposition to this approach in one of her field experiences and brought the issue up on the mailing list.

> ...I've heard several people say that whole language means that kids don't learn phonics. Is that true?
>
> Another student replied:
>
> Interesting. I have been talking with my sister about my niece's spelling. ...She's in 6th grade and she (plus several of her friends) still spells poorly - e.g., prity (pretty), fon (phone). My sister is concerned but teachers have been saying that 'spelling will come later.' When is later???? I don't know if this is related to whole language or not. But the point is a good one. What do people think about this whole language learning? and is my spelling story an example of a pitfall?
>
> One of several replies:
>
> Spelling is one issue that I have discussed with some parents concerning whole language. The other was reading. From discussions with other parents, it seems that students learn to read by memorizing words. If they see the same word again, they will recognize it - however it doesn't help them learn to read words they have never seen before because they don't know how to phonetically sound out the word. Spelling is important but being able to read words that are new is crucial. Any comments?

Again there were several replies. One of the students linked the discussion to the controversy surrounding the "back to basics" movement. An article had just appeared in a local newspaper regarding a decline in test scores in another state and the subsequent swell of support for "the basics." One of the faculty members in the program wrote a scathing letter to the newspaper regarding the article. In the letter he offered a number of criticisms and pointed out that the term "whole language" is poorly understood. He went on to offer a working definition:

> ...Whole language is an approach to literacy instruction that focuses on the idea that children will learn to read and write effectively if they experience reading and writing as interesting and enjoyable activities. Central to this approach as well is the understanding that children learn in many different ways. ...So teachers need to teach literacy skills in many ways, including teaching phonics and decoding skills explicitly to children who benefit from this instruction...

The letter in its entirety was posted to the list and students and faculty alike responded with a number of messages.

Four days later the television news magazine show, 20/20, aired a segment on whole language instruction vs. direct instruction. A proponent of direct instruction was featured claiming that higher test scores were the result of direct instruction in reading. One of the students who saw the segment posted a long message to the list which read, in part

> ...I don't know what was truth or fiction in tonight's show but I can tell you that millions of Americans have just received a strong message that teaching should go 'back to basics' and direct instruction is the way to get there. Direct instruction certainly plays a role in education but I would argue that it is overused/abused. The constructivist, student centered approach that we all know and love is certainly very appropriate as well.

Again, there were a number of replies. The conversation took another turn as a faculty member noted that there was a great deal of negative publicity surrounding public education at the time and urged students to consider a different view. She cited two references.

Finally the literacy instructor who had, in a sense, engendered the entire conversation but who had been out of town subsequently weighed in with a comment that seemed to bring the thread to a close.

> ...I do not question that it [the brand of direct instruction shown in the 20/20 segment] may be successful with some readers - we all know that any method will work with some children and a combination of methods seems to be most widely successful . However, I was distinctly uncomfortable with the finger-snapping, 'ready, here we go' routinizing of reading instruction. To say that it works where whole language has failed is a tired and simplistic argument. [Name] mistakes whole language for a 'program' when it is merely a philosophy about connecting reading instruction with — gee whiz — Real Reading. Within a whole language framework, I could see the application of direct instruction techniques . . . but the program does a tremendously uninformed disservice by — AGAIN — making it an either/or thing.

In this example we see a problem encountered in the field by a student. The student had a real need (to respond to parents) and was looking for guidance. In this case the guidance developed through the vehicle of the mailing list. The list offered a place to obtain more information, different points of view, related experiences, and reasoned judgments from colleagues and professionals in the field. It is important to note that the nature of the conversation that developed on the mailing list was different from that which might have taken place with a fellow student, a cooperating teacher, or even with a professor in the hallway. This conversation unfolded over almost two weeks. There was time for participants to consider, to reflect, to write, to revise, to read again, and to reformulate their own understanding in ways that would not otherwise have been possible.

Conclusion

One of the problems with teacher education as it is typically structured is the profound disconnection between theory and practice during the process of student teaching. Student teachers who have become used to learning through a cycle of experience, reflection, communication with others, and revision of understanding are suddenly on their own, deprived of the support to which they have become accustomed. When faced with an experience that requires action, they turn to their cooperating teacher for advice. In many cases, however, the cooperating teacher is so engrossed in the practical day-to-day art of running that particular classroom that he or she may not make the generalizations that facilitate the construction of a more powerful and generative understanding. The example given in the preceding pages illustrates the potential for an electronic mailing list to be used as a tool to reconnect the theory held by the larger academic community to the particulars of the daily experience in the classroom.

This tool is still rather crude and, at times, cumbersome. Not everyone wants to check e-mail on a daily basis, and the interface with the system is, at best, user neutral. Nevertheless, it is evolving. The World Wide Web page, with its greater visual appeal and ease of use, holds promise as a more friendly and useful means to the same end. Programs are appearing now that allow users to post and peruse messages in a much more intuitive fashion. Even in its present form, however, the electronic mailing list constitutes a powerful tool in the service of teacher education.

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The InterNet Academy and Beyond

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The professional world into which preservice teachers will enter will be tremendously influenced by the explosion of information, as well as the ever widening access to, and mindboggling capabilities presented by the Internet. Reformers who are focused on implementing the National Council for the Teaching of Mathematics (1989) Standards in Mathematics and the American Association for the Advancement of Science's (1993) Benchmarks in Science are effectively using this electronic network to disseminate the many creative mathematics and science education ideas that talented teachers and others are developing across the nation. Schools are scrambling to provide their students with the advantages of travel within the information superhighway which has great potential for equalizing educational opportunities. Though the supply of computers is growing as indicated by a recent estimate of one computer for every 18.9 school children (Market Data Retrieval, 1992), teachers underutilize computers available in their schools (Marcinkiewicz, 1993/94). Additionally, school districts need counsel in how to enhance the use of electronic network resources through purchases of hardware and software. The potential of technology in our schools can only be realized if teachers "are skilled, competent, confident, and innovative in the educational use of computers" (Makrakis, 1991, p. 47). At the very least, school districts should be able to expect that newly prepared teachers will have expertise and practice in using the Internet and involving children in accessing the wealth of information available. However, one of the greatest challenges facing teacher educators is to present preservice teachers with state-of-the-art skills that they can apply, immediately, to their teaching practice. In order to provide for this invaluable experience, there is a need to build the knowledge base of both cooperating teachers and preservice teachers, and to identify immediate applications so that the use of this resource becomes as commonplace as the more traditional sources.

Description of InterNet Academy Project

The InterNet Academy Project was funded by a mini-grant from the SMART Project, an NSF technology training grant for teachers administered by the Rhode Island Department of Education. The total project provided for an InterNet Academy for elementary and secondary preservice teachers from the University of Rhode Island (URI), a school by school (elementary) thumbnail directory of online computers from which teachers could access e-mail and the Internet, and a series of summer NetShops for inservice teachers—particularly those who supervise URI student teachers.

The purpose of the InterNet Academy project was to enrich the computer capabilities of preservice and cooperating teachers, as well as of University supervisors, so that they can utilize electronic network resources in connecting with each other and locating and generating valuable teaching resources on the Internet. In order to accomplish this goal, there was a need to provide training and share information about computer facilities so that implementation could be immediate and school based, no matter where the preservice teachers do their student teaching.

Purpose of Study

The focus of this paper will be on the background, perceptions, and products of the 48 teacher participants from the summer NetShops. Upon acceptance to NetShop sessions, teachers were asked to fill out a Pre-Academy Survey which collected information regarding previous computer/technology experiences, sense of efficacy in computer and Internet usage, personal goals for the course, fears or reservations about computers, and perceived positive aspects of computers in schools. Teachers who took a full 3-session sequence evaluated the NetShop contents and wrote learning summaries which indicated what they gained as well as future implementation plans. Finally, all NetShop graduates were sent a Post-Academy Survey to ascertain personal and professional uses of their newly acquired skills and to determine future training needs. This follow-up was sent four months following the last training session.

NetShops

The InterNet Academy provided five week-long NetShops in the summer of 1996. The NetShops were team led by three elementary teachers trained as leaders by the Teachers in Technology component of the SMART grant. All three of these teachers had been supervising teachers for URI student teachers. The NetShops were conducted in the Macintosh Computer Lab of a local elementary school. Thus, NetShop participants were able to develop their knowledge and skills in an authentic environment which demonstrated the feasibility of realizing the computer and technology rich instruction which was being presented.

The Academy instructors, along with the university project directors, designed the NetShop contents as a series of short courses that could be taken for university credit. NetShop met for 12 hours (four sessions of three hours each). Teachers could take part in all or part of the series. Thus, teachers could join the Academy at their level of expertise and take as many as three consecutive sessions. A description of the NetShops follows:

NetShop 1: Use electronic networks to facilitate conversations on education topics. Online sharing of lesson plans, Internet resources, evaluations and other student/teacher related content. Locate useful teaching/learning resources on the Internet that will enhance student lessons. Learn how to use Netscape.

NetShop 2: Build on topics of NetShop 1. Organize online information in order to make it more useful. Create, organize and use bookmarks.

NetShop 3: Build on topics of previous NetShops. Investigate student and teacher online projects and listservs.

NetShop 4: Learn how to construct a web page.

NetShop 5: Learn how to use technology such as *PowerPoint* and *HyperStudio* to enhance presentation of information and provide a new medium for creative student projects.

Participants

Participants were recruited from all schools, statewide, which had URI student teachers. Priority for participation was given to teachers who have mentored student teachers. Of the 48 teachers who participated in the NetShops, 20 had served as cooperating teachers. Only about two-thirds of the participants took the course for university credit, even though the course fees were about $300 less than normal summer school fees for a three credit course. Thus, the course credit was not a great incentive for all teachers. All grade levels—K through 8—were represented, as well as eight resource teachers (e.g., library/media, ESL, Math, Speech). The overwhelming majority of participants were just beginning to use computers and only a few teachers signed up for the advanced applications sessions (NetShops 104 and 105); thus, the beginning sessions were repeated as subgroups during the advanced NetShops. The team teaching approach allowed the flexibility to make these adjustments.

Pre-Academy Survey

Twenty-nine of the 48 participants completed the pre-Academy survey on their use of technology, sense of efficacy in computer and Internet usage, personal goals for the course, fears or reservations about computers, and perceived positive aspects of computers in schools.

The questions for this survey were shaped by education literature. Teacher change literature posits that teachers beliefs must change in advance of lasting changes in practice (Richardson, 1990). Thus, a survey to tap into teacher beliefs about computers and technology was an important first step in developing the NetShop sessions. In addition, Marcinkiewicz (1993/94) found three variable which predict whether computers will be integrated into classroom use. First, a teacher's sense of competence with computers leading to a motivation to pursue computer literacy to mastery was a powerful factor. Second, perceived relevance that computers are instrumental to improving instruction is strongly associated with adoption behavior. Third, the teachers' innovativeness or willingness to change is strongly related to future integration of computers into their teaching and classroom.

Previous Experience

Teachers were asked to indicate whether they used any of a total of 19 technologies such as VCR's and video cameras, computers and computer programs, and specific Internet and e-mail applications. Teachers' experience with technology was relatively mixed. A few teachers had very limited experience with even the most commonplace of technologies such as VCR's and video cameras. Responding teachers either used an IBM (33%) or a Macintosh (67%), but not both. Most of the computer use related to word processing (83%), with much less experience with applications such as graphics (28%) or spreadsheets (21%). Approximately half of the respondents had some experience with e-mail and the Internet. Less than one-third of the participants had experience with Netscape, the Internet access program used in the InterNet Academy.

Efficacy

The Pre-Academy Survey asked teachers to rate themselves on a 3-point scale (no doubt, need help, grave doubts) related to their sense of efficacy in computer and Internet use. Efficacy is seen as the teachers' perceived power to produce results or intended effects when using computers or other forms of technology. Generally, teachers were more confident in using computers than in using the Internet. Forty-one percent of the respondents indicated "grave doubts" about their ability to use the Internet, while only six of the respondents had no doubt of their ability in this area. Sixteen of the teachers responding indicated needing some help in using a computer and seven reported having grave doubts as to their ability to use a computer. Not surprisingly, teachers who reported having no doubts about their ability to use computers or the Internet also had a great deal of experience with different technologies (e.g., VCRs, scanners, computers). Particularly interesting was the fact that some teachers had never used even some very commonplace technologies (e.g., five teachers had never used a VCR and 11 had never operated a video camera!).

Personal Goals

Participants were asked what their personal goals for taking the course were. The 29 respondents gave a total of 58 different reasons for taking the NetShops. These responses fell into four general categories: to develop basic skills, to expand skills, to use the Internet to teach and find resources, and to learn advanced applications. About a quarter of the responses related to wanting to start to learn about computers and the Internet. One teacher identified her goal as, "To become comfortable with using computers and to learn all about using the Internet and that I can be up with the times." Another 26% of the responses related to expanding existing skills and knowledge, "to become a more efficient user of Netscape." Forty-one percent of the stated goals related to learning to use the Internet to teach and to find resources, " I would like to use the Internet to find lesson plans and teacher related materials." Finally, only 9% of the responses indicated a desire to use advanced applications, "to be able to create a web page and to be able to effectively teach it to students."

Fears and Reservations About Computers

Participants were asked what their greatest fears or reservations about computers were. In all, 33 different items were named in this area. These responses fell into four categories: lack of experience, worry about getting stuck or breaking the computer, concerns about the advisability of using computers, and those without fear. About a third of the concerns related to the teachers' lack of experience, "My limited knowledge of them and my limited involvement with them, when it seems the rest of the world is all connected with them. Time I jumped on board!" Another third of the responses related to fear of getting stuck or breaking the computer, "I'm afraid I'll ruin the computer somehow by forgetting to do something, or by doing something wrong." Said another teacher, "Every time I use the computer, something goes wrong and it ends up taking more time and I don't get the job done." Another example of quotes in this area, "getting into a program and not being able to get out." Some teachers (15% of the responses) took this question to relate to the larger question of whether we should be using computers and technology in classrooms to such a great extent. One teacher stated, "People will think that computers in the classroom will accomplish the impossible; computers are a poor substitute for good teachers and caring parents. Students will have to carefully evaluate all information they access online." Finally, 12% of the responses indicated no fears or reservations.

Positive Aspects of Educational Computer Use

Teachers were asked to indicate, "What are some positive aspects about using computers for educational purposes?" Teachers offered more than one purpose resulting in a total of 60 responses. Reducing the categories was somewhat difficult due to the range of benefits cited. The largest groups (18% each) related to the ability to access an incredible amount of material from diverse sources (e.g., "...you can access current, up-to-date material on a wide variety of subjects") and the use of computers as tools for teachers (e.g., "professional parent communication") and children (e.g., "They serve as a wonderful tool in the classroom to support the writing process..."). The next most frequent responses (17% each) cited the potential for enrichment (e.g., "children becoming familiar with their world as a friendly neighbor") and motivation (e.g., They are highly motivational..."). Twelve percent of the benefits related to the need to develop computer literacy as a necessary life skill for the 21st Century (e.g., "New educational goals are all geared toward computer literacy..."). Finally, teachers saw the advantages of computers in working with special learning needs of children, (e.g., "Computer programs are available for all types of learners and students' individual needs are better met.") Only a couple of teachers said, "You tell me!" Thus, even before taking the NetShops, teachers perceived many different advantages of greater computer use in classrooms.

NetShop Evaluations and Summaries

After each NetShop, teachers were asked evaluate their experience and to indicate how they would use what they learned in the future. NetShops facets were rated on a 5-point Likert scale (e.g., "1=No, Lousy! Boo!" to "5=A hearty yes! Great!"). Evaluations of the InterNet Academy were overwhelmingly positive. Teachers indicated that the objectives were clear, the topics useful and interesting, and the instructors were well prepared and knowledgeable. In the 10 separate categories, the ratings generally averaged between 4.5 and 5.0 out of the 5-point scale. Teachers found comfort in having fellow classroom teachers as instructors and having the workshop located in an elementary school. The instructors were able to relate specific school-based examples of uses of computers, e-mail, and the Internet.

Teachers who participated in the first three NetShops completed learning summaries in which they indicated what they learned and future plans for implementing computer and Internet use in their own classrooms in the coming year. In all, 21 teachers completed this assignment.

What They Learned

In terms of what they learned, there were 56 separate responses which generally fell into two categories: learning to use the computer and manage the specific programs such as Netscape and Eudora (61%), and utilizing the newly developed skills to use listservs and search engines to locate specific instructional information on the web (39%). Among the topics explored were math activities and lessons, information on natural disasters, dinosaur facts, and updates on the Iditarod race in Alaska.

Future Plans

Responses to how teachers planned to use what they learned in the future ranged from simply continuing to use electronic mail for personal use or for gathering information on curriculum topics, to fully developed projects for students using the Internet. Many worked on these projects during their Academy experience and set up bookmarks for themselves and their students to use on specific projects. There were 25 separate responses that can be divided into four categories. Eleven out of the 25 simply said they were going to use the research they conducted via the Internet to develop lessons and classroom activities. Seven planned to have students research topics on the Internet or use e-mail to communicate with others. Five responses indicated they planned to continue to use the Internet to search for teaching ideas and materials, and two teachers wanted to teach others, students and colleagues, some of what they had learned in the NetShops.

Post-Academy Survey

Surveys were sent to all participants of the InterNet Academy in order to ascertain whether the skills acquired during the Academy were utilized for personal and/or professional purposes during the school year. Teachers were asked to describe how the skills were used, and to provide information on further assistance or training required to enhance their Internet skills.

Eighteen participants responded to the survey. Three had purchased computers as a result of their newly developed interest in technology. All had used the knowledge and skills for either a personal or professional purpose. Five teachers had not yet used the Internet at school. Two said they had "just not gotten to it," and three cited problems with their computer or the lack of a functioning modem or other online connection. With one exception, the other 13 teachers were using their new Internet skills for both personal and professional purposes. In terms of school use, teachers: created school and classroom homepages; investigated shipwrecks, Monarch butterflies, and sea turtles; hooked up with a geography contest and e-mail projects with students from many parts of the United States, Canada, Mexico and New Zealand; collected lesson plans and online math/science projects; set bookmarks for student use on yearly themes; joined lists such as Kidsphere; and started an Internet Club.

Assistance or Training

When asked to provide information as to what further assistance or training would be needed to enhance their Internet skills for either personal or professional purposes, teachers asked for more training on the Internet and on technology (e.g., scanning, creating web pages) in general. One teacher recommended that administrators be required to take the training "...so they would support our requests for computers in the school for faculty use!". Others reported problems with the ability to access the Internet due to either software or hardware problems (some lost their e-mail account provided by the university at the end of the summer and are having difficulties getting new accounts either through the university or the State).

The statements of the teachers demonstrated a more sophisticated knowledge of computers and technology in that their interests were much more focused than those indicated by their goals listed in the Pre-academy Survey. The following examples illustrate typical responses,

> I would be interested in learning more about the process of searching the Web. The various search engines seem to have different protocols and, as a media specialist, I am particularly interested in successfully locating information. I need to learn how to narrow the search field so that I am not wasting time with a lot of useless hits.

> What I need, like most people, is more time. I would like to see how teachers actually use the Internet with their students for lessons, beyond the class first researching themes.

> ...I think it would be helpful to learn about ways to integrate the computer into the classroom curriculum. What projects are others involved in? How is the computer time managed-both in the lab and with the one in the classroom? How are students (at the elementary level) using the Internet?

Conclusions

Sheingold and Hadley (1990) identified the development of teacher skills in educational computer use as a process requiring time, support and colleagues to work with in order for the technology to become integrated. The Academy provided these elements and clearly those who participated in the NetShops of the InterNet Academy found them useful. Many learned how to find their way around the Web and locate resources that could help them in their personal as well as professional life. Future InterNet Academies would best serve past and future participants by providing introductory NetShops, as was the case during the first InterNet Academy, as well as training that would model for teachers ways in which these skills could be used in the classroom, and address some of the more practical, management issues. The use of highly trained classroom teachers as instructors and a real elementary computer lab as the setting were critical to the success of this project. By selecting cooperating teachers for the training, we have increased the likelihood of continued connections with the NetShop graduates as they continue their journey toward more effective integration of technology into their classroom and teaching practice.

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Expanding Preservice Teachers' Perceptions of Teaching Diverse Populations Using E-Mail

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I believe in the near future that letters delivered to your home via mail carriers will be a thing of the past. Instead, checking your e-mail will replace the daily task of going to the mail box, just like I have been doing with my e-pal. I have begun to explore the capabilities of the computer, discovering the powerful ways computers can improve my teaching. The rapid advances of computer technology have opened up user-friendly programs for virtually every imaginable field. Education can benefit from computers by the computer's ability to bring vast amounts of information to the user, student or teacher. [UCF Preservice Teacher]

We communicate our life experiences by telling stories. These stories reveal who we are and how we view our world. In sharing our stories we often evoke stories from others (Jalongo & Isenberg, 1995). The dialogue begins.

We can investigate the ways in which preservice teachers' stories reflect the meanings they have given to their experiences using qualitative inquiry (Eisner, 1991) and we can share our findings through qualitative narrative (story). In the following pages we will tell a story of preservice teachers' perceptions of teaching diverse populations. University of Central Florida (UCF) and Cleveland State University (CSU) preservice teachers shared stories of their respective school experiences via e-mail. Through examining these shared stories, we are able to gain insight into the ways in which these preservice teachers have interpreted their experiences. In addition, we are able to gain insights into the importance of sharing teaching experiences with others in different regions of the country, and into the use of e-mail as a vehicle for critically examining the teaching of diverse populations.

Our Stories

To begin our story, it is important that we first introduce you to the tellers and the "characters." This provides a context for the voices (Eisner, 1991) through which our stories are told.

Sandy's Story

I was a native Floridian until I moved to Cleveland, Ohio in 1992. I had never seen snow, had very little knowledge of the urban-suburban structure of the Greater Cleveland area and the various ethnic groups which lived there, and quickly found that it was difficult to tell the story of living and teaching in Florida. I had never really thought about it. I just did it.

I was startled the first time I saw all of the snow boots lined up in the hallways during the first winter storm. At that point I realized how different the school facilities were in the two regions. The Ohio schools are primarily multilevel, enclosed structures. Many of the classrooms in Florida schools have outdoor access. I had not previously thought about the role weather played in architectural considerations for school building designs.

I have now returned to Florida. I find that the words used to describe teaching and schools in Cleveland are not suitable for describing teaching in Florida. In trying to tell my story I find that I have to reflect on the commonalities and differences of the two settings. In doing so I have expanded my view of teaching and learning in various settings. Although we could not physically transport students at UCF to Cleveland, we could have preservice teachers from the two universities share their stories via e-mail.

Jackie's Story

My story is in sharp contrast to Sandy's. I have lived in Cleveland all my life. I attended suburban schools, earned my teaching degree at a local liberal arts college, and taught for six years in the same district I had attended. My first experiences in urban schools occurred several years later. I am a professional storyteller, and it was through the sharing of stories—folk stories and personal stories—that I came to know urban students and teachers. Building on these experiences during my doctoral studies, I worked with teachers and students in the Cleveland Public Schools through a long term partnership project.

Although I have not lived in another region, I have experienced Sandy's awareness of commonalities and differences in schooling in other ways—suburban and urban settings, public and private schools. I have asked my preservice teachers to reflect on their perceptions of teaching in urban settings, and my curiosity about their perceptions has grown. I viewed Sandy's invitation to participate in an e-mail project involving preservice teachers in our diverse regions as an opportunity for continued exploration into these perceptions. I was particularly eager for my students to exchange stories with preservice teachers in another geographic region.

The University of Central Florida (UCF) Preservice Teachers

The UCF participants are enrolled in an elementary mathematics methods course. Thirty-five percent of the participants have been Florida residents from birth. Twenty-six percent have lived in Florida more than fifteen years. Nine percent have lived in Florida more than ten years. The UCF preservice teachers are placed in either an Orange County school or a Seminole County school for their junior internship experience.

The Orange County public school system is the sixth largest school district in Florida. Currently over 60,000 students are enrolled in the 87 elementary schools in the district. The racial/ethnic distribution of the student population is 52.5% Caucasian, 27.9% African American, 16% Hispanic, 3.3% Asian/Pacific Islander, and less than 1% American Indian/Alaska Native. The Seminole County School District is less than half the size of Orange County Schools. There are 29 elementary schools serving over 24,000 students. The field experiences for these preservice teachers provide opportunities to work with multiple grade levels; however, there are few opportunities to work with culturally diverse populations. Many of these students do not have any idea of what it would be like to teach in another region of the country and have misconceptions or no idea of the differences between urban and suburban settings.

Cleveland State University (CSU) Preservice Teachers

The Greater Cleveland area is home to approximately 80 ethnic groups, speaking more than 60 languages. There is a distinct east side and west side, each made up of suburbs. Within these suburbs are many thriving ethnic communities (e.g. Old Slavic Village, Little Italy). Each suburb has its own government structure as well as its own school system. In some cases two suburbs join together to form the school system for that area. In addition, there is a definite classification of urban versus suburban school systems.

Preservice teachers attending CSU are required to complete two field experiences in urban schools and two field experiences in suburban schools. The urban placement must be in either the Cleveland Public Schools, East Cleveland Public Schools, or the Catholic Diocese Schools. The Cleveland Public School system consists of 81 elementary schools. Approximately 75% of the students represent minority populations, 80% are in the free lunch program and 70% live in single-parent homes (N. Klein, personal communication, December, 1996). In East Cleveland Schools, 99.4% of the population is African American, 69% of the students live in single-parent homes, and 49% live at or below poverty level (Hampton, Perry, Towns, & Mumford, 1996).

CSU participants are enrolled in an elementary language arts course. Ninety-five percent of the CSU participants live in the greater Cleveland area. Fifty percent have grown up in one of the Cleveland suburbs and now travel into the urban center to attend classes at CSU. Prior to the urban field experience many of these preservice teachers have had little experience in the urban schools. They enter this quarter with many preconceived notions of what it would be like to teach in these schools (Stuart & Peck, 1995). Seventy-five percent of the CSU participants have not lived in the south. Consequently, they have misconceptions or no idea of how teaching in a southern metropolitan setting differs from teaching in a midwest suburban or urban setting.

The Study

Jordan (1995) suggests that most prospective teachers have limited or no experiences with minority populations. That is, their socialization has been "culturally isolated" (Jordan, 1995). However, through dialogic interaction preservice teachers can critically analyze their beliefs, world views, and assumptions (Harrington & Hathaway, 1995).

This study linked 39 preservice teachers attending a southern metropolitan university (UCF) with preservice teachers attending a midwestern urban university (CSU). By establishing a dialogic interaction between these two groups we sought to provide opportunities for preservice teachers to examine their own views of teaching diverse populations.

The Method

Preservice teachers at both locations completed an open-ended questionnaire regarding their perceptions of urban, suburban, and metropolitan settings as well as teaching and learning in these settings. Each preservice teacher at CSU was then given the e-mail address of a UCF e-pal. Each was charged with finding out what it is like to teach at their partner's location. We suggested that they consider discussing the facilities, resources, instructional strategies, and types of student and teacher interactions. However, they were not limited to these topics.

After approximately five weeks, participants were asked to write a paper describing their findings. They were also asked to complete a final questionnaire. On this questionnaire participants were asked to comment on the experience itself. We asked them to suggest improvements and to comment on whether future elementary education majors should be required to complete a similar activity.

The Emerging Story

The preservice teachers' stories of the experience were analyzed looking for common themes. The following provides a preliminary discussion of four emerging themes from the stories retold by the UCF and CSU preservice teachers: 1) validation of teaching techniques, 2) inability to imagine teaching in an urban setting, 3) impressions of teaching in the urban setting, and 4) changes in perceptions as a result of this experience.

Validation of Teaching Techniques

> I did find out, however, that the classrooms up there are using an integrated teaching style. That to me is reassuring, we must be doing something right down here if we're not the only ones doing it. [UCF Preservice Teacher]

Ten of the thirty-two UCF participants were pleased to find out that the instructional strategies being emphasized at UCF are also being used at CSU. Knowing that instructional strategies were being used in more than one region of the country added credibility to what we have been discussing in the university classroom.

CSU students also described similarities in the university classes and the field classrooms.

> My e-pal's classes sound a lot like ours at CSU. She uses math manipulatives for almost every math lesson. Whole language seems to be the strategy used for language arts. [CSU Preservice Teacher]

But it was most affirming for CSU participants to learn that

> ...preservice teachers across the country are learning how to be effective and efficient and are just as dedicated to the futures of their students as those here in Cleveland. [CSU Preservice Teacher]

It is Unimaginable

> This school is such a foreign concept to me that I am not sure I can truly imagine what it is like. [UCF Preservice Teacher]

UCF participants were surprised by the stories they heard about the facilities and resources available to teachers in the urban setting. They could not imagine teaching at a school without playground equipment, where the doors automatically lock when closed. They realize that safety is an important consideration at all schools. However, they had not considered what it would be like to teach in an area where the doors had to be locked to protect the students and teachers. There is a "bell door" at each school through which visitors may enter the building. This is not a part of the UCF experience. Each individual classroom has a door to the outside in many of the schools at which UCF students are placed. One door can not be designated as *the door* through which visitors enter the school.

This outdoor access to the classrooms was an unimaginable, or at least unusual, idea for the CSU preservice teachers. CSU participants expressed surprise with exterior hallways, one-story buildings, and hurricane drills. These overlooked differences of daily life stand out when telling a story of teaching in various geographic regions.

Impressions

> Through his description of an urban setting, I almost feel like I have experienced teaching there myself. [UCF Preservice Teacher]

The most powerful stories told by the CSU participants were about the facilities, teaching techniques, and teacher attitudes. The UCF preservice teachers repeatedly described their surprise and sadness in hearing their e-pals' stories. They appreciated the wealth of resources available to them in their schools.

> I was also surprised by what I learned. As I read the e-mail these last few weeks, I began to be very thankful for the type of school I was assigned for my internship. [UCF Preservice Teacher]

CSU participants appreciated hearing the viewpoints of preservice teachers in another region. They overwhelmingly commented on the increased availability of technology in the southern metropolitan settings. One student in particular was surprised to learn that the southern school

> ...was as well equipped as it is because I expected a poorer region. This must be based upon a preconceived notion I have about Florida. [CSU Preservice Teacher]

This realization of the differences in resources and facilities led to changed views as well as generated strong reactions by the CSU participants. One CSU participant said that she

> ...found herself being jealous of [her e-pal's] 'wonderful experience.' [CSU Preservice Teacher]

Changing Views

> I had no idea how clueless I was about the different types of school settings. I am so glad that I learned about this before I entered into my teaching career. [UCF Preservice Teacher]

UCF preservice teachers overwhelmingly described a change in their perception of teaching. They had not considered what it was like to teach in other regions of the country. They just had not thought about it. Prior to this experience, some UCF participants thought that teaching was similar in all regions of the country.

> From this experience, I have learned that there is no such thing as a standard elementary school. I always thought that elementary schools were pretty similar—the same material was taught, the make-up of students was similar, and the facilities were relatively the same. I found out completely different. [UCF Preservice Teacher]

Although CSU participants also changed their views about teaching in a southern metropolitan setting, they were changed to a greater degree by their own urban experiences. This project gave them an opportunity to reflect on their beliefs. They had to find the words to tell the story of their experience.

> Personally, all of the stereotypes I had of an urban school were thrown out. [CSU Preservice Teacher]

Student Recommendations for the Future

Twenty-nine of the thirty-seven UCF preservice teachers surveyed stated that this should be a required activity for future elementary education majors. Six respondents stated that this should not be required and two did not comment. Five of the UCF participants who did not recommend doing this activity again were unable to complete the e-mail project. They had difficulty receiving responses from their e-pals. Consequently, they were frustrated with the project and did not feel that other preservice teachers should experience the same frustration. The majority of the CSU respondents also recommended that future language arts students do this assignment.

Although the UCF preservice teachers felt that this was a very worthwhile project they suggested several areas for improvement. First, the UCF students felt that more time should be allotted for the completion of this project. CSU students also made this suggestion. They suggested that the project be assigned early in the semester and continue throughout the semester so that they have more opportunities for the exchange of stories. Although we agree with this suggestion, the time constraint was unavoidable. UCF utilizes a semester system whereas CSU currently utilizes a quarter system. Consequently, CSU students began classes four weeks after the UCF students. The UCF students begin their internship experience the second day of classes. The CSU students begin their field experience four weeks into the quarter. Consequently, the CSU students cannot supply a great deal of information about the urban school setting until the eighth week of the UCF semester.

The UCF students were very concerned about the difficulty in receiving responses to their inquiries. They suggested that a system be established in which student-student interactions via e-mail could be monitored at both locations. One suggestion was to require students to submit a copy of the e-mail exchanges each week to encourage students to dialogue on a regular basis. Similarly, a CSU participant suggested we have assignments due throughout the term to ensure contact is being made. Another CSU participant suggested e-pals could schedule times to read and send messages as a way to make the exchange more intentional.

Lessons Learned

Over one-third of the UCF participants specifically commented on the importance of this project in making them more comfortable with using technology. More than half of the UCF participants commented on the importance of learning about teaching in other regions of the country.

> I had no idea it was *so* different in other areas of the country. I enjoyed this assignment and learned so much. [UCF Preservice Teacher]

More than half of the CSU participants learned to use and appreciate e-mail. Several even surprised themselves by teaching someone else how to use e-mail! One-fourth commented on the importance of learning about schooling in another region, and they appreciated "talking" online about their preservice teaching experiences with each other.

> I learned that the e-pal process is a productive one. I liked it because "it" (the technological process) literally takes you to other parts of the country to find out about the similarities and differences in the pedagogic experience. The e-pal experience hinges on cooperative learning. ...I really like the idea that this process can be used in our own classrooms with our own students. It is almost as good as a field trip to a different region. [CSU Preservice Teacher]

We found that this experience for the UCF and CSU preservice teachers paralleled our own experiences. That is, both UCF and CSU students struggled to tell the story of their respective experiences. This activity forced the participants to make the familiar strange so that they could create and tell a meaningful story. Although we did experience technical difficulties, we both agree that this was an invaluable experience for our students. Our students not only became more familiar with e-mail, they reconsidered their previous notions about teaching.

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TELECOMMUNICATIONS: SYSTEMS AND SERVICES

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The World is moving so fast these days that the man who says it can't be done is generally interrupted by someone doing it. —Elbert Hubbard

For many of us in education, we have known about the power of telecommunications for years and we have been trying to spread the word to our students, our colleagues, our administrators and anyone else who would listen. Often times, it seemed as if we were fighting a losing battle as we discussed the value of understanding and using applications such as listservs, newsgroups, and gophers. The reception was not always enthusiastic, but we persevered. In education, especially, we have been the pioneers, the early adopters and the innovators, as we helped shape the vision of a telecommunications-equipped future. But times have now changed. No longer does it look like we are losing ground in our evangelical holy war. On the contrary, we have been more successful than many of us could ever have imagined. Bill Gates is the richest man in the world and anyone who wants a presence on the Internet can have one, a fact that seems to be validated every time we cruise the Web. In fact, we don't even call it the World Wide Web anymore, it's now simply "the Web," and if there are still students, faculty and administrators who don't know what that means, they soon will.

Interestingly, with the acceptance of telecommunications as a legitimate communication medium, our roles as innovators and early adopters have not diminished. As educators, we are still leading the way in finding meaningful examples of how emerging technologies can be used in the design, development, and delivery of instruction. The articles in this section cover a variety of issues related to this idea, how telecommunications technology can be used to support the educational process and the training of students and teachers. Several papers deal with the creation of electronic communities. Others describe products and processes where telecommunications has become an integrated part of the curriculum. Issues related to developing a usable network infrastructure are explored in this section along with methods for dealing with the changing nature of intellectual property and copyright.

The section begins with a paper by Zimmerman and Greene, who describe their work in establishing an electronic community of learners at Appalachian State University. This network connects the university with local public schools and other universities, and allows teachers, students, and university faculty to become full participants in shared pedagogical dialogue and activities. Utilizing such resources as listservs, Web pages, and videoconferencing, the authors detail how experienced educators help public school teachers and preservice teachers learn to use telecommunications by using it along with them. In the next article, Alvarez examines how science students and teachers are using electronic communications to become "communities of thinkers." This collaborative project involves students, teachers and astronomers working together to analyze data and solve problems in astrophysics.

Volpentesta, Greco, Frega, and Pisculli discuss the development of CODEE, a collaborative drawing tool that can be used to support teleworking and teletraining. This exciting tool allows users anywhere in the world to draw on the same canvas. The article provides a detailed overview of the technical specifications of the program, a comparison of similar applications, and an analysis of how this program is being used in a European distance education project. The authors also include strategies that other may find helpful when using such a tool. Cote's paper is centered on the development of SPICE, Standards-Based Products for Interactive Classroom Education. This program was designed by the Colorado Alliance for Science in an attempt to use Web-based materials to support teachers in the use of technology, mathematics, and science education. The article outlines how collaboratives of schools, districts, institutes of higher education, and technology partners bringing together pedagogy, subject matter expertise, real classroom experience, supporting technologists and media specialists to develop innovative interactive learning tools that are changing the way teachers and students use technology.

Jacobs, Falk, Mooney, and Lochhead present their findings about the TEECH (Teacher Enhancement Electronic Communication Hall) program, designed to encourage communication, collaboration, joint exploration, and pooling of their community's collective resources. Using such techniques as listservs, a library of online resources, and RealAudio technology, TEECH hosts discussions on critical issues in teacher enhancement, electronic seminars with experts in the field, and special interest groups on topics such as follow-up after workshops, long-term sustainability of teacher enhancement efforts, and use of video in teacher enhancement. Miller and Melott describe a prototype system for mathematics and science education based on the *Powers of Ten* tradition. The system, which is designed to allow students to visualize relationships among the various physical and life sciences while perceiving the role that mathematics plays in each of the disciplines, uses Web technology and advanced features such as Java applets and three dimensional environments based on VRML.

In the area of developing network infrastructures, Chang, Gilbert, and Bao discuss Project Caprina, a campus-wide network-accessible archive of digital images and software applications at the University of Maryland. This innovative project is expanding the way faculty are able to teach their classes and students are able to complete their assignments. With a strong emphasis toward the use of multimedia, this project helps define how technology-based education can be used both in and out of the classroom. Jerman-Blazic presents an in-depth view of how Central and Eastern Europe countries are providing training opportunities for creating network infrastructures following the dissolution of the Soviet Union. The article provides a fascinating look at the efforts of CEEnet, the Central and Eastern European Networking Association which is focusing on academic and research networking in 19 different countries.

Simon and Abbott present an update of WIN (Walden Information Network), an ongoing distance education program at Walden University. The WIN program seeks to develop a fully electronic campus by providing all of Walden's students and faculty members with an electronic connection to each other and to the Internet. The authors report on a study that tracked students who have gone through the program and include comments from students as well as plans for the future. Bedell and Wilker write about a method they use to access Web pages locally without an Internet connection. Microweb technology, as they call it, is an innovative way that educators can simulate actual use of the Web, with the same functionality as the original site. The authors describe both the technical component of their work, and also examine other related issues such as storage of large files, censorship on the Internet, and copyright.

Robin and McNeil also examine the issue of copyright and electronic materials in their article about Archive.edu, a Web site that was developed as an online area where sharable educational resources can easily be found and downloaded. The authors invite other educators to adopt a model of sharing not only curricular resources online but also tutorials and specific examples of how various technologies can be used in the classroom. Erickson presents an overview of digital copyright issues in the Age of the Internet and describes The NetRights LicensIt System. This system allows users of content to easily obtain copyright data and engage in online (and possibly automated) licensing by way of the digital content elements, directly from the context of the document or project in which those elements are being used. The LicensIt system addresses the need for a uniform, timely and persistent means of identifying digital content in the networked environment.

The section concludes with Simon's work on DisNet, a model of a database-centered network environment that specializes in the generation of contextual relationships in a discursive format. A variety of collaborative strategies that emerged during the course of the project are also discussed

As we continue our efforts to help our students and our colleagues take advantage of the power of telecommunications technology, there is always more work to be done. Each year, greater numbers of students and educators will look to us for ways to use telecommunications technology, from finding funding to developing training to integrating it into the curriculum. The articles presented here can assist us in that task as they provide innovative ideas and specific examples of how telecommunications systems and services are being developed for multiple content areas and implemented in locations around the world.

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Building A Technology Rich Community of Learners

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With the vast array of technological resources currently available, the question for public schools is not whether to link up to the Internet, but how to link up and how to assist teachers in productive use of telecommunications and networking. Telecommunications can provide teachers with a means for communication and reflective thought and can connect them to a community of learners that reaches beyond the school building. Despite the enormous potential that telecommunications holds for education, it has been estimated that only two to three percent of teachers use this technology (Grabe & Grabe, 1996).

Our decisions about field experience shape an important part of our elementary education program. When we place students in field experiences we want them using telecommunications. It is imperative that teacher preparation programs use these resources as tools for the preparation of reflective practitioners. Pedagogical dialogue is one way that technology can assist in this process. Computer-mediated communication on various listservs reveal that unique and powerful support networks emerge as joint construction of meaning occurs (Schlagal, Trathen, & Blanton, 1996; Laffey, 1995; Levin, Waugh, Brown, & Clift, 1994).

At Appalachian State University (ASU), we have established an electronic community. We have connected our university with local public schools and other universities, creating a network where teachers, students, and university faculty can become full participants in shared pedagogical dialogue and activities. Within this community of learners, we have multi-level and multi-skill membership. Experienced educators collaborate with new teachers, enabling their induction into teaching in a non-threatening atmosphere. Dialogue among participants creates a community where all members, new and experienced, learn as they participate in practice (Lave & Wenger, 1990). We believe that a key role for university faculty in these partnerships is to help public school teachers and preservice teachers learn to use telecommunications by using it along with them. It is through participation in shared activity that learning best occurs (Rogoff, 1994). In this paper, we describe how a university/public school partnership structures telecommunications activities and dialogue to create a community of learners.

Members of the university and public schools created a *Learning and Technology Laboratory* to serve as the focal point for the application of technologies. A local telecommunications network was established between the university site and five local schools: Blowing Rock, Green Valley, Hardin Park, and Parkway Elementary Schools, and Watauga High School, in the Watauga County School District. With the establishment of the network, university and public school faculty designed a series of activities. A major activity was the application of telecommunications in preparation of elementary school teachers. Several electronic discussion lists were developed to facilitate ongoing discussions among university faculty, teachers, university students and students in public schools. For example, XMODEL was designed for university cadre discussions; XBLOCK was created for faculty and student discussions; XTEACHER promoted a dialogue between university faculty and cooperating teachers; and XSTUDENT was limited to university students to allow exchange ideas on a more personal basis. Other content oriented lists were created for members of university methods courses to discuss issues related to literacy, social studies, and mathematics. During the courses, faculty structured activities to help students connect abstract university classroom knowledge to their public school experiences.

Videoconferencing provides another vehicle for linking the university setting to public schools and for stimulating creative teaching and learning. It is a viable tool for clarifying current topics, issues, and trends in education and allows professors to view and engage in current practices. On one occasion, university faculty and an educational consultant representing a major textbook company participated in a teleconferencing session with teachers reflecting on the strengths and weaknesses of a new published reading program. On another occasion, university students were linked to a fourth grade classroom teacher and technology specialist via teleconferencing and engaged in a discussion on lighthouses and plans for teaching about them.

We have found that our electronic community provides clear advantages for both public schools and our teacher education programs. For the first time we have linked teachers with teachers, so that individual teachers in western North Carolina are no longer isolated. A community of teachers and educators creates a network to share cultural experiences, write to an audience, and make comparisons about teaching, learning, and schools. Teachers are also able to communicate with each other about issues that affect all of them.

Research suggests that traditional methods courses taught in isolation limit reflection and application (Paul et al. 1995) and consequently do not empower a novice to make connections with questions, problems, and contradictions that arise in the classroom. The ongoing community of discourse in teacher education provides opportunities for novice teachers to apply, critique, and think flexibly about their teaching knowledge. As a result, students are able to structure their knowledge base for making decisions about a critical teaching task (Greene & Zimmerman, 1996). In our community of learners model, critical teaching concepts are targeted by the researchers for development and analysis. These concepts are presented at the declarative and procedural levels (Paris, Lipson, & Wixon, 1983) during the methods courses. The conditional knowledge or the understanding of when and why to apply the previous forms of knowledge becomes the focus for the instructional discourse during the field experiences. Structures were designed to ensure all critical concepts were discussed during the year. Examples of two students, one on reading and one on behavior management, linking the abstract declarative and procedural knowledge to concrete teaching is seen in the following passages.

> I taught a reading lesson today. I used several strategies that we learned in class. I used an anticipation/reaction guide, a concept map, and a writing strategy. My students liked these strategies and they worked. I sat in on a meeting with my teacher who was being interviewed about her program. I actually understood the questions and could have answered them myself.

> I didn't understand the motivation behind my teacher's discipline plan, so I began to observe and ask questions. I could tell that she was using some of Glasser's ideas in her approach. I found her goal was to create an atmosphere where students learn to regulate their own behavior and to try to help their classmates do the same. It is amazing to see kids meet together in a democratic type of environment and set classroom goals. Now that I understand her philosophy, I have much more respect and commitment to her approach.

These examples demonstrate how telecommunications reveal the transformation from prospective teacher to beginning teacher. Students reexamine issues based on direct observation. They develop different perspectives after seeing the value of instructional strategies in practice.

To summarize, with easy access to a network and a social and instructional scaffold for support, an electronic environment within which teachers, students, and university faculty can grow and explore can be created. Factors which are essential for success such as support, leadership, and funding have been included in our plan. The application of technology has not replaced the special teacher/student relationship but has helped redefine and strengthen it. Neither a community of learners nor technology can effortlessly transform education by themselves. A combination of both is necessary to create a powerful opportunity to change the structures of public school education and teachers. For more information on our project, visit our Web site at: http://www.ced.appstate.edu.

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Communities of Thinkers: Investigating Interactive Scientific Literacy Environments

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High school teachers and students are not thinking and learning together. They are focusing on learning outcomes rather than the processes necessary to achieve these outcomes. This paper examines conceptual learning, application of electronic discourse and scientific inquiry through an emergent curriculum that uses innovative technology. The focus is on four aspects of a learner-centered scientific literacy environment designed to stimulate curiosity and inquiry: 1) how literacy and scientific inquiry is promoted by exploring the universe using self-directed case-based instruction that incorporates a multi-disciplinary approach; 2) the educational role that primary data from automatic photoelectric telescopes have on teachers and students; 3) how mathematical and scientific competencies are enhanced by engaging students and teachers in "real life" applications. The fourthj feature is unique to this project and not currently found within a traditional curriculum: 4) the impact of interactive literacy environments by demonstrating how teachers and students are using electronic communications to become "communities of thinkers."

Much of the science teaching in our secondary classrooms indoctrinates students with pre-existing knowledge. In this context, the student is limited to absorbing the information they receive. Over reliance on a single textbook and materials provided by the publisher makes this type of teaching less meaningful. In these circumstances critical thinking (thinking about thinking in ways to bring about change in one's experience) and imaginative thinking (exploring future possibilities with existing ideas) is given minimal consideration by the teacher and student. The teacher does limited thinking when preparing lessons and assignments because the lessons have been pre-prepared. Students resort to completing prefabricated worksheets and assignments with the least effort and thought. In fact, because of these types of assignments, much of the science vocabulary is reduced to rote memorization with little understanding of the concepts, details, generalizations, or theories involved (Gowin, 1981; Novak, 1990, 1993; Thelen, 1984).

The *Explorers of the Universe* (http://coe.tnstate.edu/explorers) is a project that combines pedagogy with contemporary scientific exploration of the universe by investigating authentic scientific problems that have significant implications for a global society. This collaborative project involves teachers with their students and astronomers investigating astrophysical problems and analyzing data from state of the art automatic telescopes. Astronomy students in grades 9 through 12 in two high schools, University School of Nashville, Nashville, Tennessee, and Thomas Jefferson High School for Science and Technology, Alexandria, Virginia, participate in this project. Unique aspects of this project are: (1) students analyze data received from automatic photoelectric telescopes monitoring properties of variable stars by computers; (2) they make innovative uses of videodisc and electronic technology to create interactive learning environments. These are designed and carried out *by* teachers with their students for their use; and, (3) teachers and students are involved in research dealing with "real life" exploratory space investigations.

Self-Directed Case-Based Instruction

The case-based method of teaching and learning allows students to develop their own framework to reason and think about problems and situations related to an area of study (Hunt, 1951). Our students research and develop their own cases as they investigate real problems which differ from those cases that are typically written by others *for* students (Alvarez, 1993). Their cases involve them in thinking processes as they interact with an array of print and multimedia environments. The school's library resources (e.g., books, articles, video CD's, etc.), the Internet, and persons who have knowledge or resources are consulted. Students are encouraged to think about integrating other subjects into their case (e.g., literature, art, music, social studies, etc.).

As students formulate their cases they focus their thinking processes beyond undirected thinking to more advanced stages including inductive thinking, problem solving, critical and imaginative thinking, and discovery. These types of thinking change their view of learning. Instead of thinking of ways to expediently achieve learning outcomes, these students now focus on ways to achieve meaningful learning . Their energy is redirected to satisfying an intrinsic need to know and understand.

Classroom Environment

The environmental context of the classroom also influences students' written reports. If the report is written for the teacher and classmates it may be written in one form. However, if the environment changes to one that is electronically interactive (i.e., e-mail or papers published on the World Wide Web (WWW)), the format and thought processes may be altered to meet the challenges that may be incurred from faceless and unknown readers (Alvarez, 1996a).

Students use the Web as a tool to conduct research, publish information, and direct e-mail inquiries to specific persons. They use the Web in the same manner as the library. One significant difference is that authors of documents that reside on the Web can be contacted directly through e-mail with questions to help clarify or solicit additional information. The students also publish their papers on the Web which allows anyone with Web access to read and critique the documents. The use of the Web forces students to carefully analyze both the information as well as the source. Not everything on the Web is accurate so they must discriminate and select information. Web usage also increases collaboration between students. They co-publish papers as well as develop links to other related student papers and Web pages.

The textbook in this type of interactive class environment becomes a resource rather than the sole source of science information. This results in increased ability of the students to be more critical of an astronomy text with regards to its organization, readability, and graphic features (Alvarez & Rodriguez, 1995). Many of these science texts contain a high volume of conceptual terms that require meaningful understanding. Because of the conceptual density of these texts, many students resort to memorizing these terms without knowing or understanding what they actually mean within a given context (Thelen, 1984). As a result, much of the science vocabulary is reduced to rote memorization with little understanding of the concepts, details, generalizations, or theories represented. Our students become better acquainted with the concepts and theories in textbooks due to their exposure to and analysis of other readings and resources.

The apparatus consists of small and automatic telescopes, and computer terminals with Internet access. The telescopes these students and teachers access include: (1) the Fairborn Observatory 10-in automatic telescope (APT), and the Vanderbilt/TSU 32-in (APT) at Washington Camp in Southern Arizona equipped with a photoelectric photometer. These remote automatic telescopes are controlled electronically and enable students to place their stars for observation and analysis. The classroom becomes an active place for students to communicate with peers, their teachers, astronomers, and university educators via the Internet.

Enhancing Mathematical, Scientific, and Literacy Competence

Students use their mathematic, scientific, and literacy skills to interpret calculations received from the automatic telescopes, relate the findings to their study of astronomy, read scientific journal articles, write their case reports, make journal entries, construct concept maps, and develop vee diagrams. These processes, used in combination with each other and incorporating other subject disciplines, enable students to link new information to prior knowledge. The interactive nature of the technology, together with the tools that are needed to plan and represent their ideas provide a forum for teachers and students to think and learn together.

These high school students are thinking about additional ways to analyze data received from the remote automatic telescopes. They are rewriting a program developed by one of the astronomers to make it more comprehensible. Together with their teacher, two students at the University School of Nashville have written a manual published as *TSU Explorers of the Universe Technical Report*. This program written in FORTRAN uses local Windows software to find and analyze periods of variable stars. It was piloted and is being used by students at Thomas Jefferson High School for Science and Technology. Students from these two high schools collaborate on cases with similar variable stars and discuss their progress as they evaluate data received from stars they have placed on these remote automatic telescopes. In addition to exchanging information by electronic communications, these students are interacting visually using CU-SEE-ME software. The project is soon to be expanded to include teachers and students in Stockholm, Sweden, which will add a new educational and cultural dimension to our project.

Concept maps assist students in seeing the relationships of their central and subordinate ideas pertaining to their case investigation (Novak, 1990, 1993; Novak & Gowin, 1984). Concept maps are arranged hierarchically representing the most inclusive ideas first, the less inclusive ones next, and finally the least inclusive ideas. Vee diagrams are used to aid students in understanding the structure of knowledge, and are used in this project by teachers and students to plan their research (Gowin, 1981). The vee is a heuristic that depicts important epistemological elements involved in the construction of knowledge, or new meaning. A computer based template of the vee diagram was developed to provide students with an efficient way to record and make changes. Concept maps and vee diagrams are tools used by students to regulate and monitor their own thinking. They serve to promote self-analysis and enhance critical thinking by having students think about the ideas and their relationships to each other.

Thinking and Learning Together

A community of thinkers is defined as an active group of students and teachers striving to learn more about a discipline by engaging in critical and imaginative thinking (Alvarez, 1996b, 1995). During this inquiry, the teacher thinks about the facts and concepts that students need to understand, supplementary reading materials and artifacts that need to be provided, ways to incorporate other subject disciplines into the inquiry, and selects from an array of teacher-directed/teacher-assisted strategies to facilitate student thought. Likewise, the student becomes an active thinker in the learning process by engaging in the inquiry, relating prior knowledge and world experience both informal and formal; selecting from an array of student learning; and working with the teacher toward extending meaning and understanding of the subject matter.

Thinking of ways to achieve learning outcomes are not the same as focusing on ways that learning outcomes can be achieved (Alvarez, 1996b). The former is process oriented; the latter product oriented. A learning outcome focuses on increasing a skill or perfecting solutions (Russell, 1956). In an effort to increase learning efficiency, we focus on the processes of thinking, selecting, eliminating, searching, manipulating, and organizing information. Emphasis is placed on thinking as a process involving a sequence of ideas moving from some beginning thought, through a series of a pattern of relationships, to some goal or resolution. Within our community of thinkers, teachers and students ask questions, seek answers, and reflect on their thoughts and feelings as they engage in action research case-based investigations.

Emerging Findings

This project is monitored using Gowin's (1981) four commonplaces of educating: teaching, learning, curriculum, and governance. Gowin's theory of educating is a conceptual approach to assessment within which both the cognitive and affective domains are assessed. Case reports and projects are evaluated by the teacher. Concept maps and vee diagrams of the events and objects being studied are assessed by teachers and students. Student maps and vee diagrams are assessed by their teacher and university educator to determine the degree of conceptual understanding of complex relationships using Novak and Gowin's (1984) procedures for evaluation. Students maintain portfolios of work accomplished and work in progress, for a collaborative assessment of their individual performance and progress along with their teacher (Farr & Tone, 1994). Student journal entries show a high degree of understanding of topics under study. Papers published on the WWW lend further credence to their knowledge and understanding of astronomical concepts. Writing a scientific paper that appears on the home page of their school's world wide Web affects the student positively . This is substantiated by feedback from a WWW audience. This feedback raises their level of consciousness with this electronic medium and prompts them to be more cognizant of their writing skills. Teacher and student interviews indicate positive feelings and thoughts concerning the instructional learning strategies and events associated with this project.

Also significant are ways in which the teachers and students are making their knowledge known. Several newspapers and journal articles have featured our project. One astronomy teacher, Bill Rodriguez, and several of his students have accompanied this author and presented papers at state, national, and international conferences. They have shown examples of their published papers on the Web and discussed planning and organizing their research using vee diagrams and hierarchical concept maps. We have co-authored articles and papers evolving from our project. This astronomy teacher is presently writing a scientific article, with two of his high school junior students and two TSU astronomers, reporting the results of a significant finding of a variable star that will be published in an astronomy journal.

Conclusion

A transformation is taking place within all of us. We (university educators, astronomers, and teachers) are thinking more about our disciplines and how relevant ideas can be shared with one another. Teaching and learning are also undergoing a change from reliance on linear texts to more diversified and challenging paths of inquiry using multimedia learning environments. Thinking about science and learning are becoming more evident by written and electronic communications and conversations occurring between students and teachers, among students themselves, and in dialogues with scientists. Ideas are being discussed and acted upon, meanings are being negotiated and constructed, and all of us are involved in pursuing unanswered questions. Students are learning the subject matter, but of more interest and importance is that they are looking at how they think, learn, and ask questions. They are deliberately choosing to relate new information to what they know and use this newly acquired information to make better and informed decisions.

However, this process takes time and energy and it is a mistake to believe that students accustomed to traditional teaching and learning will fully embrace this process immediately. As Bill Rodriguez, the astronomy teacher, said: "They [students] need to be 'untaught' to rely mainly on recitation and learning through rote memorization and 're-tooled' into questioners, listeners, and writers." This "re-tooling" involves caring and knowledgeable teachers who are willing to embark on a new path for their students. An interactive environment in which thinking and learning evolves presents these students with many alternatives to use language to explore multiple possibilities through interactions with a variety of individuals and circumstances. This kind of environment provides a setting that fosters a community of critical and imaginative thinkers.

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Collaborative Drawing in Educational Environments via the World Wide Web

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The development of Collaborative Drawing Systems is a significant research area in the field of Computer Supported Cooperative Work: both in Office Automation and in Educational applications. In our laboratory we have developed a tool for collaborative drawing, called CODEE, with the aim of supporting innovative methodologies for teleworking and teletraining activities. This tool is essentially a multi-user program that allows anyone with a Java-capable browser to draw on the same canvas.

In this paper, we describe the client-server architecture, functionality and implementation solutions for such a tool and provide a comparison with similar prototypes. Moreover, we present an analysis of drawing-space didactical activities that have been performed in the execution of a European teletraining and distance education project and point out some strategies in the use of such a tool.

Emerging Technology

Collaborative drawing (CD) has received much attention from researchers and tool developer in recent years (Peng, 1993). Observational studies of group interaction on a shared drawing space have been led to the discussion of design requirements for CD tools. Many of these design requirements have been embodied in research prototypes and commercial applications: (Bly & Minneman, 1990), (Krueger, 1982), (Paltakis, 1996), (Slesinsky, 1996), (Smith, O'Manley, Scanlon & Taylao, 1989), (Tang & Minneman, 1990).

On the other hand, the World Wide Web has emerged as a popular and powerful infrastructure for group-oriented activities. Thus, it has seemed useful to us to make a CD tool available on the Web which satisfies some of these design requirements.

CODEE is the name of our prototype, and it has been developed at GiudaLab to support distance education and teletraining activities during the execution of EXPERTIZE (Exchange and Promotion of Telematic and Robotic Technologies for vocational training and employment of disabled), a trans-national project to promote high level facilitation and employment of handicapped people in the European Union.

In the following paper we present:

- the basic set of functionality we have implemented in CODEE
- the CODEE architecture and client-server communication protocols
- usage scenarios and a first observational study
- future works about some extension which take into account lessons we have learned during the usage of CODEE.

Tool Functionality

In contrast to other approaches on the Web oriented to support synchronous painting activities on the same canvas (Krueger, 1982), CODEE is a multi-user program for asynchronous drawing on multiple shared canvas each of them can be accessed by an authorized group.

The tool embodies classic functions that can be normally found in most draw programs. In a vertical toolbar on the left of the drawing area, a user can select among five type of objects: rectangle, circles, lines, freehand and text. Rectangles and circles are available in both outlined and filled style. A color palette is available on the same toolbar. Objects can be selected and then deleted, resized or moved on the document. Moreover they can be grouped together in order to enable complex objects manipulations and locked to avoid further modifications.

Multiple documents can be simultaneously present on the client side, a user can select any of them and move/copy objects from one to another. Figure. 1 illustrates the client interface.

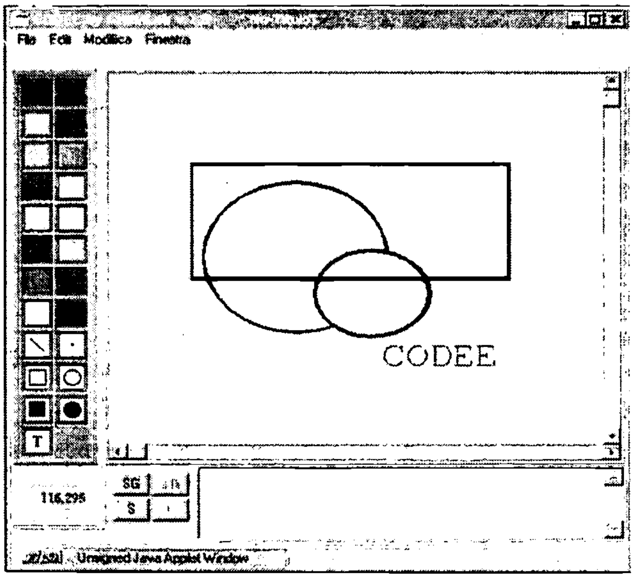

Figure 1. The Client Interface.

A file menu provides options to save, load and delete documents. A group oriented password system is provided as a support to collaborative work; actually members of a group share the same drawing space and documents in this space can be accessed only by them. Figure 2 shows the interface for group management.

All documents are grouped in directories and stored on the remote server file system, and can be accessed by any Java compatible browser.

Architecture and Protocol

CODEE is based on the client-server paradigm, see Figure 3. The server consists of a Java stand-alone multi-threaded application which manages the communication with Java applets clients via sockets.

The server's primary function is the management of a shared work space (basically a dedicated file system) where graphical documents are organized and stored for successive retrievals. A password system protects both individual and group works.

On the user's computer, the tool runs as an applet in any Java compatible Web browser.

The server makes available to a client the following functions:

- list of available files
- load a file
- save a file
- delete a file
- create a new users group
- control user access

Usage Scenarios

EXPERTISE (EXchange and Promotion of TElematic and Robotic Technologies for vocational training and employment of the dISablEd) is a trans-national project to promote high level formation and employment of handi-

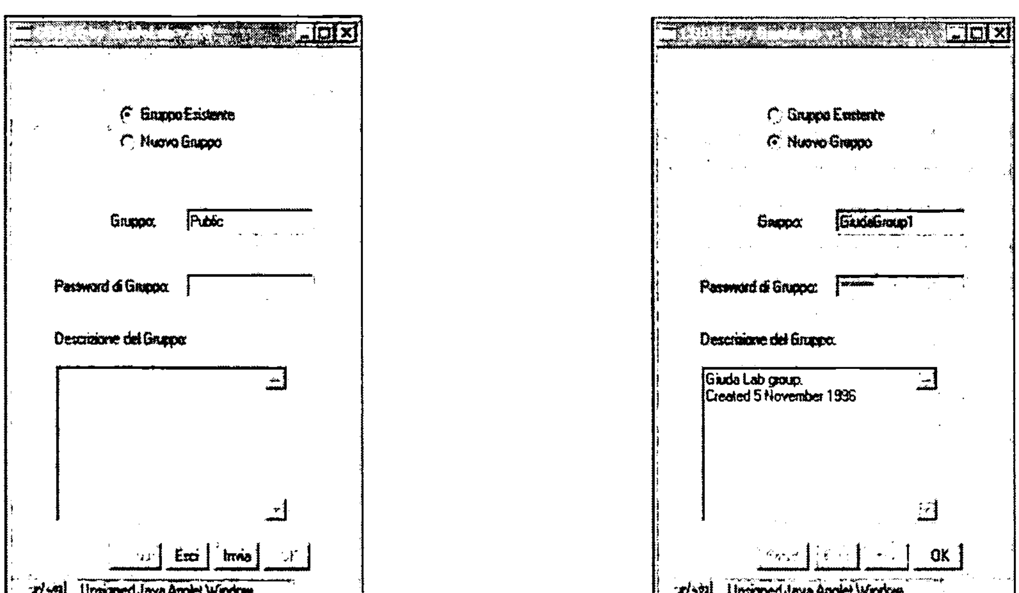

Figure 2. Interface For User Group Management.

capped people in the Horizon/Employment Initiative of the European Union. Such a project aims at providing effective tools and innovative methodologies for the vocational training and the employment of the disabled by exploiting most recent results in the area of information and rehabilitation technologies.

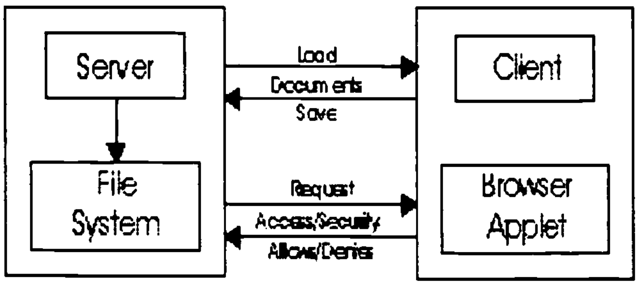

Figure 3. CODEE Architecture.

In our sub-project participants have been split up into groups composed by social assistants and disabled persons in order to better organize and control teletraining activities. Moreover, each group is supported by a tutor and all workgroups are supervised by a teacher.

Teletraining activities are supported by a distributed technology infrastructure which connects a digital lab center to peripheral nodes. Some of these activities consist of specific tasks to be performed by using distributed information tools, CODEE is one of them. In particular, we have considered two possible usage strategies:

- as a medium for asynchronous graphical communications,
- as a tool for collaborative design management.

In the first case, CODEE turned out to be a useful tool for improving communication among group members. In the second case, it made it possible to collaboratively carry out simple drawing exercises in some training modules. CODEE is available at http://sungiuda.deis.unical.it/java/HTML/Draw/.

Future Work

In our ongoing work we are trying to extend CODEE's capabilities. Such extensions deal with (1) the implementation of two different interfaces: one for the trainees and one for the trainer. In fact, the trainer needs a way to control the actions of the trainees and to direct groups composition; (2) the integration of suitable features to enable easier access to people with certain kinds of disabilities; (3) the integration of a mail system to enhance the communication among groups members and to handle the collection and distribution of frequently asked questions (FAQs).

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Standards-Based Products for Interactive Classroom Education

Don Cote
Colorado Alliance for Science

SPICE (Standards-Based Products for Interactive Classroom Education) establishes a new paradigm for supporting science and mathematics learning in the classroom. SPICE provides exciting interactive instruction for students, it places powerful knowledge tools into the hands of the teacher (who acts as a guide and co-learner), integrates the instructions with online analyses of performance and assessment histories, and matches the learning to national, state, and local education standards. SPICE is centered on standards-based learning modules developed though collaboration between classroom teachers and institutes of higher education. The modules are maintained on World Wide Web servers and are brought into the classroom through off-the-shelf personal computer systems.

This paper discusses the pressures and experiences that led to the development of the SPICE concept. It provides details on the overall SPICE structure and complimentary elements (instruction, interactive work space, and assessment) of the learning modules. It demonstrates how, the supporting World Wide Web (WWW) technology that link the elements together, provides the stimulating environment for the module's use. It discusses the SPICE delivery system that brings the modules into the classroom and provides for their execution.

Background

SPICE was developed in response to the emerging Science and Mathematics Education Standards in our communities and the need for matching performance assessment. It attempts to aid classroom teachers who are already juggling a host of demands on the limited time they have with their charges. It is reported that today's students are not keeping up with their international counterparts in science and math. The reasons are many; some lay the responsibility on teachers who are not well founded in the underlying concepts of math and science. These teachers are reluctant or even unable to adequately guide the students in these areas. Other teachers, both willing and able, are unable to make effective presentations of the complex subjects because of obsolete classroom tools or lack of constructive access to subject matter expertise. Even subject matter experts are challenged to stay abreast of advances due to the explosion of information and the rapid pace of change.

The World Wide Web has become a convenient and productive way for Internet savvy teachers to keep up with the advances and insights in many fields that may affect their curriculum. They have also found the WWW to be an excellent source of lesson plans, activities, and material for their classes. However, the overwhelming volume of resources on the Web and the many blind alleys that one may encounter requires the seeker to have tenacity, search expertise, and a measure of luck. Unfortunately, not all teachers have the expertise nor patience to navigate the Web. The result is that many teachers (and therefore their students) miss out on valuable resources available on the Web.

The Colorado Alliance for Science (CAS) decided to investigate the use of the WWW-based material to assist those teachers who are lacking a firm technology and/or science and math foundation. A few teachers have already mastered the WWW and have located numerous online resources to enrich their classes. The goal was to make this limited experience a universal result. The CAS Education/ Technology Center developed Online Activities for Standards in Schools (OASIS) - http://www-co-cas.colorado.edu/oasis - to bring together the myriad of Web science and mathematics material and the Education Model Content Standards. OASIS is a system for locating standards-matched Internet science and math curriculum materials and resources that are directly useful to teachers and students. While there is a great deal of Internet material already available, it is not always obvious how the activities or materials fit into a standards-based classroom. By linking the Colorado State Science and Math Standards with various activities, OASIS simplifies the task of integrating Internet resources into the classroom.

OASIS listings are not comprehensive, but are selections of materials designed to enhance and support current standards-based education reforms. All the entries or "links" have been reviewed, cataloged, and rated by classroom teachers. The links include "hands-on" work, group activities, student discussions, computer-based activities, general information, and indexes of photos, graphics, or articles. Each link in OASIS is accompanied by a short description of the target site, an activity icon to assist the users to readily identify the types of activities presented, and "usefulness" or quality rating. The access to this collection of online resources is provided through the OASIS Structured Access System. This system will help teachers with minimal Internet capabilities to find useful resources quickly and easily. Online information is accessible by subject matter, grade levels, types of activity and/or Colorado State Standards.

The OASIS experience has shown that while the Web does provide many valuable resources, much of what is out there requires too much work from an individual teacher to be useful in the classroom. The exercise would require a resourcefulness beyond most teachers and sadly, the Web material lacks a ready explanation of how it might be integrated with the curriculum. The great promise of the Web and its supporting technologies is not having the impact on education that they could have. CAS spawned the SPICE approach, recognizing that the pieces, willing teachers, powerful technologies, and subject matter experts were there but the integration was lacking to reach that promise.

The SPICE approach was to form collaboratives of schools, districts, institutes of higher education, and technology partners to bring together the pedagogy, subject matter expertise, real classroom experience, supporting technologists and media specialists. As with OASIS, teachers had to be the backbone of the endeavor. This partnership of inservice teachers and subject matter authorities creates exceptional knowledge tools that support classroom/erudition-based inter-activity in the acquisition of knowledge and skills. It involves higher education in the generation of the guidelines and exercises, and most importantly allows the teacher to manage the learning experience for the students. These teams would develop the SPICE modules.

SPICE Modules

The SPICE Modules are constructed around attention grabbing multimedia interactive presentations with embedded instructions and assessment. The technical information contained in each module is dynamic and voluminous. They will be executed by users with a variety of education/system environments. The World Wide Web (WWW) provides a unique platform that best supports these interactions. Maintaining the modules on Web servers enhances their accessibility, provides accountability, supports the broadest suite of multimedia displays (video, audio, virtual reality, digital imagery, graphics, etc.), eases and encourages positive updates, and enforces configuration management. Users access the server resident modules using Web browsers on their Macs/PC's. The SPICE modules are 1) WWW server-based, 2) interactive, 3) content-assessment coupled, and 4) self documenting. They are developed along uniform guidelines providing a consistent look and feel. The layout of each module corresponds to a single display screen architecture.

Screen Architecture

The SPICE screen architecture brings instruction, interactive work space, and assessment/feedback together on a single display screen, each in its own individually sizable window (see Figure 1). The screens are received by WWW browsers on the user's machine.

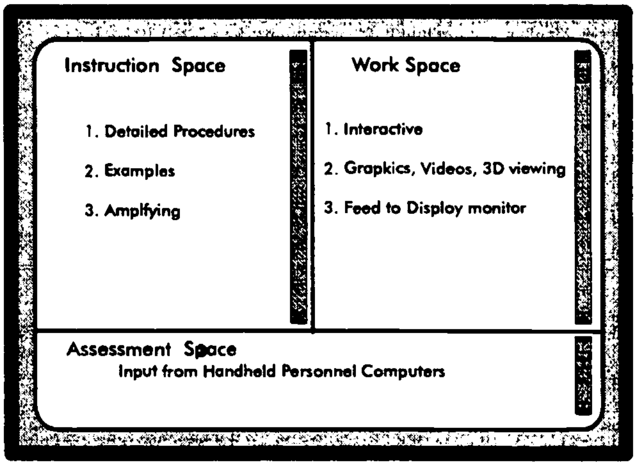

Figure 1. SPICE Screen.

The structure of SPICE modules is designed on a standard screen configuration that integrates Instructions, Interactive Work space, and Assessment/ Response. Each component resides in a separate window or "frame." Frames break up a screen or page into several mini-pages all on one screen. The mini-pages are independent. Each frame has its own Uniform Resource Locator (URL) address, so you can click a link in one frame and view the corresponding information in another frame. For example, you might click a topic heading in the Instruction Space and view an image under that heading in the Interactive Work space. Or, you could request a computation from Instructions and view your results in the Work space. The Work space contains the largest amounts of information - text, graphics, even multimedia content.

Instruction Window

The Instruction Window is used to provide detailed directions. In the Presentation Mode it supplies step by step instructions, gives the teacher additional information on the subject matter, presents standardized questions, and prompts the teacher to review assessment data. In the

Practice Mode, it outlines the problems, presents material, makes suggestions, and leads students through the multi-threaded exercise based on performance.

Work Space Window

The Work Space Window is interactive, linked to the Instruction Window, and accepts participation from the teacher console or from the student hand held PCs. Results of interactions can be integrated with server-based resources and displayed as animations, video loops, graphics, plots, 3D viewing, etc. The Work Space Windows may also be displayed on a separate large screen monitor.

Assessment/Feedback Window

During Presentation mode, this window gives the teacher ongoing assessment information, captures student responses, displays the analysis of individual student and group performance, and gives suggestions for follow-up work. During Practice Mode, it displays assistance, provides answers, and encourages the students.

SPICE Delivery System

SPICE modules are maintained on Web servers and are provided interactively to the classrooms over the Internet (see Figure 2). In the classroom, they are requested through an Internet browser residing on the teacher console. The browser returns the SPICE screen described above for the module selected. Following the instructions, the teacher leads the class through the activity. The class views the interactive work space on the separate large screen Presentation monitor and interacts through their Hand held Personal Computers (HPC). Based on class performance, student raised lines of inquiry, SPICE suggestion and teacher discretion, the exercise may take a variety of paths through the multi-threaded module.

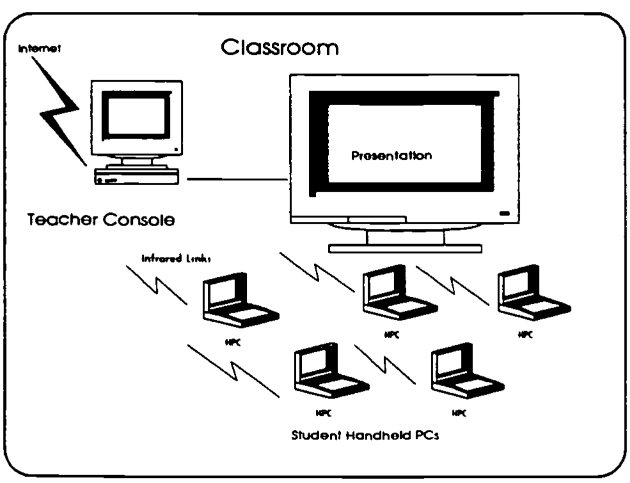

Figure 2. SPICE Delivery System.

At various junctures in the exercise, students are requested to participate using their HPC's. The data is collected via infrared links at the teacher's console. The answers are analyzed and presented in the assessment window for the teacher. In this window the teacher can see quickly how individual students are doing and the direction the class is moving. Current assessment data are combined with historical data from other related SPICE modules and standardized test to make recommendation for reconstruction. Specific areas that need additional review or reconstruction are highlighted to strengthen the student proficiencies.

SPICE reconstruction suggestions can range from the recommendation that certain students should have one-on-one interaction with the teacher on a specific point, to a suggestion that a group of students should practice elements or exploration of new concepts of the lesson using supporting SPICE sub-modules. In these sub-modules, instructions are tailored to the student; the work space is local only and the information in the response windows is directed at the student.

Supporting Technology

The content and structure of SPICE modules are profoundly enhanced because of the synergy with the exciting supporting technologies. SPICE relies upon the WWW to make modules easily available to users anywhere across the world. Browser capabilities such as frames allow cooperative linking between instructions and display work space. Common Gateway Interface (CGI) and Java make it possible to present the content as an interactive multimedia presentation. The structure of the Web allows dynamic updating of material and central monitoring of module use.

World Wide Web

The WWW is primarily an information retrieval service on the Internet, which is designed around a technology called hypertext. It was developed in the early nineties at CERN, the European Particle Physics Laboratory, and is probably the most user-friendly and useful tool available on the Internet today. The Internet has had a variety of information retrieval services since its inception, however, the WWW, or the Web as it is called, is the single most important factor in the explosive growth of the Internet in the last five years.

The SPICE architecture relies upon the browsers features: 1) Multimedia, 2) HyperText Markup Language (HTML), 3) Interactive Content, and 4) Virtual Reality Modeling Language. These basic Web functions access the module content and provide the connectivity between the modules' major segments.

Frames

Frames provide excellent instructional opportunities via the Web. They make navigating an Internet site easier, especially one with a lot of information such as a SPICE site. SPICE users can scroll and resize frames. Frames can also remain frozen on the screen, acting as horizontal or vertical ledges. Large amounts of information can be presented clearly. With frames - which divide SPICE pages into multiple, scrollable regions - information can be presented in a more flexible and useful fashion. As the user navigates the site in "live" frames, the static frame's sharing the user screen remain fixed, even though adjoining frames redraw.

An Instruction frame can contain links that, when clicked, display results in the adjoining Interactive Work space frame. The side-by-side design allows queries to be posed and answered on the same page or screen, with one frame holding the query form and the other presenting the results. Note: Frames have been submitted to the Internet Engineering Task Force and the WWW Consortium for consideration as Internet standards.

Common Gateway Interface

Within each SPICE frame, the pages come to life with audio, video, 3D viewing and other enhancements to HTML. The pages no longer look flat and static, nor are they constrained to textual environments. Common Gateway Interface (CGI) allows the SPICE server to run programs that generate "dynamic documents," rather than being restricted to delivering "static documents." When the user requests a document from a CGI directory, rather than sending the "document" to the user, the server runs the program and sends the output to the user's screen.

CGI is a standard for interfacing external applications with information servers, such as HTTP or Web servers. A plain HTML document that the Web daemon retrieves is static, which means it exists in a constant state: a text file that doesn't change. A CGI program, on the other hand, is executed in real-time, so that it can output dynamic information. In SPICE, requests from the user console are routed by a Web daemon on the server to a CGI program. The CGI program passes the requests in real time to an executable that operates on it and integrates it with current performance information. The program also receives the results and displays them to the client. In effect, it generates HTML code on the fly.

JAVA

Another approach used by SPICE to create dynamic pages is the use of Java APPLET's. A Java™ applet is a program that can be included in an HTML page, much like an image. The SPICE system uses Java-compatible browsers to view SPICE pages. When the page contains a Java applet, the applet's code is transferred to the SPICE classroom system rather then the server and is executed by the browser. Extensions to the basic applets such as Marimba's Castanet channels are being investigated to create and maintain persistent data, such as documents and preferences, that can communicate data, such as usage patterns, back to their servers.

Running on a user machine, a Castanet tuner can install new versions of a channel's files while the current version is running. For maximum efficiency, channels are "differentially" updated: only modified files are sent by transmitters to tuners, and all files are sent in a single TCP connection. Because only a small percentage of a typical file change, updates can be frequent and fast. Castanets maybe used with Hybrid Media to smooth out the communications loading as the Internet bandwidth grows. SPICE modules may combine session sensitive data pulled from the Internet with graphics, animations, video and audio stored that were captured locally during off-line downloads.

Conclusion

SPICE modules will be built on an existing technology that has been demonstrated, and is anticipated to grow. It only requires the wise application of these proven elements to contain and present the expert subject matter. Evaluation of this new paradigm as it applies to school-to-career connections and to the acceptance of education standards will be conducted in 1998.

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Experimental Strategies for Promoting Teacher Leadership using Internet Audio Technology

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The TEECH (Teacher Enhancement Electronic Communication Hall) program is a three year National Science Foundation (NSF) funded project aimed at fostering collaboration among leaders of teacher enhancement grants. Its purpose is to encourage communication, collaboration, joint exploration, and pooling of this community's collective resources.

TEECH (http://hub.terc.edu/terc/teech.html) has used Internet technologies to build a body of professional knowledge to inform the online teacher enhancement community. TEECH has employed such techniques as listservs, a library of online resources, and RealAudio. TEECH hosts discussions among Principal Investigators (PIs) on critical issues in teacher enhancement, electronic seminars with experts in the field, and special interest groups on topics such as follow-up after workshops, long-term sustainability of teacher enhancement efforts, and use of video in teacher enhancement.

During the past year we experimented with Internet audio as a tool for teacher enhancement. RealAudio (http://www.realaudio.com/) is an up-and-coming technology used on multiple Internet sites that range from news programs, record companies, and online courses. Internet audio is appealing, novel, and allows for user multi-tasking. It provides real-time streaming of audio information over the Internet and allows us to present discussions, debates and conference presentations asynchronously. It is now being applied as a tool for educational purposes (Figure 1). By having several experts in the teacher enhancement field address issues of concern, we are providing a forum for informed discussion and intellectual debate.

In this demonstration/poster session, we will share how the TEECH project has used Internet technologies to build a body of professional knowledge to inform the online PI community. Our focus is on the project's use of audio technology. The audio is accompanied by full text transcripts, so that people can listen while reading.

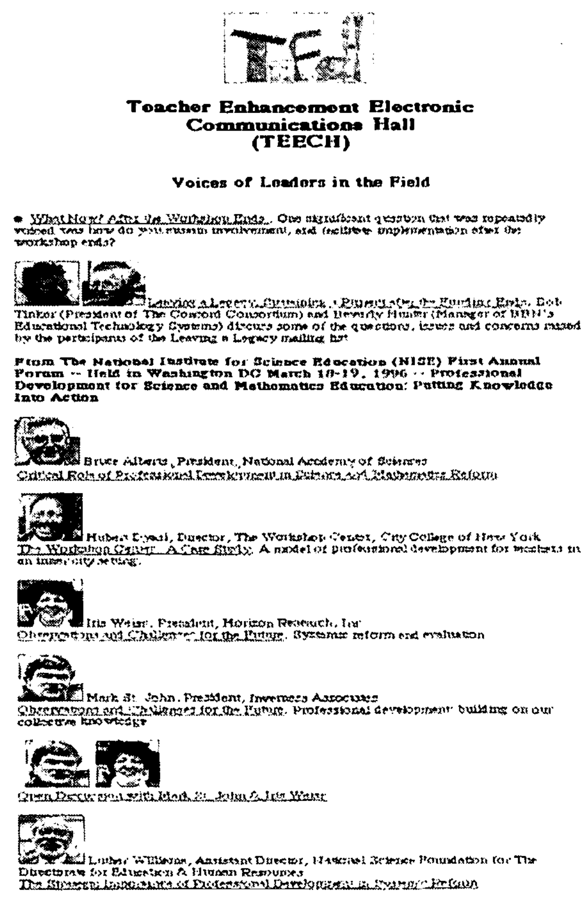

Figure 1. Leaders in the Field.

During the past year, we have experimented with three different formats:

- Conference Presentations — This format takes a live conference presentation and makes it permanently available to a wider audience. The user interacts with the Web-based presentation in ways similar to presentation software, with the audio and the presentation slides available at the same time (See Figure 2);

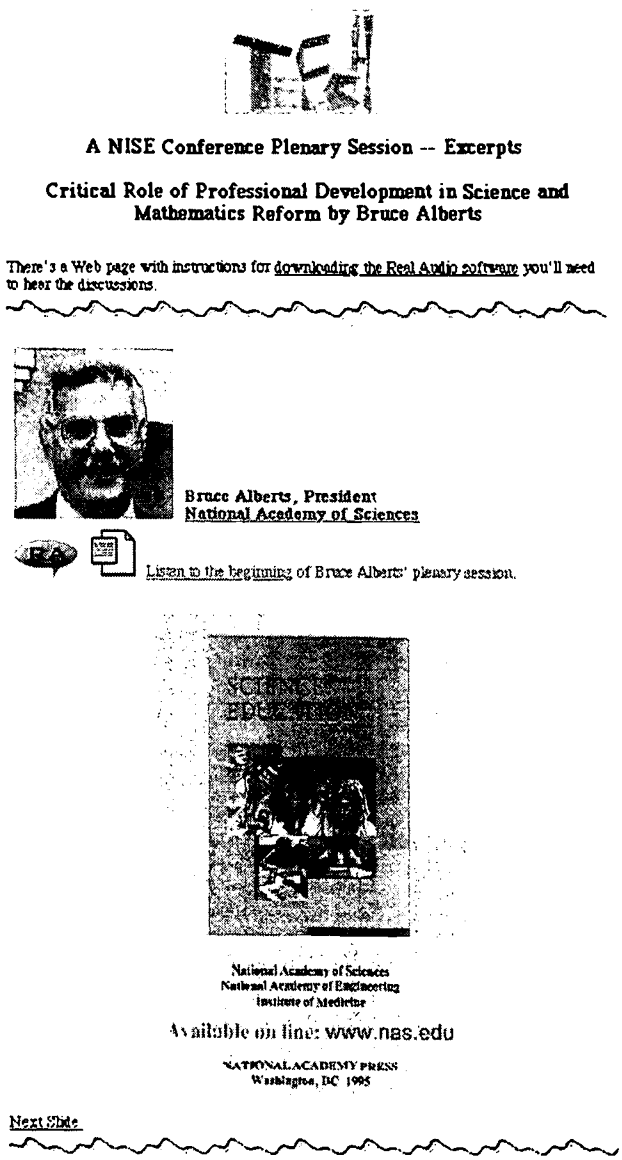

Figure 2. Audio Excerpts from the NISE Conference.

- Online Debates — While debates are usually real-time, an intellectual exchange of ideas doesn't have to be. By interviewing leaders in the field and asking them a set series of questions, we are able to represent different perspectives on a single question. (Figure 3) Their different thoughts and perspectives can be fuel for thought and future discussions/debate;

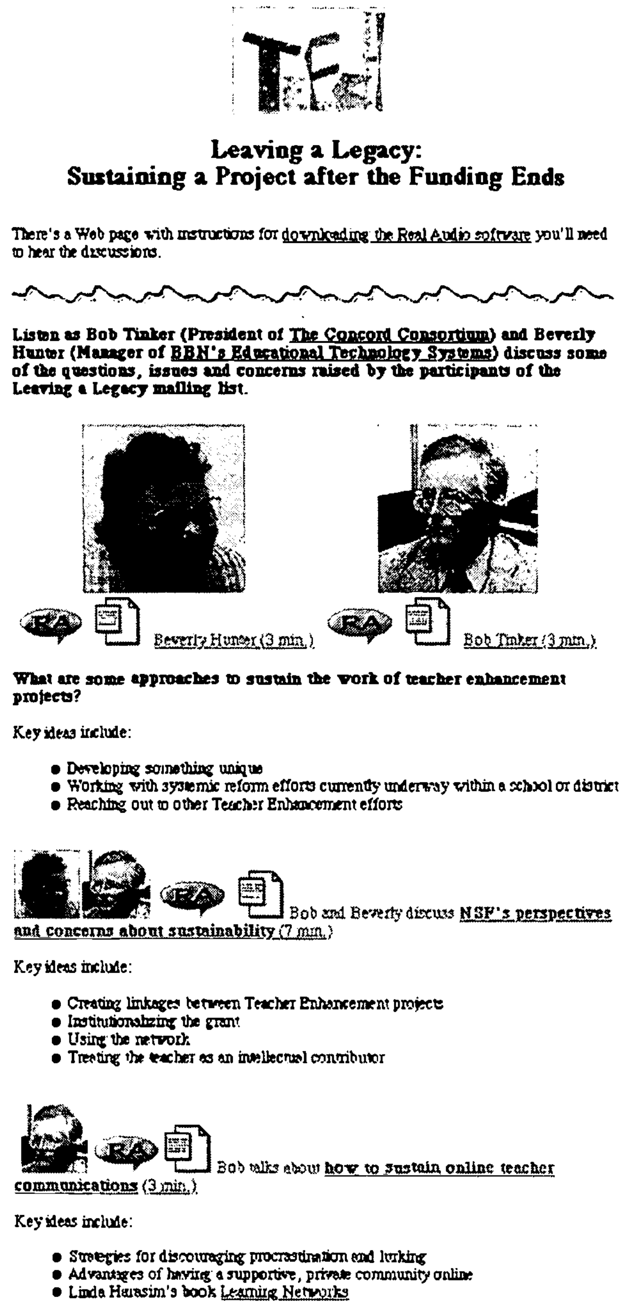

Figure 3. Example of an Online Discussion.

- Case Study Discussions — The user is able to hear the presentation of a case study as well as multiple reactions and insights from the audience. (Figure 4) To date, group reactions were recorded at the time of the case study presentation. However, RealAudio provides the opportunity for people not present at a presentation to comment on it and for users to then hear the presentation and multiple commentaries.

A NISE Conference Case Study

The Workshop Center

There's a Web page with instructions for downloading the Real Audio software you'll need to hear the discussions.

Hubert Dyasi, Director
The Workshop Center
City College of New York

The Case Study began with An Introduction to The Workshop Center (12 min.)

The Introduction indexed by topic:

What is The Workshop Center?
Where is it located?
What is its population?
(3 min.)

What are the professional development tenets of The Workshop Center?
(1 min.)

How does The Workshop Center work with teachers?
(6 min.)

What support systems does The Workshop Center use for teachers?
(2 min.)

Some thoughts about teachers as professional developers of other teachers
(1 min.)

Then, Hubert Dyasi answered questions about The Workshop Center.

During the second half of the session, members broke into small groups to discuss the issues raised by the case study. Each group shared a summary of its discussion with the entire group.

Figure 4. Example of a Conference Case Study.

These multiple formats allow us to experiment with Internet audio and bring the voices of leaders to a larger audience. As technology moves to incorporate real video transfer over the Internet, it will be important to reflect upon the lessons learned from audio Internet use. This has the potential to expand the scope of invitational conferences to a broader base of educational leaders.

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INTEGRATING MATHEMATICS AND SCIENCE EDUCATION USING THE POWERS OF TEN

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In recent years, we have witnessed an enormous growth in the use of the Internet in general and the World Wide Web (WWW) in particular. More significantly, the modality of use has evolved from simple perusal of hypertext to the use of very sophisticated tools which enable platform-independent interactive distributed processing. This confluence of technological developments has enabled exciting new educational tools which are accessible to anyone with a Web browser and access to the Internet. The fact that these web resources are programmable and hence dynamically configurable means that they can readily be made applicable across an extremely wide range of age levels. The availability of these technological tools at this point in time is fortunate when there is a renewed national commitment to improve the quality of today's science, mathematics, engineering, and technology education (NSF, 1993).

In this paper, we describe a prototype system that we are building which presents an interactive organizational framework for mathematics and science education based on the *Powers of Ten* tradition. We believe that use of this system will allow students to visualize relationships among the various physical and life sciences while perceiving the role that mathematics plays in each of the disciplines.

One of the major problems with existing science education is that students study science as if it were comprised of independent and compartmentalized disciplines: biology, chemistry, earth science, space science, etc. They acquire little or no sense that these and other disciplines are highly dependent, and that major concepts cross the boundaries of these domains. It is equally important for students to understand that mathematics is a tool with important applications across all the sciences. Therefore, it has been increasingly recognized in recent years that instruction in mathematics and the sciences must be integrated. This has led to a greater emphasis on team teaching of mathematics and sciences in middle and high schools.

We believe that visualization capabilities based on state-of-the-art graphics technology can be used to bring to life, and thereby significantly aid in teaching, important scientific concepts. We further believe that mathematics and science curricula can be developed in an integrated fashion using a powerful unifying metaphor coupled with compelling interactive visualizations. We begin by justifying the unifying metaphor.

In the broadest sense, science seeks an understanding of the universe in which we live. Our current understanding spans all levels, from the scale of 10^{-16} meters at which quarks are bound into a proton in the nucleus of an atom up to the scale of about one billion light years (10^{26} meters) where the large-scale uniformity of the universe becomes visible. Viewed in this way, the scales (i.e., the *Powers of Ten*) form a "table of contents" for the bulk of our current scientific knowledge. The traditional scientific disciplines — biology, geology, astrophysics — are best understood as overlapping segments of this table of contents.

This scheme for organizing our scientific knowledge was first exemplified in the late 1950's by a Dutch school teacher named Kees Boeke. He produced a book whose goal was to help students and teachers understand the nature of our universe (Boeke, 1957). Beginning with a girl in a chair, the reader sees a series of pictures ten times bigger (or smaller) on each page. Boeke's images spanned 40 powers of ten scales from 10^{-14} to 10^{25} meters. This book inspired the production of two movies, the first was produced in the 1950's, the second in the 1970's. These films are still widely used in K-12 science classrooms. There is an updated book version based on the second movie (Morrison & Morrison, 1982), and a third generation IMAX film has recently been released (Summers, Mihos, Herquist & Bryan, 1996).

Clearly the fact that strong interest in this approach has been sustained for the past four decades is powerful evidence of the importance and value of this pedagogical approach to the organization of scientific knowledge. We wish to extend this approach into an interactive medium by developing a prototype web-based organizational framework for mathematics and science education. The system we are building will extend far beyond a simple updated version of this visualization. We plan to use the *Powers of Ten* framework as an index of scientific disciplines from which interactive, engaging hands-on lessons dealing with specific topics and disciplines can be accessed.

The overall goal of our efforts is to provide the necessary infrastructure to support the development of tools promoting educational practices which can be used to integrate and improve the quality of mathematics and science education across the K-12 grade levels. Clearly this is a huge and obviously open-ended effort. For the purposes of our prototype, we are focusing initially on the middle school level and the physical sciences. We will see in a later section how the system architecture will help us deal with the "open-endedness" that arises as we add support for additional subject matter, other grade levels, and even adult learners.

The remainder of the paper is organized as follows: In the next section, we discuss how the system would be used by students and teachers. The following section discusses high-level architectural features, focusing on how the system can be extended indefinitely. Finally we summarize and make some concluding observations.

System Usage

As in the book and movie versions, students initially see an image of a person where the size of the image corresponds to a one meter by one meter area. Using the image of a person allows us to zoom into the skin, then into the cells, on into carbon atoms, and so forth, thus allowing us to explore various life science concepts along the way. Starting at the one meter scale ensures that our starting point relates to our everyday experience, hence the student will have an immediate sense of familiarity with the image. There is a system parameter which allows the visualization to start at any scale, but we anticipate that it will be most common to start at the one meter scale.

A sense of how the various scientific disciplines are interrelated will be achieved by seeing that major concepts cross boundaries between the domains. That is, since the sciences are highly dependent, in general, several disciplines will serve to explain what is happening at the current scale. For example, at the cellular scale, both biology and chemistry are relevant in understanding how nutrients get inside cells.

In our view, this tool is best viewed, not as an adjunct to the curriculum but rather as its backbone. As such, the educational possibilities are open-ended. At the level of the human, for example, students can explore in small frames the differences in follicles and visual appearance between straight, wavy, and curly hair when magnified. However, they will also learn that the descent to the molecular level or expansion to the large scales causes these differences to disappear: we live in the same Universe and are composed of the same kinds of molecules.

Upon entering the skin, both a hair follicle and a sweat gland come into view. At this point the student can choose to examine one or the other. Choosing hair can branch the user to examine the types of human hair, lessons on its growth rate, alterations to its chemistry by humans (curl and color), and a physics lesson on light (kinds of light reflection that lead to highlights) and heat (explanation of thermal insulation by air entrapment). Choosing the sweat gland can lead to learning about its role in maintaining body temperature, the fluid and salt balance of the body, and the relationships to subject areas such as physics, chemistry, physiology, and sports, in each of these cases.

A maze of conceptual connections is possible at each level, some more than others. At the level of atoms the basic general structure of an atom will be presented. At the middle school level we will only introduce the elements of the idea of chemical bonding by molecular orbitals, but we insist that pictorial instruction of these basics is an essential. In addition, the uniqueness of the carbon atom and its multiple bonding capability which is so important to life will be mentioned.

Mathematical concepts and methods can be presented at each scale in appropriate scientific contexts as well. For example, integration of functions can be introduced while studying how long it takes an object to fall to the ground. Distance, surface area, and volume computations can be introduced with meaningful visualizations.

For purposes of discussion, we briefly explain the screen layout currently used by the prototype. The primary display is partitioned into five major regions. The largest region is the middle of the screen where the current *Power of Ten* image will be displayed. The other four regions surround this central image. Above the image is a caption identifying the current *Power of Ten* scale and a set of buttons which allows the user to zoom up or down through the scales. Along the left and right hand side of the images are buttons for associated operations; those on the left are scale-dependent (e.g., links to explanatory text, exercises, and auxiliary visualizations and simulations), while those on the right are for tasks which are scale-independent (e.g., there is a button which creates a "tear-off" frame containing the current image for purposes of visual comparison with a subsequent image). Along the bottom of the image are buttons which control an animation of the images. Using these buttons, a student can see a movie version in the center of the screen by having the system continuously zoom up and down through the scales. Various aspects of the animation, such as the delay time in milliseconds between subsequent frames, can be controlled by the user.

At each scale, embedded links along the left side of the image will be used to take the student to appropriate and related resources such as simple raster images (GIF, JPEG, etc.), interactive 3D visualizations defined using the Virtual Reality Modeling Language (Pesce, 1996), interactive programs or simulations, movies, related external web sites, and so forth. For example, when the student is at the scale of a human cell, a video of cell mitosis might be displayed in one window while relevant vocabulary terms are displayed in another. These scale-dependent static and interactive resources will enable students to visualize important phenomena as well as provide them with an environment in which to perform experiments relevant to the current topic.

System Architecture

The core of the system is being based on standard WWW technology. We believe that to be most effective, these materials (as well as additions, corrections, and updates) must be disseminated as widely and efficiently as possible. There simply is no better way to achieve these goals than to use the infrastructure of the WWW.

Specifically, the Hypertext Markup Language (HTML) and standard protocols such as Hyper Text Transfer Protocol (HTTP) are being used for all textual explanations as well as providing the context for the controlling program which is being developed as a Java applet (Arnold & Gosling, 1996). The Virtual Reality Modeling Language (Pesce, 1996) will be used to model and deliver realistic interactive 3D visualizations appropriate to the current scale. VRML is a language designed to support multi-participant interactive simulations across the Web. One defines a structured three-dimensional world with this language, complete with interaction handles and "hyperlinks" to other VRML worlds. These hyperlinks work in a manner analogous to those in standard HTML documents, but here the links are embedded in three-dimensional space, and their selection typically results in a dramatic change in the visual context since the student literally moves to a "different world". In our case, for example, the student may move from an interactive environment in outer space to an interactive earth-based environment with a simple click on such a link.

Our use of VRML visualizations differs from that of the *Powers of Ten* image frames themselves in that the VRML scenes are fully interactive three-dimensional environments. By contrast, the flat projections of the *Powers of Ten* scales provide us only a "table of contents" organizational structure and corresponding navigation mechanism for getting to move to a particular frame in the *Powers of Ten* sequence.

As is true of many of today's web resources, we are not developing a single computer program per se, rather an interconnecting set of tools which include such things as hypertext reading material and embedded interactive tools for students to learn in a hands-on fashion. The general infrastructure of the WWW and the Web-related tools reviewed above allows this set of tools to grow continuously, embracing new subjects, thereby appealing to ever-larger segments of the population.

Java and VRML will be indispensable parts of this approach. We are using Java applets (and we may use standalone Java applications) to do the basic zooming through the *Powers of Ten* images. Java will also be used for many of the auxiliary applications and simulations. VRML scenes will be used for interactive worlds as noted above. We are closely watching the Java-VRML programming interface developments as we anticipate that the ability to create and manipulate VRML from Java based on end user input will make our visualizations and simulations dramatically more powerful.

The use of these web-based tools allow us to deliver this technology in a platform-independent fashion, supporting everything from personal computers to high performance workstations. This platform independence is extremely important since it means that the materials are accessible to students in virtually all public schools. To access the system, one needs only a relatively modest computer and software configuration.

But there is a definite price to be paid for this platform independence. Java achieves its platform independence by being an interpreted language which requires a virtual environment implemented inside of a web browser. Interpreting Java code inside of a web browser entails a significant performance penalty, particularly when the sort of numerical computations that we will require for our associated programs and simulations is involved.

That there is a performance penalty to be paid can hardly be considered a surprise. To be sure, the Java community as a whole is well aware of this problem, and much work is currently being done to develop a technology known as "just-in-time compilation." The idea is that, as the byte codes for a Java class are downloaded, the just-in-time compiler translates them into machine code for the platform on which the browser is running. If these tools are successful, the performance of Java programs will get much closer to that achievable with actual compiled code.

The Java applet reads configuration information at startup time which allows it to be tailored in various important ways. For example, the base location of the sets of images and the base location of the associated descriptive text are separately specified. This allows different *Powers of Ten* image sets to be used, thereby making it easier to appeal to learners across a wide range of ages as well as ethnic and cultural backgrounds. In a similar manner, the separate specifications of the base location for the primary descriptive text associated with the image frames makes it easier to tailor descriptions according to age and background as well.

Also included in the configuration information is a description of the set of applications, exercises, and so forth available at each scale. Java does not require that all of this information be known at compile time, hence auxiliary Java applets can be added to the system at any time (even while the applet is running!). This capability allows us to provide a mechanism which would permit anyone — a student, for example — to write an applet which could be executed at the appropriate time by the controlling *Powers of Ten* applet.

Summary

We are developing a prototype, interactive suite of WWW-based tools for producing and controlling the display of images which help students visualize vast scaling concepts. In the prototype, students will see an initial image and will use interactive graphical controls to zoom in or out. A set of mathematics and science lessons and other auxiliary material will always be selectable. The specific materials available will depend upon the scale currently being displayed. For example, one student might be looking at an image whose scale is 10^{-8} meters while watching a video on molecular structure; another student might be at the image whose scale is 10^{21} meters and be doing a high school mathematics lesson related to distances between galaxies.

As the project progresses, exemplary teachers will assist in identifying problems that advance critical imagery skills that are consistent with emerging standards of the National Science Teachers Association (NSTA) and the National Council of Teachers of Mathematics (NCTM). Ultimately we envision serving students across the K-12 spectrum, college students, and adult lifelong learners, but we are initially targeting our prototype towards middle school students. The prototype (as well as the full system) will require only the most modest of computer hardware: a personal computer and access to the Internet. We recognize that there are significant performance issues to be addressed, however, so we are closely monitoring developments on a number of fronts including the just-in-time compilation tools mentioned earlier. Other possibilities will be to become a "trusted site" which would allow us to avoid a number of performance issues which exist because of security-related concerns.

It is important for students to learn *how* to learn in an increasingly technological world. Our knowledge of the world changes continuously. Technical books rapidly become obsolete, hence lifelong learning becomes very much a research activity. We believe it is imperative that we teach students not only the important scientific facts and formulas of today, but also the skills they will need to seek new answers and even new questions tomorrow. We believe experience gained by students using a tool such as this will provide an important part of these necessary skills. Links embedded in the pages of our system will point to outside science and math resources, and exercises for students will include problems which require them to scour the Internet for required information. There will generally be no one "right" place to obtain information, and often the teacher assigning the problem may not know exactly where answers are to be found. But this is precisely the nature of research.

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Project Caprina: University of Maryland's Mini-Application-Web (MiAoW)

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Project Caprina, the Mini Application Web (MiAoW) at the University of Maryland at College Park. began as a collaboration between the Computer Science Center and the Department of Art History. The Caprina Project has expanded quickly to many other disciplines as innovative faculty have devised uses for computer-based images (1992-1995) and later for application software (1995-the present) in teaching and learning. The campus-wide optical-fiber-based network permits access to Caprina images and Caprina-supported applications from thousands of computers in student labs and faculty offices. Caprina uses a Novell server for image storage and delivery; a limited World-Wide-Web format is also available: http://www.umcp.umd.edu/caprina/home.html. To date, Caprina has been utilized by University Maryland departments and colleges, including Art History, Chinese, Anthropology, Architecture, College of Business and Management, Textile, and College of Education. Caprina-supported applications range from commercial software to various departmental designs in the University.

Caprina: The Image Service Provider Era (1992-1995)

Goal and Benefits

The initial goal of the Caprina project is to improve education, research, and community service by providing ready access to large collections and a wide variety of digitized high-quality images via the campus optical-fiber-based network. Therefore, the authors define the initial four years of Caprina development as the "Caprina: Image Service Provider (ISP) Era" (Figure 1). Such a concept is very similar to the invention of an "Internet browser" like Netscape Navigator and Microsoft Internet Explorer. Since Caprina was developed based on the Local-Area Network (LAN) architecture, the authors intend to refer to Caprina as an "Intranet browser."

The beginning stages of the project are already yielding unanticipated benefits. The large number of students in disciplines such as Art History and Architecture has usually precluded their access to departmental slide libraries for review of images seen in class. In turn, instructors have restricted their syllabi. Now faculty are unrestricted in their choices of images since they are all available on the network. Other benefits of the Caprina project are listed below:

Easy Access. Perhaps the most general and far-reaching benefits of network-accessible digital images will come from "armchair" access to large collections of images. Not only will the images be available, but search techniques for finding images will be vastly improved, especially for people who are not content specialists.

Permanence. It is sad to realize that many of the materials which are fundamental to many lines of study are perishable: pottery breaks, audio tapes demagnetize, buildings decompose, and slides fade. While digitized images are only a representation of a real item, they do not fade, melt, dent, rust, scratch, chip or peel.

Rapid Availability. Many disciplines can benefit from the rapid availability of images. An image can be scanned and loaded into a special collection in a few minutes. Astronomers, meteorologists, and geographers can study the latest images from space. Botanists can access recent images of diseased plants. Medical students can view recent surgeries.

Classroom Use. A collection of digitized images can be shown in class directly. It is much easier to return to a previously displayed image with the click of a mouse than to resort to the trial-and-error search of a slide carousel. With an adequate index, an instructor can spontaneously show images to support a temporary diversion from the mainstream of a lecture. In selecting images for presentation in a course, instructors are no longer limited to those which students can independently find copies of for later study.

Access by "Non-traditional" Users. Facilitating the lives of current image users is noble, but expanding the horizons of others is extremely beneficial. The greatest potential of the online access to digitized images is their use by people who, for reasons of ignorance or inconvenience, do not currently use them. Already we see secretaries and administrators browsing the collection from sheer curiosity — just because it's there.

Collection Management. Not only can the art gallery and small museums improve the management of their collections by having digitized images of their holdings, the rest of the campus community can benefit from their availability. Imagine having a preview of an art show online.

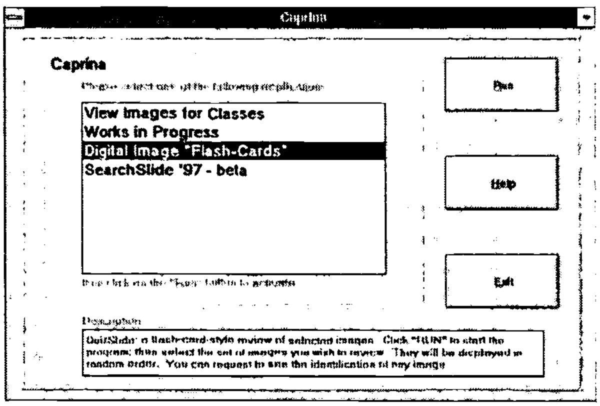

Figure 1. Caprina Interface During ISP Era.

The Making of Caprina During I.S.P. Era

The Target of Implementation. The Caprina project began in fall, 1992, as a collaboration between the Department of Art History and Archaeology and the Computer Science Center. Art History has a collection of about 250,000 slides. While this collection is well managed and effectively housed, access to it is limited to faculty and some graduate students; there is no way that access by the hundreds of undergraduate art history students could be accommodated either physically or administratively. Therefore, while there were many approaches which could have been taken to digitizing the collections, it appeared that the most pressing need was providing image access to undergraduates.

Hardware Implementation. Since ease of image accessibility was a key design goal, it was decided that the basic delivery mechanism would involve the campus data network. This optical-fiber-based network reaches over 11,000 faceplates on campus with both fiber and 10baseT Ethernet. The basic protocol is TCP/IP but it also passes Novell Netware packets so that any of the 5200+ computers on the network can potentially reach any of the 60+ Novell servers.

The 1000+ computers in the 30+ student computing labs on campus are all attached to the network via a local server. However, the NeXT computers have monochrome monitors and the Apple computers cannot access the Novell servers — they use local AppleTalk servers; therefore, the initial thrust of the project was the use of IBM computers and compatibles. IBM is the dominant computer on campus; most of them have monitors with 1024x768 pixel resolution at 256 colors, which displays a very nice image. Microsoft Windows 3.1 is the standard operating system. (We expect software will be available this year to permit Macintosh computers to fully participate in the Novell networks.)

Software Implementation. Student access to images is via several locally-written programs. One presents the student with the bibliographic citations of the images in the order in which they appeared in class. Clicking on a citation produces the image. Multiple images can be displayed simultaneously. A flash-card program presents students with sets of images in random order.

Storing Images. We currently copy the 768x512-pixel image to the server and reduce its color palette from 16 million to 256-colors. This is only 1/48th of the information in the original image on the Photo-CD but it is adequate for several reasons: 1) this is a good size for viewing on most monitors (the next larger size, 1538x1024 pixels, will not fit on a 1024x768 monitor); 2) the network transfer time of 5 seconds is tolerable; 3) modern color dithering algorithms are so effective that the difference in appearance between an image displayed with 16M colors (24-bit color) and one displayed with 256 colors (8-bit color) is surprisingly very small; and 4) the disk space required on the server is tolerable: about 200KB to 390KB per image in uncompressed bit-mapped format (.BMP).

Accessing and Displaying Images. The search technique (program) is designed specifically for students who are taking classes requiring image study. The first, called MultiSlide, permits a student to simultaneously view as many images from the class list as they desire. The second, QuizSlide, is a flash-card-like self-test program which randomly presents the user with images from a preselected set. Clicking on a button will display the description of the image. Both are Windows-based programs written in Visual Basic.

In MultiSlide, the student selects the desired class by clicking on its name in a list (see Figure 2).

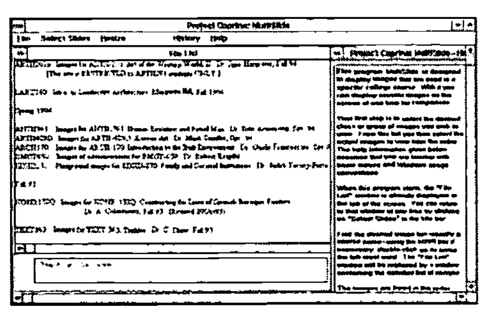

Figure 2. MultiSlide Software Interface.

The list of all of the images for the class appear in a scrollable window; it is actually just an ASCII file so it is easy to prepare. The student scrolls through the file and double clicks on the name of the image to be viewed. The image is loaded from across the network and displayed. Multiple images can be displayed at one time although a 1024x768 screen size imposes a practical limit of three or four. The ASCII text file is prepared from the data entered via WordPerfect.

In QuizSlide, the student also selects the desired class by clicking on its name in a list. Next, the name of the set of images to be used in the self-quizz for that class is selected from a list (see Figure 3).

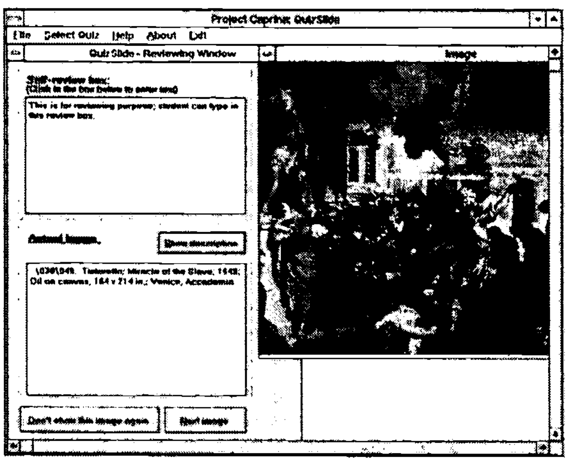

Figure 3. QuizSlide Software Interface.

For example, one quiz list could include all of the images in the course, another could be those to be covered on the midterm exam, and another could be the floor plans of all of the buildings studied. Once the list is selected, an image is randomly selected and displayed for identification. Students can confirm their identifications by clicking on a button. (Kozintsev, Stenchikova, Chang & Gilbert, 1996).

Caprina: The Application Service Provider Era (1996-Current)

Caprina was realized as an Application Service Provider (ASP) during late 1995, though it has served as an ASP for applications like MultiSlide, QuizSlide and SearchSlide since 1993.

Such transformation (or recognition) has been highly encouraged by the campus community and thus targeted by the Caprina development team. A simple yet strong support to the shift in emphasis from Caprina (ISP) to Caprina (ASP) can be derived from the important role that JAVA plays in the Internet (World Wide Web) community. Similar to the JAVA applet terminology, Caprina (ASP) enables instant application access from a remote application server. Caprina (ASP) to the University of Maryland "educational Intranet" is analogous to JAVA to the worldwide Internet. Caprina (ASP) was also coded as TT Attach '96 during the development stage (see Figure 4).

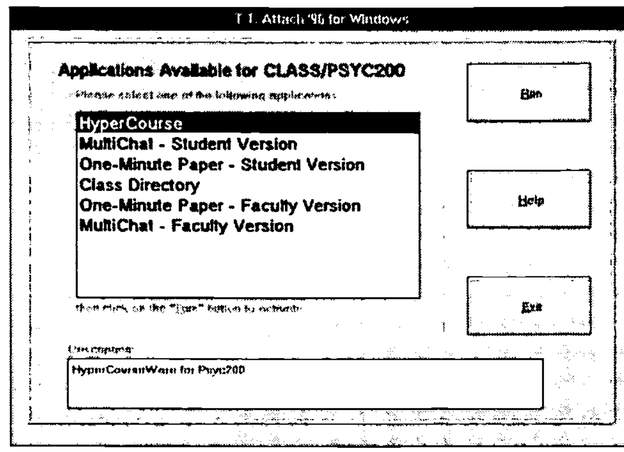

Figure 4. Caprina (ASP) - Sample Display for a PSYC200 Class.

Extensive Acceptance of Caprina as A.S.P.

The authors research and summarize below the extensive use and acceptance of Caprina as an Application Service Provider:

GEDS (Department of Government and Politics). The Global Event-Data System (GEDS) is designed to provide computer-aided identification, coding and abstracting of daily international and domestic events, as reported primarily in Reuters international newswire service as well as other sources. GEDS project is a part of the Center for International Development and Conflict Management (CIDCM), which is dedicated to analysis of the needs of nations and resolution of their conflicts.

CIDCM provides undergraduate student internships/ research assistantships to develop practical research skills in computer-assisted generation and application of international and intra-national event data through GEDS. At the University of Maryland, GEDS is made available through Caprina '96. GEDS was also developed at the University of Maryland with National Science Foundation support as a basis for updating and expanding the major event-data banks, and also as a basis for the prediction of future trends, crises, and conflicts.

Multimedia Toolbook (Department of English). "The Computer and the Text: Multimedia as Critical Expression" is an innovative course offered by Professor Robert Kolker. This course encourages students to create projects in which words, images, sounds, and design interact. The course examines how multimedia computing offers new ways of critical and imaginative expression (Kolker, 1996).

Course readings and discussions cover some computer basics and some theories of the text and hypertext.

Hypertext techniques such as linearity, non-linearity, structures, links, hiding, showing, connecting, searching, and guiding are illustrated in class. A software package "Multimedia Toolbook" is used for creating class projects (Kolker, 1995). This project development is scheduled as a between-classes task, therefore, students need to access "Multimedia Toolbook" outside of the classroom through Caprina (ASP).

HyperCourseware (Department of Psychology). HyperCourseware is a model of instructional interaction designed by Professor Kent Norman to facilitate the application of hypermedia and electronic collaboration in the classroom. Objects used for classroom activities, such as the course syllabus, lecture notes, the class roll, etc., are represented in graphic form on the computer network (Norman, 1994).

Many students take advantage of such a unique and powerful creation to prepare and review course materials both inside and outside of the classroom. Since the contents of HyperCourseware are updated frequently by the faculty, the best place to store these materials is a remotely accessible file server. Caprina provides an ideal bridge for students to get connected to the file server to obtain HyperCourseware and related material.

Microsoft Access (College of Journalism). In fall 1993, the College of Journalism opened a new computer lab dedicated to computer-assisted journalism. The inaugural computer-assisted reporting course was taught by Bill Dedman, a former Atlanta Journal/Constitution reporter who won a Pulitzer Prize for documenting mortgage discrimination against blacks. His series remains a model for computer-assisted journalism. The course is now taught by Penny Loeb, a senior editor in charge of database projects at *U.S. News & World Report* and a leader in this fast-growing field.

Upon completion of the course, students produce an in-depth computer-assisted reporting project. Microsoft Access is the database management application used for the student database projects. Many database files are larger than two MB in size and can not be carried around by students using regular floppy disks (1.44 MB average). Some students even produce several database files up to 300 MB. Caprina is thus adopted by the class for downloading large-size database files that were conveniently placed by the students on the filer server.

Total Quality Management (TQM) Tools. The TQM software was invented jointly by Professor Maryam Alavi and Professor Youngjin Yoo of the College of Business and Management. Most TQM software components were designed to encourage faculty to deliver innovations in course content and teaching methods around total quality principles and team teaching; to foster students with knowledge and experience in total quality; to highlight the opportunities provided by current information technologies by teaching and learning in a state-of-the-art "virtual" classroom. Some TQM software modules such as One-Minute-Paper and Class Directory are made available through the assistance of Caprina. (Stenchikova, Chang & Gilbert, 1994; Yoo, 1994).

The Making of Caprina During A.S.P. Era

The basic building blocks of Caprina (ASP) are the same as Caprina (ISP) except that Caprina (ASP) has become more class-oriented. The technique for providing application and image access to students is to use a remote Novell server to deliver the application/image. All that is stored on the local server in each computer lab is a special program, the application launcher, which: 1) connects to the remote image server, 2) executes the desired programs from the image server, and 3) automatically disconnects from the remote server (but not the local server) when program execution is terminated in any way.

On each individual computer is a Windows icon; when selected, it invokes the application launching program. Therefore, application maintenance is minimal: the icon on each local computer is just part of the standard Windows configuration. The application launching program on the local server is configured with a small, Windows-compatible initialization (.INI) file which identifies the image server; this file changes only if the name of the image/application server changes — infrequently. All of the "real" software, including the main initialization file, resides as a single copy on the image/application server — easy to maintain. For Caprina (ASP), additional coding was appended to Caprina (ISP) to accommodate any special requirements by the applications to be launched. Below are the four unique features being built into the Caprina (ASP)

User Name/Password. Unlike Caprina (ISP), Caprina (ASP) builds in a unique "user name/password" dialog box that requires each user to enter his/her assigned user name and selected password. This method allows Caprina (ASP) to determine the appropriate items listed in GROUP.INI and REMOTE.INI files as illustrated below (see Figure 5).

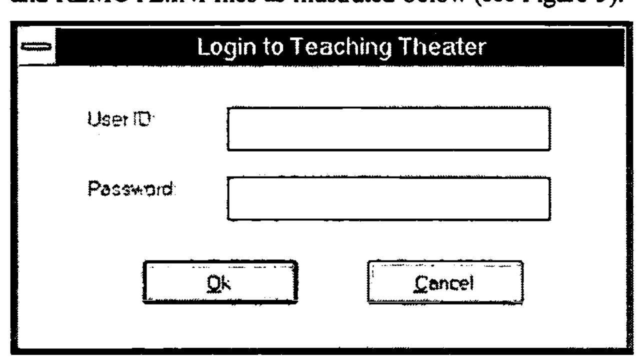

Figure 5. User Name/Password Feature for Caprina (ASP).

GROUP.INI File. This file is used by Caprina (ASP) to determine the actual home directory of each user (student, TA, faculty or technical support personnel).

Unique Network Drive Letter. Since different classroom applications have different pre-defined drive requirements, Caprina (ASP) automatically connects and build the desired drives. Below is a list of standard drives that are established after Caprina (ASP) connects to the application server:

- M Drive: User Personal Home Directory
- N Drive: Class Share Directory (for class notes and homework)
- K Drive: General Application Directory (mostly used by students)
- H Drive: Student Digital Photo Directory
- S Drive: Special Application Directory (mostly used by faculty and staff)

REMOTE.INI File. This file is used by Caprina (ASP) to determine the displayed title/name, actual location, and physical execution file name of each individual application required by class users (student, TA, faculty or technical support personnel).

Implications for Teacher Education

Perhaps the most important contribution of all of both Caprina (ISP) and Caprina (ASP) is the opportunity to change the lecture process to include more student involvement and collaboration. Currently, a lecture is where the instructor does something *to* the students. Much better is a setting where the students participate in the process. By having access to the slide library and advanced learning tools, students could prepare special presentations as class assignments; for example, a presentation on Russian mosaics to be given at a local elementary school. Or they could construct a in-depth database report on international trade analysis; or take pictures of rooftop ornaments in a certain part of town, have them scanned and made part of the permanent image collection. This concept, of students actually contributing to the information base locally in the classroom and remotely before/after class, is the leading trend in teacher education.

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Trans-European Networks and Their Role in Improving the Education in Countries with Transition Economy: Educating the Educators

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There are many notions that include networks and education. There are networks of people involved in education or special education topics, networks of excellence, networks of institutions, universities or networks of programs or relay centres. These networks are just some of many involved in the educational process. This paper deals with other type of networks - networks of infrastructure that enable the exchange of knowledge and information relevant for the development of an educational revolution in the late part of this century.

Eastern and Central Europe (CEE) has for many years been the shorthand reference for those countries in the political/military and economic sphere of the Soviet Union with the exception of Yugoslavia and the countries that appeared after its dissolution. The political transformation of these countries after the fall of the Berlin Wall made it possible for these countries to enthusiastically embrace the technology that was developing without political and institutional barriers - the new communication networks and the Internet.

These emerging technologies enabled setting up educational and research networks in Eastern and Central Europe. The infrastructure for basic Internet connectivity was built relatively quickly, since it was mainly matter of funding; but the rest was much more demanding. The building of the infrastructure required knowledge, organisation, management and other skills that were not present in these countries. Several initiatives were launched in cooperation with European Union programs and projects to foster the development and bring necessary knowledge, but some actions were initiated by the countries themselves. One of these successful actions was the setting up of the Association of Academic and Research Networks of Central and Eastern European countries. This action was launched three years ago and now the new-born child known as CEEnet is moving successfully towards new challenges and duties.

The basic ideas that governed the setting up of CEEnet, a complementary organisation to the existing Trans-European Association of Academic and Research Networks (TERENA) are presented. CEEnet activities and experiences in organisation of international schools for educating the educators from CEE countries in the field of networking and Internet-related technology are described and the evaluation prepared by the attendees is discussed.

Setting up an Organisation - the Birth of CEEnet

CEEnet was set up in 1994, however, representatives of seven national networking organisations for academic and research networking started discussions on the coordination of the networking activity in Central and Eastern Europe in 1993. Very soon after the first discussion began, a new networking association was created - the Central and Eastern European Networking Association - CEEnet. CEEnet is a legal body registered in Austria. Currently, 19 countries belong to the organisation. Members of CEENet are national networking organisations focusing on academic and research networking of Central and Eastern Europe. Each country is represented by only one organisation with official authorisation, as follows: INIMA - Albania networking organisation (N.O. in the text that follows); ACOnet - Austria, N.O; UNIBEL - Belarus N.O; UNICOM - Bulgaria N.O; CARNet - Croatia N.O; CESNet - Czech Republic N.O; EENet - Estonia N.O; ICM - Georgia N.O; HUNGARNet - Hungary N.O; LATNet - Latvia,N.O; LITNet - Lithuania N.O; MARNet - Macedonia N.O; NIC - Moldova N.O; NASK - Poland N.O; RNC - Romania N.O; FREENet - Russia N.O; SANET - Slovakia N.O; ARNES - Slovenia N.O; and UARNET - Ukraine N.O.

The main objective of CEENet is to coordinate international aspects primarily of academic and research networking in the region of Central and Eastern Europe. In order to attain this objective, CEENet:

- promotes and encourages technical and organisational co-operation between national networks;
- supports the exchange of operational, directory and technical information;
- protecst and serves the interests of CEENet and its members with respect to other organisations;
- when appropriate, sets up and maintains common services and technical facilities;
- establishes working groups to perform technical activities in line with objectives of CEENet;
- supports and organises conferences;
- publishes and distributes documents, brochures, periodicals.;
- promotes and encourages the development and establishment of appropriate national services;
- prepares and submits proposals to international and European organisations to promote network developments for CEENet and its members;
- participates in any other activity that supports the goals of CEENet.

The main body of CEEnet is the CEEnet General Assembly. Regular meetings of the Assembly are held twice each year where all important decisions for the organisation and its work are made. The CEEnet WWW home page can be found at: http://ceenet.nask.org.pl.

Educating the Educators

Identified Needs and Requirements

New information technologies, especially information networks like the Internet offer enormous possibilities. While it is true that in most of the CEE countries these technologies are not necessarily developed, or are available only for a smaller community, even these restricted possibilities far exceed the existing human and other resources, and are often unnecessarily limited by the conservative or traditional, but in any case, inappropriate organisational and managerial methods applied. In order to overcome these current difficulties, resulting from the well-known inertia, CEEnet tries to consider various means for the promotion of user demand and awareness. Some of them are very well known such as media, training, clubs, demonstrations, schooling, etc.

In order to get potential users interested and initiated, CEEnet recognised that more information should be provided in the following areas:

* available services, databases, tools,
* new possibilities and methods offered by the world-wide network,
* examples of practical use of network services,
* costs of introduction and usage,
* where and how to start.

In preparing the activities, three different levels of awareness were identified among CEEnet organisations. The scientific and academic community is very active in the field of networking. Its efforts are now coordinated and channelled by the national network organisations. Mail services and list servers offered by the Internet are recognised as an obligatory element of research in many centres and institutions. Still there are some differences among various groups of researchers, but the leading ones, especially in the fields of technology, have both experience and skills.

The medium level of awareness can be found in libraries, chambers of commerce and some specialised technology information centres. They can identify the sources of information that are most relevant to them but usually they lack experience and facilities to get access to it. Libraries are exceptionally poor in facilities due to the budget limitations during the last decade.

The lowest level of awareness is presented by local administration, sometimes even by central institutions, and small and medium sized enterprises (SMEs in the text that follows). The reasons are different. Administration in many CEE countries is poorly equipped with network facilities and personal knowledge on working with the network services is almost nonexistant. Moreover, administrative procedures usually come from the past and do not require networking as a means of collecting information. SMEs in CEE are involved now in problems that are more basic and vital for them, so they do not fully recognise all of the possible gains of networking. They tend to consider more active participation in a network information system as a very distant option for them. In terms of an unstable market and serious transformation difficulties, they are not aware of the relevance and importance of their participation in the Internet and related networks.

Various groups of current and potential users of information within the international networks are very different in terms of facilities, experience and knowledge about networking. Many organisations do not recognise networking as a valuable tool or as a means of support for their activities. Even experience with computers is sometimes not adequate for use of the network services. Unfortunately, the administration, which is in many cases also a decision maker, does not sufficiently recognise new possibilities brought by the information networks and the Internet. The administration is also poorly equipped with network facilities - the majority of Internet users come from academies, universities and research institutes with the most advanced groups of users coming from the scientific and research community. The CEEnet idea was to use these realtively advanced users as information disseminators and tutors in training courses organised for other groups. Analysing the situation in all CEEnet countries, the following need for training and education were recognised:

* introductory courses for beginners,
* upgrade courses, tips and tricks for advanced users,

* user support, peer support, self-support,
* up-to-date on-line help, help-desk,
* new methods, good examples and ideas.

After several months of discussion on the CEEnet mailing list, it became obvious that the best way to meet the identified needs for education is to organise international schools where people committed to disseminating the knowledge they will get, will be invited to attend the school. In other words, CEEnet decided to organise schools where the future educators can be trained.

The International Schools and Workshops

The schools were organised in 1995 in Warsaw and in 1996 in Budapest and were attended by more than 100 participants from all CEEnet countries. The schools were funded by Open Society Institute (SOROS Foundation), NATO and some manufacturers who are also sponsors of the school. Every participant was selected by his native organisation and the number of participants per country was determined during the CEEnet Assembly meeting. All lecturers volunteered and were provided by the CEEnet membership organisations. During the summer, the program which was set up in Warsaw was slightly modified with the introduction of several new topics and the order of lectures was revised, based on the consultations with the track leaders. The format of the previous workshop, namely, to have two tracks - one technical and the other services and management oriented, was maintained. Proceedings from the first school that contained all basic tutorials were printed and prepared for this second school. The lectures started on August 25, 1996 and ended a week later, on September 1, 1996. The program consisted of the following topics:

- The History and the Nature of Communications
- The VSAT Links
- Local and Wide Area Networks
- Basic Internet Networking
- The Internet Network Organisation
- Serial Communications
- Network Management
- Internet Sources and Systems
- Connecting Networks
- Network Security
- Local IR Training
- User Support and Training

In addition to the regular lectures and exercises, the schools had two tracks of value added events. The first track consisted of a short presentations called "Sponsor's Spotlights" with mainly technical content. These sessions were sponsored by Sun Microsystems, Cisco, and NetSat Express. The second track utilized an 'all in one place' workshop organisation, and contained general topic lectures and round table discussion. This special free style of the "Evening Lectures" become the success story of the workshop. Theses lectures were organised each night after dinner and included refreshments. The topics were exciting and thought provoking, and the refreshments along with a relaxed atmosphere made practically every evening a social event. The Evening Lectures covered a variety of topics, including: Virtual Reality, Internet and Society (with a panel discussion), Java and Assorted Flavours, VSAT Communication, the development of Hungarnet - the new ATM network, the Internet in High Schools, Internationalisation of the Internet and Character Sets. The representatives of Bosnia also spoke on the topic Internet in Crises.

The last lecture at the Workshop was devoted to the problems of User Support and Education where a number of attendees presented case studies of the experience in their respective countries.

The school was held in the facilities provided by the Central and Eastern European University Centre (CEU CC) in Budapest. Many of the school's facilities were used for the conference. The instructional facilities included:

- two laboratories with about 50 personal computer stations), five Sun Workstations, one Silicon Graphics, and one Hewlett Packard with Open View Software installed;
- six PC's in the lecturer's room, a UNIX workstation, along with a copying machine, a fax machine, and two telephones;
- three lectures rooms, with two sets of Video-beams and LCD tablets and a direct Internet connection, which could easily be combined into a very large single room;
- eight PC's were avaialable to lecturers in their rooms;
- eight CISCO routers, in addition to the ones that provided communications services to the CEU CC;
- a large number of hubs, terminal servers, modems and transceivers for establishing various network topologies and executing the hands-on exercises;
- a special room for administrative services, and a separate dining hall for the participants.

The entire building was wired with Cat5, while a T1 link provided external Internet connectivity to the outside world.

Evaluation and Feedback

The school ended with an evaluation provided by the attendees. The format and the content of the evaluation form was completely changed from the previous year, and was based both on quantitative grading and verbal answers and comments. The overall grade given to the school was very good. Some of the answers and attendee's opinions are very interesting and the comments from the evaluation process are included below. The questions addressed the lectures as well as social and accommodation issues. The most relevant issues appear below with comments from participants:

A) The learning environment (program, instructors, teaching)

A1) The relevance of the program content with respect to your expectations:

- deeper covering, but very good
- some difficulties because of the differences in the levels of the audience
- no possibility to hear all the lectures
- additional training on OS for people with no experience in UNIX (Linux, BSD)
- on servers, more about content creation rather than technical details
- some of the lectures too easy
- sometimes too overloaded (some lectures should be optional)
- excellent program, occasionally too demanding
- complete program
- more serious than the ISOC (International Internet Society) workshop

A2) The quality of teaching:

- very high level - very good lecturers
- occasionally, better need for explanation
- no TV in the rooms (in order to study)
- better explanations for lab exercises

A3) The instructional facilities (equipment and labs)

- some exercises too elementary
- too little equipment, especially Cisco routers
- more lab time
- little bit more help in labs
- great place
- such good labs should have been more accessible
- longer lab hours and no TV in the rooms
- very good connectivity
- good program

A4) The suitability of distributed materials - the tutorial in the last year proceedings:

- my grade is four, it would be five if the W/shop results in the book as one from the last year
- more detailed examples as supplement
- put some materials on the Web
- more full text on some topics
- even more materials
- it is a good idea to join all the materials in one brochure (like the year before but more complete)
- materials also in a digital form
- hope to put full materials for downloading
- hope to have a full book
- please, additional text
- very good materials, covering the whole range of FAQ (Frequently Asked Questions) arising in my technical work
- the book should be distributed a month before the W/ shop
- very good, right on time

A5) How useful were the Evening lectures:

- very useful to have two different viewpoints on VSAT technology
- it is good to learn about the social impact of the Internet
- Internet in Art for the next year
- all new developments
- some of the lectures excellent
- could be used for representations of national networks
- security issues in detail
- to hear more about social and legislative issues
- excellent, although sometimes tiring
- interesting topics and relaxed evenings

A6) Was the Sponsor's spotlight worthwhile?

- some not very well prepared
- more technical issues and less advertising
- companies like Sun and Cisco must use on-line facilities (video + network) for their presentations and not plastic slides
- next year Microsoft should be sponsor

A7) What should be improved and/or changed in the Program and its execution in the future:

- I think it is very good such is now, it was very well organised
- more labs
- closer connections between lectures and labs
- too much lessons per day
- more solicited program
- more practical information
- additional lectures on multi-casting services
- two kinds of programs: beginners and system administrators
- lectures Vs exercises - 1:2
- more time in lab
- extensions of the lab time
- different venues for system administrators: beginners and advanced ones
- labs need to be organised for different levels of experiences
- more information
- track 2 programme should be more advanced
- may be another track 3
- unlimited access to labs
- CEENet has to have permanent educational programs, not only during the W/shops
- no changes whatsoever, only hope to repeat the same experience

B) The Living Environment(travel, housing, food, social events)

B1) How was your room accommodation:

- enjoyed connectivity in the room
- connectivity + computers in the rooms=great
- never seen that class of dormitory before

B6) From a logistic point of view in the future, I would prefer certain things done in a different manner. For example,

- for prospective future students in advanced info on the Web should be nice
- to have lecture descriptions, one day in advance
- more information, but good organisation otherwise
- the lab policy should be improved, and should be open all day and night
- the lectures should be ordered by previous knowledge and announced so if you already know the basics just skip the lecture
- the training in the lab over particular issues, so that every participant can do a complete lab by himself

C)Additional issues:

C1) Do you think that your country might be a good candidate forCEENet W/shop. Please, explain

C2) In case you have a local w/shop in your country, would you require a help from CEENet to organise it? If so, how could we help you?

Combined comments on C1 and C2:

- yes, good experience CEENet 1 (Poland)
- no technical base for the W/shop (Bulgaria)
- I do not think so, our country has no experience
- yes, but this (Estonia)
- not enough equipment
- yes, if in Yaroslav (YSU) we have developed environment for lectures and labs, and many places for sightseeing and visits
- of course yes because we have very heterogeneous environment and many service providers (Russia)
- Yes, we have fairly developed network
- yes (Bulgaria)
- we actually already discussed some potential places, there are a lot of lecture rooms in Tartu university and the hotels are not too bad, plus the Internet connection (Estonia).
- no, slow link
- no, not yet
- Estonia would be a good candidate - good infrastructure, people to do the logistic (technical) work, local experience to be shared.
- I think so, but depends on the people from CESNet and CEENet
- CEENet might help organised summer student exchanges

What more would you like to tell us?

- I would like to thank you very much for all that you have done for us
- Thank you so much
- Home Page with materials-please organise
- Thanks for organising the whole event-it was worthwhile to organise
- A Web site and the book should come out of this
- If the point of the W/shop was explaining most of the Internet topics and giving systematic view of them, that you did it.
- very professional event
- excellent place with excellent organisation. Congratulations.
- the security of the labs needs some revisions.
- I appreciate very much what you have done. Actually, I believe that the CEENet W/shop is already competitive to ISOC W/shops and has the same efficiency.
- thank you very much
- I liked it. There are things to be improved and I am ready to co-operate
- we are very tired, but we are lucky to get many new ideas for our work at home. Thanks.
- an effort at least as good as the ISOC Workshop, but more demanding and serious
- thank you. Waiting for the book.

Conclusion

After two years of experience in organising the education of the educators, CEEnet learnt that schools of this type are still necessary for the users and future service providers in the CEE region. The evaluation report has also shown that despite the fact that some CEE members have good and well organised infrastructures, such training is beneficial for both the less and more developed. The less developed gain basic information and learn how to set up, run and use a network, while the more developed get in touch with the most advanced technology provided through Sponsors Spotlight events and the evening panels and roundtables. The evaluation of the guests coming from ISOC, NATO, and SOROS were encouraging and stimulating. It was evident that CEEnet and its members managed to addressed the real educational needs in the region.

Acknowledgment

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High Tech...High Touch at Walden's Electronic Campus - Revisited

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Walden University (WU), a distance learning doctoral degree program accredited by North Central Association, supports the philosophy that adult learning should be pursued at a pace determined by the student. The rationale for the Walden curriculum is grounded in the beliefs that what is learned should be relevant to students' needs; that learning demonstrations should be negotiated between the student and the mentor (a relationship that should be one of mutual respect); that knowledge to be acquired should be applied to practice; and that learning how to keep on learning is more important than acquiring facts.

Walden University offers six Ph.D. programs, 1 M.S. program, and Distance/Collaborative/Adult education courses. The students and faculty come from many walks of life including: managers, executives, teachers, health care providers, consultants, and social workers. Although Walden does not have a traditional campus, it does support its students by providing access to the research libraries at Indiana University, Bloomington. A Walden librarian is available on site, and on line, to find and forward the books and publications students need for their research.

The WIN at Walden

To further increase the effectiveness of distance learning, without decreasing human interactions, Walden has developed an electronic campus. In May of 1994, Walden took the primary steps needed to make this electronic campus a reality. This involved providing the entire Walden Community (approximately 1200 students and 129 faculty members) with an electronic connection to each other and to the Internet. This virtual campus has been christened the *Walden Information Network* (WIN).

The rationale which led to the creation of WIN was based on the belief that:

1. Students should be able to receive training when and where they need it. During asynchronatic workshops an instructor need not be present, so the student can select the time which best fits their personal schedule.
2. Students should be able to exit a training session at any point and return when it is convenient.
3. Students should be able to do more collaborative learning and group problem solving with each other and with members of the faculty.
4. There exists a vast range of instruction, and especially gifted lecturers should be able to reach a greater number of students.
5. Universities need to become a true community of scholars and focus more on the content of education.

Many people are concerned that electronically-mediated education will lack the human touch that is essential for true understanding. Although most of these concerns are normal, the experience of those who have participated in computer conferencing, or other interactive media, feel that these fears are unwarranted. In actuality, it appears that the intensity of relationships is often enhanced by the technology.

Translating the dream of an electronic campus into a reality has been fraught with challenges, many of which were not foreseen. Not only are electronic advances being made continuously, but development with respect to the National Information Highway seems to defy predictability. It has been almost three years since WIN has been operational. All students and faculty members have made it on to the I-way.

Dr. Marilyn K. Simon is one of the faculty members who participated in a pilot project to determine the efficacy of WIN. What follows is a descriptive evaluation by Dr. Simon, of WIN over a six month period. During this time, Dr. Simon had 12 advisees who were enrolled as doctoral candidates; 5 were connected (C) and 7 were not yet connected (NC).

Advantages of WIN

The following benefits have been observed by Simon's advisory group C at Walden University who have been connected to WIN:

1. A high level of faculty/student; student/student and faculty/faculty interaction. Generally WU community members only get the opportunity to interact during

Admission Orientation Workshops (AOWs), Regional Intensive Sessions (RISs), cluster meetings, and summer residential sessions (SS).

2. The ability to have a written record of discussions. Telephone conversations, and conversations in general, can often be misconstrued. When a student receives electronic information from their advisors or other students on WIN, they have the option of printing this message for documentation purposes and for future reference.
3. The asynchronous nature of the dialogues allows time for reflection. Students and faculty can prepare responses to poignant and probing questions. They can then work at times which best suit their needs and learning styles.
4. The anonymity of this media allows for a more free flow of ideas.
5. Being place-independent means that participating on WIN does not disrupt a person's work or their private and personal lives.
6. There is a more democratic process since there is an equalization of participation between those individuals who are more assertive and those who tend to be more reticent in group discussions.
7. There is a greater sense of a shared Walden culture. Participants interchange information they have ascertained about the events, policies, and procedures at Walden. They look forward to meeting each other at regional meetings.
8. There is a great deal of collaborative learning and group problem solving taking place.
9. There is authentic learning as participants enhance their communication and research skills and broaden their perspectives by considering other points of view.

Progress with WIN

There is a wide range of time tables that students produce as they advance in the Walden program. Amongst students who have obtained degrees from Walden in the past few years, the mean average stay is between 2.5 and 3.5 years. To determine the progress made by the sample students in this study, the investigator dissected the Walden program into units as follows:

- 1 = PDP (Professional Development Plan)
- 21 = KAMs (Knowledge Area Modules)
- 4 Basic KAMS, 3 Advanced KAMS

[demonstrations of Breadth, Depth, Application of knowledge]

- 6 = Dissertation Proposal
- 9 = Dissertation Completion [once proposal is accepted]
- 1 = Oral Presentation of completed Dissertation

[no units were awarded to students for the completion of a Learning Agreement].

Of the 12 students in this study, 5 were fully connected to WIN either through the address provided by Walden or through their own internet connections. There was a great variance in the amount of work units produced during this time period between the members of the study. The mean and standard deviation were: $\mu = 2.25$, $s = 1.9$ units, and ranged from 0 to 6 units.

To determine if there was a significant difference in work units produced between those who were on WIN (C) and those who were not (NC), an independent t-test was performed. The mean number of units completed by those not on WIN (NC) was $\mu = 0.875$, $s= 1.89$ whereas the mean value for those on WIN (C) was $\mu = 4.52$. $s= 2.5$. The t-value of 3.743 ($p = .0032$) was determined. This indicates a statistically significant difference between the two groups with those connected, C, to WIN showing significantly more progress than those who were not, NC.

To determine if there was a statistically significant relationship between a student's status on WIN and the amount of work units that student produced, the linear correlation coefficient r was computed. The r value of 0.82158 ($p = 0.001$), indicates that a statistically significant linear relationship between these two variables exists. Having determined that r is significant, the regression line was determined, and the coefficient of determination, $r^2 = 0.675$ was computed. This means that 67.5% of the total variation can be explained by the regression line, and 33.5% of the total variation remains unexplained.

WIN Student Comments

The following are responses from students who were asked about their experiences on WIN. The length of time, in years, that the student has been enrolled at Walden appears in parenthesis.

PT (0.75)

Keeping in touch by e-mail inspires me and gives me the extra energy to maintain the momentum that is necessary to complete the work that is before me. It is also great to have an answer, most of the time the same day, rather than using snail mail which at times does not make it to the destination in this life time.

KK (1.5)

Being able to be in touch with my advisor and receive a reply within a few hours and at my convenience are by far the most important advantages to me. There are plenty of messages that I save and file and some end up as a hard copy in my papers. On-line communication fits with my busy life-style.

GD (0.5)

E-mail has made my Walden experience very enjoyable, so far, and has given me the direction that was missing from my previous experience with distance learning.

In conclusion, I would like to share the thoughts of Gary Miller (1995) of DETC NEWS which were picked up online and reflect my own beliefs and opinions about WIN:

> The irony of distance learning is that it was intended to allow students to work alone but is now bringing them closer together. Students can participate in education programs from anywhere in the world. These technologies not only allow students to study at an individual pace but to interact with each other, with their teachers, and with the universe of information sources, from databases to international libraries.

Students who have enrolled in Walden after Sept. 1, 1995, are required to demonstrate technological competency by completing a WIN I based learning experience. These entering students are placed in a group facilitated by a specific faculty member. To complete a WIN I seminar the student must:

- Identify, access, and use, technological support services
- Engage in collegial e-mail networking with faculty and colleagues
- Utilize many of the services available on WIN
- Join and contribute to professional listservs
- Access various data bases

This presentation will begin with a description of WIN 1 + which is a high tech/ high touch new student orientation program. This will be followed by examples of applications such as: new systems of advising, accessing student records, faculty and student conferences, on-line seminars, corroborative research projects, and how WIN I has enhanced critical thinking skills while augmenting technological knowledge.

This presentation will also describe the pilot project, used to determine the efficacy of WIN. An interactive demonstration that will enable participants to evaluate WIN will follow. Information will then be provided delineating the operational procedures involved with creating an electronic campus, followed by examples of applications such as: new systems of advising, accessing student records, faculty and student conferences, online seminars, corroborative research projects, and enhancement of critical thinking skills will be discussed.

The presenters will discuss their views on *telelearning* and the implications of technology providing a lifelong learning system. Participants will be invited to share their views and experiences in these areas.

Conclusion

Distance learning is no longer a marginal part of higher education; it is an important means of providing access to educational opportunities and resources. Moreover, the dramatic rate of change in information is forcing us to realize that we don't need an "educated" population, but rather that we need to become a nation of learners who combine work and education. Learning must become an active and ongoing process rather than a test of memorization skills based on some acceptable list of core knowledge (Cochenour, Rezabek, & Burton, 1993). WIN was created to support this type of learning. Walden University was created to support this type of scholar-practitioner.

The Walden Community has discovered that when adopting informational technologies, it is critical to involve stakeholders at all levels of the organization. Faculty, however, must be involved in the governance of these systems, and the introduction of telecommunications-based education should be a collaborative effort. A successful process-created team is one weighted toward professionals who can best consider the non- technical questions that are asked (Duning , Van Kekerix, & Zaborowski, 1993). One must place the learners' (customers') needs ahead of organizational convenience and at the center of planning and decision making.

As colleges and universities in the future will no longer control all access to knowledge, we will find ourselves competing for students with other entities such as the telecommunications and entertainment industries. Walden University has embraced this new paradigm and hopes to serve as an exemplar for others seeking similar distance education programs.

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Microwebs: An Alternative to the World Wide Web

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Few educators would argue that the World Wide Web is a wonderful tool for energizing the classroom. A recent survey by the National Center for Education Statistics (NCES) indicated that half of the nation's public schools have at least one computer connected to the Internet (Milone, 1996, p. 1). The ability of students to access information immediately, independently, and with all of it's multimedia technology makes Internet access a must for all teachers, administrators and school leaders whose motivation is to prepare students for the world of the 21st century. However, this exciting educational tool is not without it's shortcomings. Funding for both hardware and software, network management including downtime, and the ethical ramifications involved in controlling access are just a few of the many issues that teachers and school leaders must address prior to developing and implementing a plan for online telecommunications. Most educators today agree that one of the biggest constraints of this technology is the cost. The expense can be so staggering that to many schools the prospect of an Internet connection is just that, a prospect.

An alternative to the high expenditures associated with Internet access is Microweb technology. A Microweb is a collection of Internet sites that have been copied and downloaded from the World Wide Web. It is, in effect, a locally run Internet, with access to preselected sites that have been chosen and controlled by the faculty. Microwebs have the same functionality as original Web pages which can include graphics, sound, motion and links.

Simulating the World Wide Web

Simulation programs have been developed by computer software designers for a number of years. Presently there are a number of software packages available which allow the user to copy entire sites. With the advent of new and emerging hardware, such as an A/V hard drive and a recordable CD-R drive, complete copies of remote Web sites, or "Microwebs", can be created which simulate a portion of the World Wide Web. Through the use of software programs like *Web Whacker,* actual Web sites and their links are downloaded and copied ("whacked") on many levels to create in-depth simulations of the World Wide Web on any single topic or entire content areas. Once downloaded, the site can be stored in a number of different media.

Task Focused

Educators are voicing many concerns regarding the granting of student access to the Internet. Some educators fear that when students explore the World Wide Web they gloss over information preferring to hyperlink their way from site to site without really learning anything (Sturm, 1996, p. viii). They become sidetracked by "slick" graphics or even games and pass over the required information when using the Internet. This is an all to common occurrence when the Internet is used directly to teach a lesson or unit of instruction. The capacity for students to "surf" their way out of the designed instruction is all but eliminated when Microweb technology is implemented because it allows the teacher to tailor presentations of specific content for a lesson or unit and choose which Web sites students will utilize. In this way teachers can readily adapt objectives to meet the goals of the curriculum. By downloading an entire Web site and placing it in local storage, focus on a specific task is ensured. The use of Microwebs also guarantees immediate access to the desired sites and subject matter without the frustration of waiting for network connections and delays when the server is busy during peak hours.

Technology vs. Curriculum

Does curriculum dictate the requirement for technology or does technology decree the change to curriculum? As educators, we hope that the curriculum distinguishes the requirement for the use of technology in the classroom. More often than not, however, the latest technology is implemented in the classroom with little or no forethought to curriculum design. An online connection alone does not produce educational magic. Educators need to know how to integrate technology into the curriculum and manage online learning experiences effectively (Dyril & Kinnaman, 1995, p.79). The adaptability and flexibility of Microwebs can make the issue of curriculum design for technology a secondary consideration if not a moot point. Microwebs can easily be designed and adapted to fit a particular lesson or if need be, an entire curriculum. The ability of the faculty to tailor presentations of specific content, therefore satisfying the daily lesson and ultimately meeting the objectives of the curriculum, makes the Microweb an ideal classroom tool from both an educator and administrator perspective.

Networking & Telecommunications

The idea of connecting your school or classroom to the Internet seemed like a practical and sensible insight when it was made back in the early 1990s. The ability to provide students instant access to unfathomable volumes of research materials made this technology a "must" for all schools in order to prepare students to take their place in the twenty-first century. The popular notion, at that time, was to simply run a few extra telephone lines into the school and hook them into a couple of computers with external modems and like magic the school would be connected to the world via the Internet. Soon, a sobering reality manifested itself. The actual cost for hardware and software upgrades, Local Area Network topology design, wiring configurations, and maintenance, just to name a few, became apparent. The costs were so staggering to a large number of schools, that the idea of Internet access was shelved until one of two things occurred, either the costs dropped to an acceptable level or until a viable alternative could be found.

The concern over the cost of network access have not dissipated. It is not uncommon for the costs of Internet access to be identified as one of the larger expenditures in the budget of many of today's schools. Currently, the costs of accessing the Internet range from approximately a $1,500 one time start up fee and a recurring annual cost of more than $12,500 for the establishment of a minimal single text based workstation. A more sophisticated and representative multimedia model involving multiple workstations with a one time cost of approximately $260,000 and a reoccurring annual cost of almost $150,000. These rates and costs vary considerably, however, and are much lower in some states due to state-mandated rate reductions for schools and business-school partnerships.

The exorbitant cost associated with school telecommunications can be dramatically reduced with the implementation and integration of Microweb technology. Using a Microweb design, schools can transform their entire network computer topology, consequently reducing the number of lines to the Internet Service Provider (ISP). With the application of a compact disk recordable device (CD-R) and an external

AV hard drive for a one time cost of about $2,500, Internet cabling to every classroom is no longer a requirement because the programmed CD can be used in a stand-alone configuration. If, however, the school already operates a Local Area Network (LAN) configuration, the server can be utilized in its present form simply by loading the CD. Access to the Internet itself could still be maintained by the teacher or administrator.

Even if controlling Internet access is not an issue of concern for a particular school, the use of Microwebs can still be of value to both the teacher and administrator. If you have copied a Web site including the hypertext links, you can still access Internet sites simply by choosing the link. As long as there is an operating link to the Internet, the Microweb will function as well as the original Web site, possessing full Internet capability and capacity. If you are using your Microweb and want to access a site that you did not copy, all you need to do is type in the address or select the hypertext link to access at that page on the World Wide Web.

Microweb Storage

Microwebs can be stored using the same storage devices that save other forms of computer data. Internal or external hard drives and Zip drives work well for this purpose. Diskettes can even save the data from Mircoweb sites. Mircowebs do not restrict how the data is saved, however many Web sites, particularly those which have audio clips, video clips or abundant pictures are generally very large sites and thus require a lot of storage space. A technique that has proved very successful is to save the copied sites on an external drive, edit as needed, and then use a CD-R device to permanently imprint them on a CD for future use. As mentioned earlier, this is the preferred technique for either a stand alone configuration or when utilizing a server. Additionally, once a site is downloaded and recorded on a CD it is permanent. If for some reason the Web site is abandoned or discontinued, the site with its links is preserved.

A further advantage of using the CD-ROM as a storage device is the capacity to save data in a duel operating system mode. Most writable CD's have a cross platform capability that allows the data to be written so that both Macintosh and IBM platforms can read the same CD. The advantage of this capability is apparent when working in classrooms and computer labs that possess both types of hardware. Consequently, the practice of purchasing two copies of same software title, one for each type of machine, can be eliminated.

Ethical Issues

A number of ethical issues continue to evolve regarding the use of information available on the Internet. Educators will want to consider the possible implications which these issues reflect when using a Microweb to simulate the World Wide Web.

Censorship

When Microwebs are created, the student is restricted from exploring any other than what has been locally copied. Microwebs designed to be used in a classroom should reflect the content of the curriculum in much the same way as a textbook or a computer software program with suitably selected information that is developmentally appropriate. Students should be able to experience the full range of materials available in the content areas being studied. Through the use of Microwebs extraneous material can be eliminated. As a result, the student is able to concentrate and focus on specific information, eliminating the temptation to become sidetracked or go off on a tangent that is irrelevant to the subject being studied. While this maybe considered a form a censorship, attention to the broader picture must be addressed.

An appropriate and interesting analogy has been expressed between the Internet and a school field trip (Salpeter, 1997, p.1). A teacher would not plan a field trip to an inappropriate or irrelevant site or allow students to venture forth on their own without the appropriate supervision. Surfing the Internet permits students to experience the world outside the classroom. However, like a field trip it requires the appropriate planning and supervision by the teacher.

Copyright

With the advent of electronic media, the use of copyrighted material has become an issue which should be considered by educators. Guidelines for the use of materials loaded on the World Wide Web are still being formulated. Teachers should consider when and if Web sites with copyright notifications will be used to create Microwebs that will be permanently stored on CD's for continuous use in the classroom. A number of Web sites, especially those that include graphics and video are copyrighted. However, currently, provisions have been made to download the information providing the copyright notification is included with the work when it is downloaded. Graphics, especially clip art, that are copyrighted can often be used royalty free or with the permission of the creator.

The copyright symbol (the letter c inside a circle) is the standard for indicating copyright. Since the advent of electronic media, the word "Copyright" can also be used in the United States.

At this point in time, there appears to be a doctrine of implied public access on the World Wide Web. The WWW was created on the basis of being able to attach hypertext links to any other location on the World Wide Web. Consequently, everyone publishing on the WWW is deemed to have given you implied permission to link to their Web pages (O'Mahoney, 1996, p. 4).

Leveling the Playing Field

The issue of computer equity has fanned the flames of passionate debate amongst professional educators within the US and elsewhere. The long-standing contention of the "haves vs. the have nots" continues to be an issue of concern for all of those who teach technology based subjects. How do we as educators determine who will receive the technical instruction of such a limited resource? Introduction of Microweb technology may provide a respite in the debate over technology equity. If implemented Microwebs can dramatically reduce both size and scope of school network topology. The monetary savings gained from network downsizing can be employed to purchase additional hardware, therefore granting greater student access to technology. Microwebs are certainly not the answer to all of the issues and concerns of computer equity, but they do provide a short term resolution.

Microwebs that can be produced and stored permanently have enormous potential. Resources with current and topical information are unlimited for the teachers and students who will occupy the classrooms of the 21st century.

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An Archive of Sharable Education Resources on the Web

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This article discusses the development of an electronic archive of sharable resources that can be used by educators to support a variety of instructional activities. The authors and their students at the University of Houston have developed Archive.edu, an educational storehouse of classroom materials on the World Wide Web. This site was created in response to a number of trends that the authors view as having important implications in the area of networked educational resources.

One trend is that new Web sites appear almost daily, and this ever growing list of sites vie for the attention of Web users. Although the proliferation of Web pages adds to the number of matches found by Web search engines, the volume of material makes it difficult and often frustrating for users to locate the information they are seeking. Additionally, there is a rapid rise in the number of commercial Web sites, where copyrighted material is displayed, but users are not allowed to download and use these materials for their own purposes.

Further, the ability of users to download material is becoming faster and easier as the Web matures into a more user-friendly resource. Perhaps most significantly, the Web is now capable of distributing multimedia materials that go beyond just text and graphics. Hypermedia projects developed with software such as PowerPoint, HyperStudio, and Authorware are increasingly being disseminated through the Web. The promise of high-quality audio and video delivery via the Web is also becoming a reality.

Implication for Educators

These trends are having a dramatic effect on the educational community as more K-12 schools, colleges, and universities become connected to the Web. Many educators are wanting to, and in many cases expected to, integrate technology into their classroom instruction. But today's Web, with all of its potential to deliver educational materials, is frequently a confusing and underutilized resource for teachers and students.

To summarize, the state of the Web today for educators is as follows:

1. There is a comparatively small amount of relevant downloadable courseware, instructional graphics, video clips, and technology tutorials available on the Web for educators.
2. What materials do exist on the Web are often difficult to find, and educators frequently do not have the required navigation and search skills to access them. Perhaps more importantly, many educators simply do not have the time necessary to search for materials that can be used in their classrooms.
3. When educators do find instructionally-relevant materials, many times these materials are copyrighted. The issue of copyright and it's implications for educators has become an important component in the development of Web sites as a means for disseminating digital materials and will be examined in greater detail in the next section.

What is Needed

A growing body of research indicates that many educators would like to develop multimedia materials that can be used in their classroom but do not posses the knowledge and skills necessary to do so (U.S. Congress, OTA, 1995). The authors have found that one of the most successful teaching models for developing meaningful multimedia projects has three major components:

- multimedia projects, stacks, files, presentations
- a description of how multimedia is used in the classroom
- step by step instructions for creating similar multimedia projects

In most educational Web sites, one or more of these components may be found. For example, there are numerous good examples of multimedia projects on the Web.

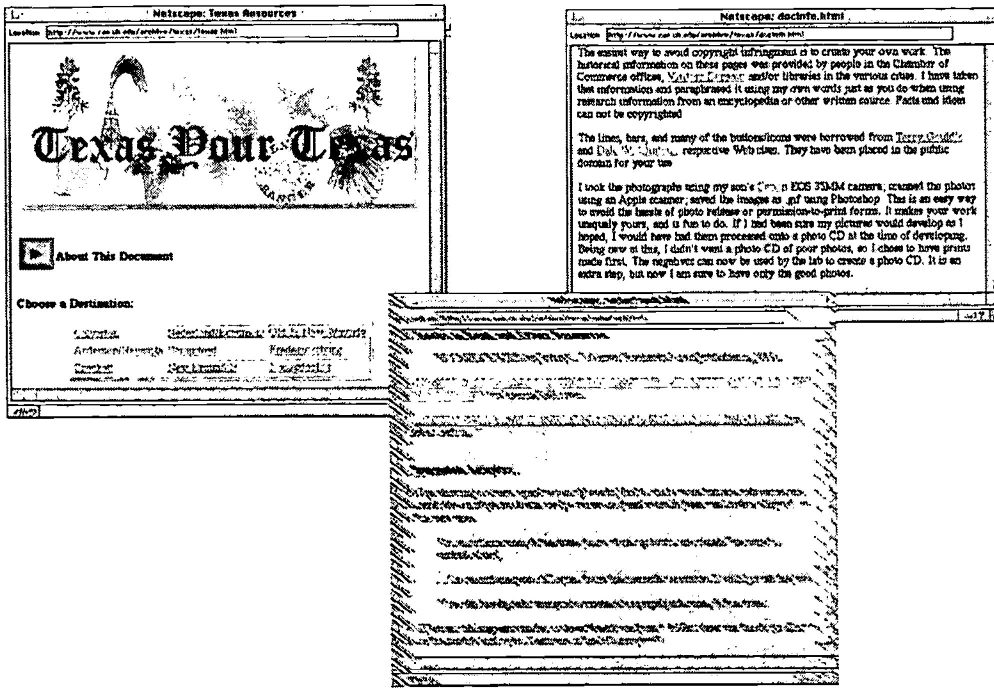

Figure 1. Three Components of the Archive.edu Model.

There are also many theoretical models of how multimedia can be used in education. In addition, there are many Web sites that focus on how to use certain software applications to create multimedia projects. However, there are relatively few places where all three components, the project itself, how the project can be used instructionally, and directions for creating new projects, are found together so that the entire development process is documented and may be studied, not in isolation, but as a complete, integrated unit. The Web is an excellent medium for bringing these components together in one location, and this model has served as the foundation for Archive.edu.

One example of this model is *Texas Your Texas*, a Web site developed by a graduate student at the University of Houston (Berg-Chandler, 1996). This resource was created for use in Texas history classes where students can go for a "historical field trip"—close enough to home to be familiar, but too far away to go with a class. The site provides a vehicle for integration of technology into the classroom by extending rather than duplicating the existing social studies curriculum and expands student knowledge and interest about the history of their state, while motivating further student exploration.

Figure One illustrates the three components of the model. The first screen shows an example of the information about various cities in Texas. The second screen presents related resources and ways that this material can be incorporated into classroom instruction. The third screen demonstrates how the Web site was created and includes guidelines for creating a similar site.

Copyright Issues

There has been much discussion recently about what is legal and ethical regarding copying and using works created by others, especially, the use of digital material found on the Internet. The ease with which information may be copied from the Web has forced many developers and users to consider the issue of intellectual property, perhaps the first time. Copyright laws for the electronic dissemination of information are still evolving, and most educators are unclear about their rights and responsibilities.

Copyright law, simply stated, means that legally one is not allowed to take someone else's words, graphics, video, or any other type of media and use it for their own purposes. However, the long-standing tradition of "educational fair use" allowed many educators to feel comfortable using parts of other people's works for instructional purposes as long as those materials remained within the walls of the classroom. But education today does not always remain within an isolated classroom. Many schools are developing their own Web sites and sharing the work of their students and teachers. A potential copyright infringement problem occurs when, for example, students surf the Web, download graphics or audio clips, insert them into their own work, and redistribute this "borrowed" material on their school or classroom Web site. This situation has forced educators and legal experts to reconsider the issue of what is legal in the world of digital manipulation and electronic publishing.

According to current guidelines, every work that is found on the Internet is copyrighted by its author, whether a declaration of copyright is explicitly stated or not (U.S.

Copyright Office, 1996). Copyright guidelines in the past have even included a "Classroom Exemption," which covers such things as the display of a work by a teacher or student. Today, however, the copyright situation is murky and filled with uncertainty. The average educator does not know what the law actually states, nor where to go to get answers about how digital information can be used instructionally and shared with others. According to Baer (1996), even unintentional copyright infringement is still a violation and "...the same powerful tools that make your original creations possible are also unsurpassed tools for infringing copyright" (p.163).

Archive.edu will serve as a storehouse of instructional materials on a variety of topics that educators can easily access. But more than just another Web site, Archive.edu is a location where educators will have full permission to download any of the materials. These materials can be used as they are, or customized and incorporated into other instructional projects.

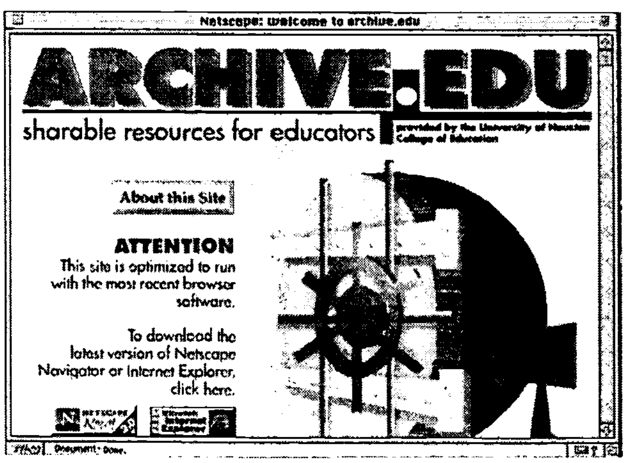

Figure 2. The Main Screen of Archive.edu.

Basic Organization of Archive.edu

The design and development of Archive.edu is based upon interviews with educators and students who have expressed an interest in locating educational materials on the Web and plan to use this resource. The prospective audience for Archive.edu includes preservice and inservice K-12 teachers and technology coordinators, university faculty and students, and others interested in educational materials. The Web site has begun with a series of content areas or "vaults" that include resources for Math, Science, Social Studies, Language Arts, Multicultural Education and Technology, among others.

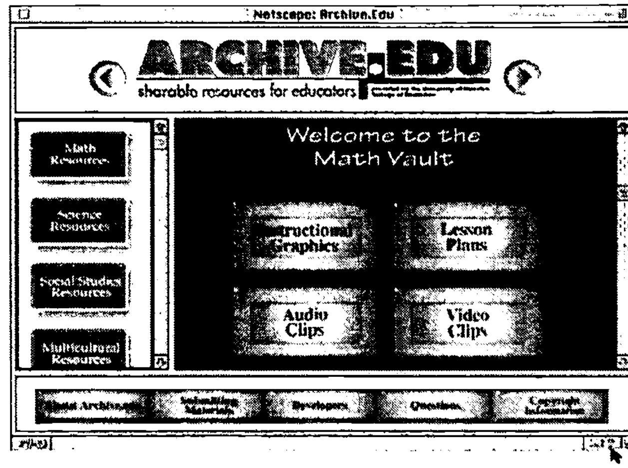

Figure 3. The Math Vault.

Within each vault, the following materials are available:

- Instructional Graphics - such as student-created maps, diagrams and charts
- Lesson Plans - such as instructional materials that describe ways to integrate technology
- Audio Clips - such as short interviews with professionals who use technology in their jobs
- Video Clips - such as short motion segments that demonstrate multicultural songs and dances
- Hypermedia Applications - such as a PowerPoint presentation on Graphic Design Principles
- Related Web Sites -such as NASA Web pages containing sharable images from the space program

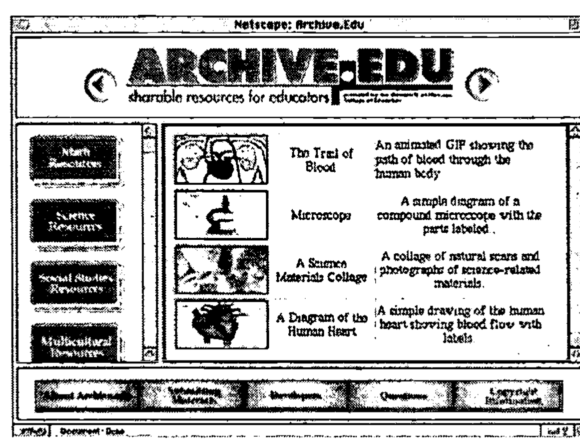

Figure 4. The Instructional Graphics Menu of the Science Vault.

The Technology Resources Vault contains those six choices plus two additional areas: 1) Research, which will include master's theses, doctoral dissertations, research papers, and works in progress, and 2) Tutorials, which might contain a presentation about adding sound to a hypermedia program.

A variety of methods can be employed by educators to successfully develop multimedia materials that are free from copyright restrictions. One such technique involves the use of digitizing student work to create graphic images. Teachers might have their students create their own drawings and paintings and then convert them to digital format. This can be accomplished using scanners, digital cameras, or video camcorders and inexpensive video digitizing cards available for a variety of personal computer platforms.

The work of teachers in Maryland's Montgomery County schools has pioneered this effort to use technology as an integral part of classroom activities and share their experiences with other educators via the Internet. Students in a fourth grade class designed a Web page based on self-portraits that the students created (O'Haver, 1996). Each student then wrote a paragraph describing themselves and explaining the setting of their portrait. A sound clip was also recorded and included on the Web page. This process demonstrates how educators and students can become multimedia developers and integrate customized images into their own hypermedia projects and share them via the Web.

Figure 5. Electronic Self-Portraiture Web Page.

Tutorials, Guides, and Step-by-Step Instructions

Tutorials and instructional guides for developing technology resources will maintain a strong presence on Archive.edu. One of the consistent findings of our interviews with prospective users of the archive indicates that educators would like to have access to materials that will help them become more proficient with educational technologies (Pinell-Joffrion 1996). Instructions for how to integrate technological resources into the classroom was also of interest to potential users.

A variety of research materials will be included in the archive. Doctoral dissertations, Master's theses, and scholarly articles that deal with the use of technology in education will be collected and categorized. In this way, a broad perspective on the use of new media by educators will be available in one common area on the Web.

Submitting Shareable Resources

To make Archive.edu a worthwhile resource, it is hoped that the Web site will also become a place where educators can submit resources that they and their students create and are willing to share with others in the educational community. The authors have begun this process by "seeding" the archive with a number of useful materials that have been developed by faculty, students and teachers from Houston area schools and universities. It is our hope that other educators from around the world agree that this method of sharing instructional materials is beneficial and can further expand the usefulness of the Web as a truly collaborative networked resource. Visitors to the Web site may find guidelines for submitting their materials at: http://www.coe.uh.edu/archive

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New Technologies for Digital Copyright Management

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The explosive growth of the Internet as a backbone for creative development and distribution has put the issue of digital copyright into the spotlight. Much of the debate surrounding the copyright protection of digital works has focused on the *distribution* side of information commerce, calling for technologies that achieve secure delivery and micropayment-based, metered use of content (Murphy, 1996; Cox, Tygar, & Sirbu, 1995). In the context of copyright management these are considered *strict-enforcement* methods.

The creators, owners and derivative users of digital content have begun to realize that the *production* side of information commerce is unique, with varied legal, business and technical requirements that may be ill-served or even hindered by strict-enforcement technologies. A new approach called *enhanced attribution* links multimedia content elements with complete, readily available, secure copyright data and specifically addresses the problems of the production environment (Erickson, 1996). The NetRights LicensIt technology, building on this concept of enhanced attribution, allows users of content to easily obtain copyright data and engage in online (and possibly automated) licensing by way of the digital content elements, directly from the context of the document or project in which those elements are being used. The LicensIt system addresses the need for a uniform, timely and persistent means of identifying digital content in the networked environment.

Industry analysts find this approach interesting "...because it is targeted at content creators occupying the middle ground in the copyright debate" (McKenzie, 1996). While acknowledging that some publishers are looking for "pay-per-view" technologies, a recent report stated that "[m]any others...(we venture to say the majority), are looking for a system that adds flexibility and openness to the traditional rules of exchange, without forcing them to simply abandon their works in cyberspace and hope for the best. LicensIt seems to strike this balance (McKenzie, 1996).

Internet: The Mixed Blessing

The Internet is about connecting people and sharing information. By its nature it has the potential to radically change the way new media is created and distributed. Creators are rapidly adopting the tools they need to develop digital content but have been slow to embrace the Internet as an infrastructure for collaborative development and product distribution. This is rooted in the fact that content owners and creators cannot usefully and persistently identify works in the digital, collaborative, networked environment. Without some assurance that their names, services and processes will remain associated with their work, and without confidence that they retain control of the rights to their work, creators of original digital content have been forced to orphan their work in cyberspace (Dyson, 1995).

Multimedia developers and other derivative users of digital content have a related problem: it is frustrating and expensive to locate, identify and acquire rights to content elements targeted for new productions and it is difficult to match the content requirements of projects with possible content providers. Until the development of the NetRights LicensIt technology, no regular, systematic method has existed for identifying works found on the Internet and obtaining detailed, current information about ownership, creatorship and licensing terms. Before LicensIt no solution existed that combined a means for free and unfettered evaluation of content with a system of persistent attribution and authentication.

Multimedia developers who choose to incorporate content elements created by others in their works are required to obtain authorization from a large number of creators and owners. For every work used there may be a different authorization mechanism in place — for some content direct contact with the creator may be appropriate while others may require them to do business with another rights holder or through a collective agency such as the Copyright Clearance Center (CCC) or the Harry Fox Agency. While this rights acquisition process may be expensive and time consuming, the absence of proper authorization for content elements used in a multimedia work may mean that the entire work may not be sold commercially (Gaster, 1995).

The essential balance that defines rights management in the production environment can be summarized by the following (Gaster, 1995):

- Multimedia products cannot be economically developed unless their producers are able to easily identify the holders of rights and appropriate negotiation and licensing mechanisms for content elements they wish to use.
- Holders of rights for multimedia content have an interest in effective systems for rights acquisition since such systems would increase the dissemination and use of their works.

There remains a paucity of substantive multimedia services directly available on the Internet. The cost of entry into the market for creators of digital content is lower than ever, and the Internet certainly promises low costs of distribution and collaboration. In the electronic marketplace wholly new categories of creators will have the opportunity to compete. But without a means to authentically associate content with providers, the risks for content creators outweigh the potential gains and growth in networked multimedia development will continue to be sluggish.

Rights Management: Where Are We Today?

Over the past two years much attention has been drawn to the dangers of copyright infringement on the Internet. Many organizations have produced reports that begin to explore the problems of copyright management on public networks and summarize certain proposed commercial solutions (Ebersole, 1994; Weber, 1995).

Debate raged throughout 1995 and 1996 after the introduction of bills in the US (National Information Infrastructure, 1995) based on the recommendations of the US Commerce Department's "White Paper," *Intellectual Property and the National Information Infrastructure* (Information Infrastructure Task Force, 1995). This period saw the launch of the Digital Content Rights Management Group (DCRMG), an inter-industry organization sponsored by the Information Industries Association (IIA) to consider standardization and business issues amongst vendors, customers and adopters of rights management technologies (Information Industries Association, 1995). These events have made it clear that rights management on the Internet is a huge issue, content creators and owners have a wide variety of requirements and ad hoc solutions are not sufficient.

The problem is fundamental: most of today's ad hoc attribution schemes and emerging document packaging technologies are *end-use solutions* that don't allow the Internet and a developer's creativity tools to work in synergy to lighten the rights management burden. Rights clearinghouses (Broadcast Music, Inc. (BMI), American Society of Composers, Authors and Publishers (ASCAP), CCC, and others) offer self-consistent points-of-entry for licensing works, provided those works have been clearly identified and are associated with those clearinghouses. Restricted access and encryption technologies offer a means for controlling access to a work but are not conceived with collaboration and derivative use in mind. Likewise, metering and subscription technologies are directed at end-use or consumer access, solving the distributor's problem of collecting payment for use without addressing the multimedia developer's production issues.

Most emerging technical solutions have little to do with collaboration and sharing, instead focusing on keeping information under lock and key. In particular, controlled access and metering approaches do not address the problem of enabling multimedia developers, editors and publishers to use the Internet to reduce the real costs of production: finding and identifying content, competitive and best-in-class contracting for new content, and rights acquisition. *The answer is rooted in the fundamental purpose of attribution: associating the people behind creative works with their content, wherever it may be found and however it may be used.* As technologies for expression evolve, so must our means of attribution; from this was born the concept of enhanced attribution.

What is Enhanced Attribution?

Enhanced attribution, the approach introduced by the NetRights LicensIt technology, bridges the gap between the creator and user by facilitating real-time rights transactions and other networked communications. Creators and owners may use the technology for tasks as simple as identifying a work and its creator or as complex and extensive as listing the variety of source works from which a derivative work is composed, all of the creative contributors and their contact information. It also allows the creator to affix a set of *minimum permissions* to a work, specifying activities for which rights transactions are not required (Erickson, 1995). Minimum permissions represent a unique, systematic way to provide for free and fair use.

When creators and owners use LicensIt to register new works, information about the work, minimum permissions and links to communications services may be associated with the work. As works progress through the creative process those attributes will likely change. Some, such as ownership and rights administration data, may only change at the registry (since the work itself has not changed). Modifications of the work or derivative works will typically require new registration

Any information that an owner or creator may associate with a work is accessible via the content itself. Enhanced attribution typically first becomes evident when a possible infringement occurs. For example, when an attempt is made to copy a work (e.g. dragging and dropping between applications or copying at the operating system level) the current ownership and copyright information may be displayed immediately. Through the same interface, the user may instantly review ownership details, examine minimum permissions for use and request permission for a specific use by e-mailing the rights administrator or completing an integrated electronic form.

The LicensIt interface enables the user to communicate directly with owners or creative talent using their current, preferred means of communication. This interface may be used to negotiate new licensing terms or to establish collaborative development arrangements. Eventually a worldwide network of LicensIt registration servers will enable searches for content and providers based on type of work, media, subject matter, or other attributes.

From the perspective of enhanced attribution, properties attached to data are *persistent*, propagating through the "family tree" of a work. As derivative works are prepared, the attribution records for source works are accumulated and become part of the final attribution for that work. At each stage of the project, licensing status and a complete list of source works is available. Since each record points back to a LicensIt Registration Server, rights management and licensing is made easy.

Enhanced attribution focuses on making compliance and related communications effortless, not on making cheating difficult. It is targeted at those honest, hard working multimedia developers and electronic publishers who spend a large percentage of their production costs in an effort to comply with copyright as they produce great works. Enhanced attribution makes ubiquitous on the Internet the ability to authenticate digital content and engage in real-time communications and rights transactions related to that content. With enhanced attribution, every work becomes a launching point for communication and commerce.

The NetRights LicensIt System

The NetRights LicensIt System is an Internet-based application that is built around the LicensIt Object and has as its major components the LicensIt Creator's Toolbox and the LicensIt Registration Server. Underlying components, including the LicensIt ActiveX Control and Shell Extension, enable LicensIt Objects to be viewed on target operating systems and from within a variety of applications.

Digital works created today become part of a worldwide content asset library. It is a library with no systemic organization and no clear entry point and is therefore difficult for developers to exploit. The application of enhanced attribution to digital content by way of LicensIt's packaging tools and the registration of works by authorized users on a network of registration servers will facilitate the location, identification, licensing and use of content worldwide. This network-wide collection of registration servers becomes a *virtual clearinghouse* (Greguras, 1995). Primary access to this worldwide virtual clearinghouse will be through content elements (packaged as LicensIt Objects) that appear on web pages, CD-ROMS and through other means of electronic distribution.

The LicensIt Object: A Uniform Package for Digital Content

In today's digital network environment, there is no way to uniformly represent content to applications. This means that creativity tools — graphics, sound, video, word processing, and multimedia authoring tools — must be shipped ready to recognize the wide variety of media formats that they may encounter, and in particular those formats that may be included as elements within compound documents, in multimedia presentations or on the Web.

This presents a significant problem for both the rendering of the content within a given context and for the storage and representation of the content element's metadata — the authorship, ownership, licensing, and other useful information associated with that content element. LicensIt packaging allows content of all types to present a uniform interface to host applications, relieving those applications from the responsibility of rendering all media types.

There must also be a way for creators and owners of content to uniformly store and later make available for use the volume of metadata that may be critical to that content's licensing and use downstream. Currently very few media types provide for any form of identification within their respective file formats. Fewer do it in a way that is flexible, allowing the owner to choose what information should be presented and how. And none do it in a way that allows the content element to provide its own interfaces and facilitate communications with its "home" (owner, creator, rights administrator or some other entity), regardless of its context.

The LicensIt Packaging Process

The NetRights LicensIt technology transforms flat content elements into LicensIt Objects through a process called packaging. LicensIt packaging involves the merging of content, metadata and user interface elements that will be presented to the user through a set of *property pages*. The layout of a property page is customized for the intended audience and expected use of the content.

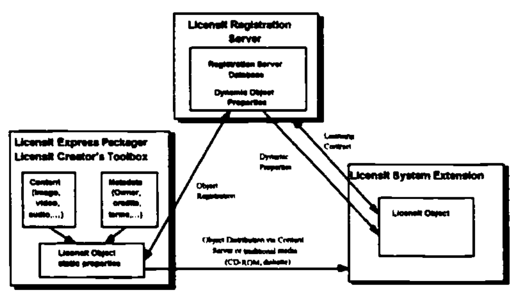

Figure 1. Components of the LicensIt System.

Typically the owner/creator will choose to attach a small amount of identifying data to the object, with the larger and/or most volatile data being supplied to the object from a remote registration server via the Internet. After their work is packaged as LicensIt Objects, owners and creators can be confident that potential users can always obtain up-to-date ownership, contact, and licensing information about specific content elements.

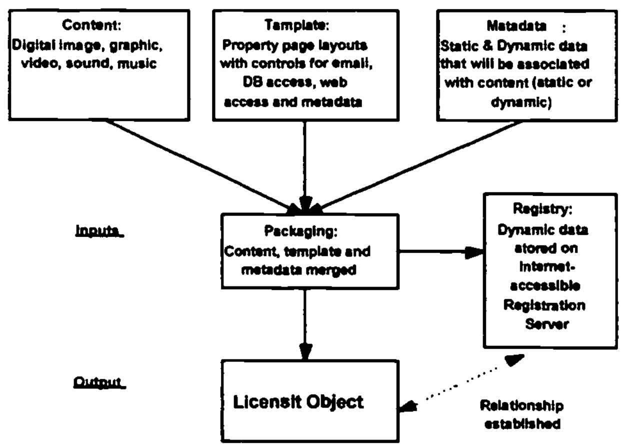

Figure 2. The LicensIt Packaging Process.

Customized Layouts with the Template Editor. The flow from flat digital content to LicensIt Object begins with the use of the LicensIt Template Editor. This tool presents an easy interface for designing sets of properties and property pages that organize the presentation of the object's metadata and buttons that initiate various functions of the object.

The Template Editor enables content owners to create layouts for property pages, placing various viewing and interaction controls on the pages. These controls may include *text fields* for static and dynamic data that will ultimately be bound to the object or stored on a remote server, *labels* for clarifying or identifying sections of the property page, *buttons* for initiating an e-mail or web access action, *buttons* for retrieving dynamic data from a remote server and other elements including illustrations, logos, or icons. Figure 3 shows an example of a LicensIt property page.

LicensIt Packaging. After creating the Property Page Template a user employs one of several versions of the LicensIt Object packaging tools according to their needs: the *LicensIt Creator's Toolbox*, the *Express Packager*, or the *LicensIt Software Developers Kit (SDK).* In each case the user of the packaging tool specifies a source content element (photo, sound, video, text, etc.) and a template to be used in the packaging process. The user then fills in any data required by the template. When all the data is supplied the packager, taking its basic instructions from the template, creates the LicensIt Object, binding static data to the content and automatically storing dynamic data on a designated server in the process.

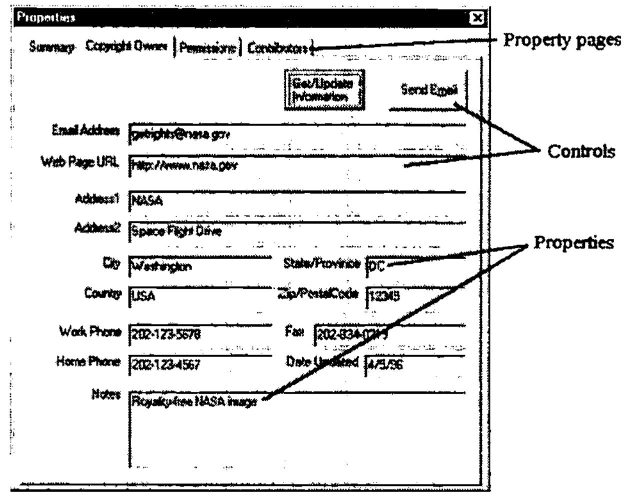

Figure 3. An Example of a LicensIt Property Page.

The *LicensIt Creator's Toolbox* is a graphical desktop tool intended for individual users who will package relatively small amounts of content. Users specify the source content file and designate the appropriate template using a familiar graphical user interface. The Toolbox provides a tabbed dialog metaphor through which the user enters required and optional metadata specified by the template. The Toolbox then updates the selected registration server with dynamic data, if any, and creates a LicensIt Object.

The *Express Packager* is a batch-oriented tool intended for packaging a high volume of content elements. The Express Packager operator specifies a set of content files, the template and a source of the required input data. The Packager automatically packages the content as LicensIt Objects.

The *LicensIt Software Development Kit* (SDK) is intended for applications in which LicensIt functionality is to be built into existing content production tools. The LicensIt SDK enables developers of third-party imaging and creativity tools to take advantage of core LicensIt functions by calling NetRights libraries through convenient COM interfaces or through more conventional C/C++ API calls.

Servers for LicensIt Registration & Rights Management

In the process of packaging an owner creates a *registered object* by communicating with a LicensIt Registration Server. Alternatively, the owner may prefer to create an *unregistered object.* In this case static information is bound to the content but there is no record placed on a remote registration server.

The LicensIt Registration Server provides the communications back-end to LicensIt Objects. Usually it is the creator of a Template who establishes relationships between dynamic data required by the LicensIt Object and the registration server. The registration server responds to requests from LicensIt Objects for specific elements of metadata that will be displayed on property pages or other data that may support functions such as e-mail or web site addressing. Requests from LicensIt Objects may also initiate transactions that involve interfacing to legacy business systems or financial transaction systems.

Responses by the registration server may involve queries to existing information and transaction systems. In this role a server may retrieve product information or pricing from a business system so that it can be displayed on a property page; it may receive an incoming payment request and submit it to a third-party payment handling system; or it may supply transaction activity data to an in-house marketing database.

Many institutional content owners will choose to have their existing business information and transaction systems inter-operate with a LicensIt Registration Server. Other customers, however, may opt for an all-LicensIt approach by choosing the LicensIt Rights Administration Server. The Rights Administration Server is a database containing document and business information and transaction rules pertaining to owner's distributed content, supplying this information to the Registration Server when requested by the LicensIt Object.

The LicensIt ActiveX Control & Shell Extension

Viewing LicensIt Objects, accessing the LicensIt property page interface and initiating other functions from the context of a container document or Web page require that the LicensIt ActiveX Control be installed on the user's system. Similar actions and other added functions at the shell level require the installation of the LicensIt Shell Extension. Both software components act as extensions to the operating system, ensuring that LicensIt functionality is available from within various applications and not just through an Internet browser.

The LicensIt ActiveX Control and the Shell Extension are compact, self-installing and freely distributed via the Internet. Users who come across LicensIt content but do not have these components installed are automatically prompted by the operating system, at which point certified copies are downloaded, installed and the LicensIt objects are displayed without rebooting.

Summary

The multimedia industry has waited too long for networked rights management solutions. Arguably, the tools and technologies should have evolved as the means for delivering information payloads evolved. Now is the time to provide attribution tools and technologies that support and extend creativity tools.

The value of networked communications will be realized when new media creators can supply new, original content with confidence, when consumers may readily access that work, and when commercial communication can easily take place between owners, creators, and potential consumers. Our belief is that those who deliver the means for enhanced attribution will go the farthest towards supporting this type of commerce.

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TEACHING: PARTICIPATING IN AND STRUCTURING DISCURSIVE NETWORKING

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DisNet (Discursive Networking) is the model of a database-centered environment that specializes in the generation and representation of contextual relations in a project. A contextual component is formalized by a multi-slot object-structure, called a "frame", which can be defined by the user. This strategy makes contextual relations between objects explicit on several contextual levels and thereby accessible to representational methods, referencing and differentiation. System functions are modularized in order to configure setups for different work situations and to support stand-alone as well as networked operation.

Two forms of Networked Learning are (1) collaboration (the idea to distribute tasks among peers), and a special form of collaboration: (2) role-playing (structured distribution of tasks). Both are discussed from the perspective of this environment. The functional relations between peers established in the working codex constitute an infrastructure, and its continuous (re-)definition can be seen as an essential part of a project. A condition for learning is the requirement to represent and make a context accessible on several levels, and to allow seamless switching between different types of interactions.

The initial idea of the "Discursive Networking" model has been developed and specified by Julean Simon and David Wohlhar,t and a minimal version of a "DisNet"system has been implemented as part of an educational, broadband-network research-project commissioned by the German Telekom in 1994/5. The project required the creation of a model of collaborative networking appropriate to pedagogical demands and study of the impact of the system on collaborative learning. Since then the model has been significantly reformed and extended by the author.

Introduction

The bi-directionality and network to network connectedness of the Internet is a fairly atypical result of coldwar-related strategic considerations of the US Department of Defense which usually supported uni-directionality, hierarchical order, and centralism. Nevertheless the net-structure happens to be the perfect basis for collaborative learning strategies. Since the net-structure is liberal enough to allow forming sub-structures of other logical types the dominant use of the Internet as a kind of a broadcasting medium obscures this potential of the net.

The appeal of the service-characteristics and businesscard-mannerism on the web also encourages old learning concepts (traditional courseware) to be decorated with the nimbus of the new packaging and delivery formats. The booming edutainment aspect of telecommunications is accompanied by the trend to monopolize and devalue notions such as "collaborative learning". Listening carefully we may find that "learner-orientation" occasionally means that the *business plan* is learner-oriented, rather than the learning strategy, or material.

On the other hand interesting and promising developments can be observed in the field of Computer Supported Collaborative Learning/Work (CSCL/CSCW) research and many other more or less obviously related fields. Synegetic effects can also be expected from recent developments of network-specific languages and development environments as well as of newer communication models (such as distributed, parallel processing).

Networked Learning

The term Networked Learning is introduced and given preference over others because it centers on learning and specifies the organizing structure (not necessarily the medium, application, or content type) in which it takes place. We tend to causally relate and colloquially identify learning with the teaching strategy, or the delivered material, but learning still is a cognitive process performed by the learner: knowledge is "actively constructed" (Piaget, 1973) in this process, rather then delivered to the learner.

Of course the learning situation (learning environment) has a more or less supportive influence on this process. In particular, environments that encourage and facilitate active involvement in the situation can foster learning because it is experienced directly and more intensively, because it can relate new experiences to known situations, and because it motivates students to activate their own prior knowledge. The learning situation therby functions as a scaffolding providing connection points for new contextual relations.

Setting up a collaborative experience (conventional, or networked) requires an educator to make decisions at least with regard to the following aspects:

- participant relation
- learning environment
- project organization and process
- context structure and differentiation

Participant Relation

As constructivist learning theories have emerged, common notions about the transferability of knowledge and the traditional roles of the student as a receiver, and the teacher as a mediator of established knowledge tend to become obsolete. From a constructivist viewpoint, knowledge seems to be acquired more efficiently and comprehensively in the social communication and interplay of self-responsible actors.

The functional relations between these actors constitute the infrastructure, and its (re-)definition can be seen as part of the project work. Apparently it is difficult for a teacher to find an appropriate position in this setup. S/he may play the role of a commentator (reflect actions), or moderator (direct the course of the collaboration), a motivator (support individual participants), or an agent provocateur (stimulate response), a translator (integrate different approaches, or work styles), a communicator (solve conflicts), an interface to sources, a provider of materials, or a real participant, with equal rights and duties. The teacher may also stay outside as an observer (not to disturb the collaborators with analyses), or an evaluator (grading), etc.

Note, however, that these types of participation are not reserved solely for the teacher. Students may play all of these roles as well.

Learning Environment

Some CSCL systems put a lot of effort into the creation of a realistic virtual space. Although it has some appeal to users (especially when they are not too comfortable with the system usage) this strategy dedicates most of the available representational dimensions to the representation of users and world metaphors. An additional spatio-temporal representation of knowledge structures often results in a mixing of representation metaphors. Our own observations indicate that a collaborative environment is established actually by characteristics of the communication between peers. The environment provided (representational, topical, logical) serves as a scaffolding.

Project Organization and Process

Usually a significant portion of project work has to be dedicated to its own organization. Setting up the context of a collaboration is an ongoing process throughout a project; it concerns the establishment of work standards, rules and conventions, the (short/long-term) goals and evaluation criteria, the definition of interfaces between collaborators, the selection of methods and strategies, and many implicit decisions with unforeseeable consequences; these parameters have to be negotiated and (re-)evaluated in praxis. This meta-discourse establishes the "axiomatic" basis of a project and should - especially in a learning project - neither be shortcut by using predefined conventions or treated as external to the project.

Context Structure and Differentiation

The structuring of context is influenced by the subject matter as well as by the project setup, the chosen working methods and strategies, and also by the form and logistics of storing and representing material in the project space (e.g. organized threaded-topic, or hypertextual). The granularity of contextual units determines the "interactivity" of a context and it sets, to some degree, the possibilities and limitations on interactions (such as commenting, referencing, differentiating, reusing, rearranging and extending contextual components).

DisNet, Outline

Any discourse defines by its discursive rules what can be said and what is reasonable to say (Foucault, 1974). Discursive Networking is a discourse-model based on the idea of organizing (group-)work as a rhizomatic (Deleuze, Guattari, 1980) networking of discursive actions creating a knowledge map, called a "contextual network." Formally a discourse is the interaction with the context it generates (rather than with the peers).To a certain degree the discursive rules are established within the discourse itself, which makes it a recursive, dynamic system: every interaction differentiates the context, and the context determines the differentiating potential of an interaction.

DisNet is the model of a database-centered environment that is specialized for the generation and representation of contextual relations in a discursive, or productive project. A contextual component is formalized and instantiated by a multi-slot object-structure, called a "frame", which can be defined by the user. This strategy makes contextual relations between objects explicit on several contextual levels and thereby accessible to representational methods, referencing and differentiation.

System functions are modularized, in order to configure setups for different work situations and to support standalone as well as networked operation. The approach conforms to the basic idea of hypersystems (Delany, Landow, 1990; Kuhlen, 1991; Cordes, Streitz, 1992) in that it allows us to represent context as a linked, nonlinear knowledge structure integrating multiple data types. While conventional hypersystems focus on representing and browsing preproduced material DisNet is a generative system. (For a more detailed description of the system and its use, see (Simon, Wohlhart, 1996; Simon, 1996.)

Object Structure

While the information-unit (node, card, page, site) in hypersystems usually has a header-body document-structure Disnet uses the frame approach. Besides selecting from obvious slot-types (such as creation-date, author-name, object-title, content, content-type, source, link-type, object-size, status-flags, object-representation, object-behavior, etc.) the user may define slots that make any contextual property explicit that s/he regards as essential with respect to the requirements and the scope of the project.

Contextual components with frames that share slot-types have a relation in that they are comparable; components which have the same value in corresponding slots belong to a context-class. The relation of the content-slots of objects may be made explicit by determining the link type (Rittel, 1980; Conklin, Begeman, 1989) in the link-slot. Also, another slot may describe the type of speech act (Austin, 1962; Searl, 1969) a component represents in its local context.

Database Organization

The core of the system is a database organized as a *tuplespace* (Carriero, Gelernter, 1988). In particular, it is a distributed, object-oriented tuplespace with a special instruction set. A tuple contains a reference to (a tuple that determines) the frame-type of the object and the corresponding slot-values (which may be references to other tuples). The main methods are matching (template-tuple, slot-value, value-value) and compression (substitution, optimization).

The tuplespace model has been chosen to de-couple data from an address-based organization and to thereby allow the database to perform internal restructuring. Another reason is that a collaboration in many aspects resembles parallel processing and that a collaborative environment has to provide solutions for similar problems. The tuplespace model is based on the orthogonality between creator and receiver, creation and usage: in the process of a collaboration the relations and function an object may have at a certain time in a certain context change - the way an object is integrated in a context should not preclude its relevance in another context. Object orientation allows us to apply methods without regard to the particular structure of an object. These methods are realized as tasks (such as search, filtering, version management, synchronization, access control, data transfer, representation, etc.) which are controlled by user interfaces.

Domains of Interaction

The user-interface is de-coupled from the database (Model-View-Controller paradigm). It is modularized, so in fact several modul-families are provided for particular domains of interaction and may be combined at will. The idea is to provide a construction set to allow the user to construct interfaces for special requirements. In the following only two of five currently specified domains of interaction and only essential aspects with regard to the scope of the paper will be described.

JECTOR. JECTOR is the obJECT browser and editOR for displaying and editing slot-values of an object; it allows users to browse through a project on the basis of relations between objects and slots.
The JECTOR-prototype consists of several fields and two popup menus; one to select a slot from the slot-list, the other to navigate to the same slot in another object. A slot can be assigned to a field. Usual GUI-features such as drag and drop, multimedia capability, context-sensitivity, etc. are provided. When the object that defines a frame ("configuration object") is selected by the JECTOR it allows users to configure the frame (edit the slot-list). The selected slot-name is displayed in the active field and can be edited, the order of slots can be determined, other frames can be referenced.

Several JECTORs (a family) have been designed to suit particular project-settings, or use cases (stand-alone, network-enabled, personal organizer, etc.). The figure below shows a JECTOR as a web-browser. It combines web-related features with that of DisNet. It can be used to script and display HTML-documents in a single application, to excerpt a web-page (field3), or include it into a DisNet-project.

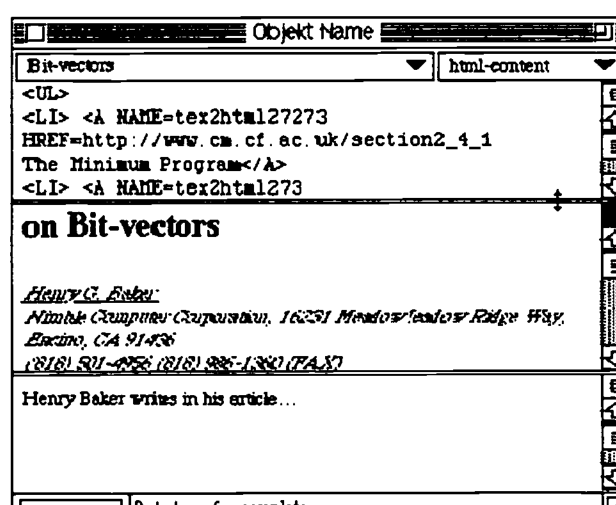

Figure 1. JECTOR on the Basis of a Web Browser.

STRUCTOR. The STRUCTOR is an interface which graphically represents a project's object-structure as a knowledge map, or semantic network. The structure can be represented in a 2D-, or 3D space. Objects are represented by graphical images (icons, 3D-objects) that carry a label, are connected by links and that may have behavior. The space can be navigated and objects can be manipulated. Clicking an object opens it in a JECTOR [Simon, 1996].

Object-behavior, Scripting

The system has the potential to actively participate in the collaboration by executing scripted object-behavior; e.g. the positioning of objects in the representation space, or of tuples in the tuplespace is controlled by constraints the system seeks to satisfy. Background-matching uses idle-time for matching slot-values and proposes found matches to the user and thereby supports relating and compressing redundant data/structures. Another feature lets the system form questions on the basis of production rules, using slot-values. The purpose of this feature is to motivate the user to reflect the project-work.

Collaboration Strategies

Several aspects of collaboration that emerged in the course of our project will be described as well as strategies that are supported well by the proposed system. Some teachers in our project thought of collaboration as a supplement of their lectures much in the way textbooks provide questions at the end of a chapter. Assignments could be solved collaboratively. More interesting is the reverse approach: pose the problem to a group and supply specific instruction and references when needed. The teacher may operate from the perspective of a participant, using the same interactional infrastructure, and manage with the same rights and functional possibilities. The student should be able to apply the same operations, or strategies the teacher used.

Another approach involved introducing new concepts on the basis of a learner's own attempts to solve a problem. New concepts are more easily understood when they relate to problems or questions already conceived. This approach allows users to more specifically adapt the scope and presentation of a new concept to a learner in a non-trivial and personally meaningful way.

Another application of a scaffolding strategy concerns the structuring of the project-space, which can be used to initiate, direct and control the course of the project work. This would not be done, however, to accomplish the traditional goal of having the teacher define precisely what is to be done as well as when and how. Instead it is a way of providing some preliminary structuring of the problem-field by means of questions, projections that provides a beginning point and helps learners define and formalize the problem for themselves.

A special form of collaboration, role-playing, can also be supported. Role-playing is a strategy to delegate partial responsibility to and thereby motivate individual collaborators. It requires users to organize his or her infrastructure and gain special competence; it may increase productivity by specialization (essential for structuring a project); it may improve group dynamics and foster respect for different approaches and integration of different work-styles. Role-playing adds playfulness to the characteristics of collaboration.

In the educational context, it requires special effort to define the roles, their interrelation and interfaces. The moderator-role has been observed to be counter-productive by some, in that it hinders self-organization; it is a good candidate, though, to be distributed among all collaborators so that every one moderates the actions related to his or her special role.

Learning does not only concern the acquisition of first-order knowledge, but also of meta-knowledge, such as determining the core of a statement, analyzing and structuring context, representing contextual relations, or social aspects of a collaboration. The meta-discourse of a project concerns two major aspects: the negotiation of the project organization seen from a general perspective and the discussion of local questions from the perspective of the particular work situation.

Both, the continous (re-)evaluation of rules, conventions, work methods, strategies, coordination of tasks, interfaces between roles, as well as the continuous monitoring and questioning of the current collaborative interactions significantly supplement the topic-related (first order) actions and should be performed within, and integrated into, the project-space to naturally involve participants in a collaborative process and stimulate a differentiated understanding of this process (first-order- and meta-knowledge cannot be clearly separated, anyway).

The information-delivery approach of conventional teaching emphasizes the delivery of the same content to all members of a group of students, who usually receive the content at the same time. Many multi-user systems used in education also adhere to the postulate that all participants should, at a given site and time, see the same world represented. Assigning priority to this kind of consistency favors a hard-wired, global worldview with the characteristics of a broadcasting medium.

There are cases where global synchronization is appropriate and efficient, but there are many situations where that is not the case. In DisNet, representation is first a private task of the client that can be made subject to diverse manipulations according to a user's wishes and needs. Of course a collaboration system must be synchronizable, but selectively and on demand. The standard communication between peers can be reduced to the exchange of a Compliance Code that contains information about system states and configurations. "Synchronization on Demand" extends this concept in that it suggests that - not only for efficiency reasons - synchronous collaboration (conferencing) should be embedded in an asynchronous environment.

Summary

It is well understood that an essential condition for learning is to represent, and make a context accessible on several levels and to allow seamless switching between different types of interactions such as orienting, editing, browsing, and restructuring. DisNet provides domains of interaction on different levels of a project and encourages their modification. The frame-base object-structure has the effect that objects are related to other objects on different levels. This feature supports a Stratification of Context and provides multiple-level operability.

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THEORY

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This section of the Annual has never been large, but it has traditionally dealt with broader conceptual and theoretical issues that have widespread implications. Whether that is good or bad depends on your perspective. Some readers avoid the entire section on the assumption that they are practitioners and theory only gets in the way. Others see theory as the critical heart of education and may read a theory paper far more readily than papers in other sections with "practical" titles.

Actually, none of the eight papers in the 1997 Theory section really fit either of the two extreme characterizations of "theory." For the most part these papers are about real world issues that are important to most of us. They deal with the point of contact with reality, "where the rubber meets the road" so to speak. But, they do not focus exclusively on the details of a particular problem or issue. Instead, the papers attempt to pull back a bit and take a more conceptual view, or look at an issue from within a particular perspective or theory. We think you will find these papers both worthwhile and useful, regardless of your predilections toward "theory."

The first paper, by Patsy Clarke and Mari Pete from Durban, South Africa, presents the ubiquitous burger as a metaphor for thinking about educational software evaluation. Their paper is both an example of the use of metaphor and allegory to address significant professional issues, and a thoughtful approach to an important task, thinking about evaluation. This paper looks at evaluation at the level of a single software product. Another paper, by Szabo and Poon, addresses a more specific issue, the use of visuals in computer based instruction and testing.

William Rosener's paper has no food analogies, but it does address another important issue: technology diffusion in teaching in higher education. Rosener discusses the shift away from lectures as the primary means of instruction in education and the critical role technology can play in supporting alternative approaches to teaching and learning. His main focus, however, is on the reasons why adoption has been less than spectacular thus far. The final section of his paper offers some suggestions for improving the rate of uptake of technology among college faculty.

If Rosener's paper is about the social technology of diffusion, then the paper by J. Caviedes and colleagues at Phillips Electronics and the University of Pittsburgh is about both the instructional theories of distance education and the technical infrastructure needed to support it. This article addresses two critical areas: 1) the alternative models of delivering instruction at a distance, and 2) an environment created to support group distance learning that includes problem based learning. This article shows clearly how the type of teaching and learning activities planned can influence and guide the creation of the technology support environment needed.

Linking a social or educational theory with a question about technology is also at the heart of the next paper. A British paper, by Loveless, Longman, and McDonnell looks at the match, or lack thereof, between what it means to be literate in a modern, information-intensive society and the type of experiences students receive in schools today. Within this framework they look at the question of what types of teacher training and support are needed if schools prepare students for today's society. The authors use a project at the University of Brighton to illustrate the points they make. In their paper, Blomeyer and Clemente also point out that the concept of what it means to be literate has changed and the change has significant implications for how we prepare teachers. They look at the issue through the lens of change theories, particularly those of Rogers and Fullan.

The final papers in this section have the same format. They all look at an issue in technology and teacher education from the point of view of a particular theoretical framework. The paper by Rodriguez considers implications of constructivism for teacher technology training;

Hutchinson looks at the implications of Gardner's multiple intelligences for instruction in K-12 education while Sweeder, Bednar, and Ryan consider the implications for teacher education. Finally, Gannon Cook discusses semiotics, particularly the theories of Vygotsky, as a framework for thinking about society. Finally, Sianjina looks at issues in the preparation of school administrators in the area of information technology, and Pari discusses the use of learning tools in Argentinian education.

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The KwaZulu Concept Burger : A HyperText Concept Map of Educational Software Evaluation

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The KwaZulu Concept Burger is a co-operative, culinary delight conjured up by Marí Peté, Patsy Clarke and Ari Naidoo. They form a threesome home group of distance learners, reading for a master's degree in education, specializing in computer-assisted education (CAE). In essence, the "Burger" is a metaphorical representation of the concept, *Evaluation of Educational Software,* in the form of a hypertext concept map. It is presented in HyperText Markup Language (HTML) format and can be viewed with a World Wide Web (Web) browser on the Web at *http://www.und.ac.za/users/clarke/kzb/concept1.htm.*

Why Construct a Concept Map of CAE Software Evaluation?

CAE presents potential advantages for South Africa, where an educational priority is to improve learning environments. Advantages include multiple access to learning materials, reduced learning time, instructional consistency and increased motivation (Craig, 1995).

Educators who become engaged in the use of CAE are inevitably involved in evaluation: summative evaluation, conducted during the selection of programs from the existing commercial market; and/or formative evaluation, a cyclical process during the in-house development of software (Hannafin & Peck, 1988). Regardless of the form of evaluation, it is important to make informed decisions based on more than intuition.

It is therefore important to develop a thorough understanding of all aspects that need to be considered during either type of evaluation. To this end, constructing a concept map was considered an effective way of making complex information regarding evaluation theories and techniques more palatable and digestible to learners and educators.

The Medium: Why the World Wide Web?

The three distance learners from Durban work at three different educational institutions in KwaZulu-Natal and study part-time at the University of Pretoria in the province of Gauteng. One reason they opted to exploit the World Wide Web was to facilitate the speedy delivery of the concept map to their lecturer's desktop on the other side of South Africa, 700 kilometers away.

In addition, the Web has proved to be useful both as content provider and delivery medium to reach a growing number of "Burger" users beyond the original target. The Web has also made it possible to update the "Burger" regularly in response to feedback from these "Burger" users and the expanding knowledge bases of the authors.

The concept maps that were devised by other students as part of the same project were either in the form of placards or physical three-dimensional models. Although all were valuable representations of how the concepts relate, they were not easy to adapt in response to feedback.

HyperText

HyperText is the default text medium of the Web. Fortuitously, hypertext facilitates the following aspects of constructivist learning theory:

- presentation of multiple perspectives;
- learner control;
- facilitation of non-linear and multi-dimensional traversal of complex subject matter ; and,
- linking and making connections between subject components (Mc Manus, 1996; Ross, 1993; Spiro, Feltovich, Jacobson and Coulson, 1991).

Bloom's taxonomy of the cognitive domain consists of the following six levels: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, Engelhart, Furst, Hill, & Krathwohl 1956). Ross (1993) suggests that hypertext could be used as a resource to facilitate the realization of learning objectives belonging to each of these categories. He indicates how various HyperText models correspond to the six levels:

Table 1.
HyperText and Bloom's Taxonomy of the Cognitive Domain (Ross, 1993)

Bloom's Taxonomy	Learner Skills	Correlating Hypertext Models
Knowledge	Identify, specify, state	Single frame design
Comprehension	Explain, restate, translate	Linear
Application	Apply, solve, use	Jump Linear
Analysis	Analyze, compare, contrast	Tree
Synthesis	Design, develop, plan	Network
Evaluation	Assess, evaluate, judge	Highway

The home group opted for the Network design which corresponds with Synthesis in Bloom's taxonomy, (see Table 1). Network design presents granules of information in hyper-linked format, allowing learners to discover information in their own order and to synthesize their own understanding. As learners who browse through the HyperText burger may come from different backgrounds and institutions with a variety of implementation needs, it was decided not to impose a definite order of learning, but to let them develop their own schemas through discovery learning.

The Method: Why a Burger?

"Metaphoric and allegorical thinking draw on models to interpret the world and to infer and even create relationships that may not be obvious" (Viau, 1994, p.10). To the authors the layered structure of a burger paralleled the way in which they envisaged the hierarchy of evaluation concepts (see Table 2).

Furthermore, during the period when the designers were constructing the KwaZulu Concept Burger, a hamburger franchise company opened their first branch at the southern tip of Africa. This event made the burger "flavor of the month" and an appropriate metaphor which enabled its designers to express their view of the topic in an accessible way.

Theoretical Underpinnings of the "Burger"

The foundations of the multi-dimensional model suggested in this paper are the pedagogical and user-interface dimensions suggested by Reeves (1994). Reeves' dimensions provide systematic guidelines which enable educators and trainers to see through software vendors' marketing ploys in order to establish whether products are educationally sound.

According to Reeves (1994), pedagogical dimensions are those aspects of the design and implementation of CAE that directly affect learning while user-interface dimensions deal with aspects of CAE that ensure the learner can engage in meaningful interactions.

Table 2.
Hierarchy of a Selection of KwaZulu Concept Burger Ingredients

Ingredient	Function	Aspects of evaluation
	Pedagogical Dimensions	
Bun	Context /cohesive force that encompasses all and holds it together	Evaluation model e.g. qualitative, quantitative and other paradigms
Patty	Core / the main ingredient	Evaluation matrix Juxtaposes the questions to be asked during the evaluation and the techniques chosen to elicit the answers
Other Essential Ingredients		
Cheese		Objective setting
Tomato		individualization
onion		evaluation team
	User interface dimensions	
Extra Zest		
Salt		Menus and icons
pepper		screen design and interaction
vinegar		color

Make a Meal of Your Metaphor

The authors consider that the development of the "Burger" has been effective for their learning as it evolved from a process of negotiating meaning through co-operative learning.

Since the first version of the KwaZulu Concept Burger in February 1996, it has been transformed continuously and become more multi-dimensional as ingredients and condiments have been added in response to feedback from other learners and practitioners.

As suggested by Viau (1994), the effectiveness of the constructivist process has been enhanced by on-going evaluation, challenge, criticism and transformation which has prevented the metaphor from becoming static and losing impact.

This refinement process has facilitated the authors' deepening understanding and internalizing of a wide range of evaluation theories and techniques. The result has been successful transfer of knowledge and application in their practice.

The authors acknowledge the facilitative role of the World Wide Web in this learning process.

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EFFECTS OF VISUAL AND NON-VISUAL TESTING ON IDENTIFICATION, TERMINOLOGY AND COMPREHENSION LEARNING

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Desktop visuals are now easily created and accessed in computer-based instruction and increasingly in testing. Research on the use of visuals in instruction is rather extensive, but there is little in the context of computer based instruction (CBI). There has been little investigation of the effects of visuals in testing on the effectiveness or efficiency of learning outcomes. This experimental study was conducted to assess the effectiveness of using visuals in testing when the instruction employed multimedia forms of instruction.

In a study on visual testing in a non-CBI environment, Szabo, DeMelo & Dwyer (1981) found that students who received both instruction and testing with the same visuals learned more than students who received visual or non-visual instruction and non-visual tests. Szabo & Schlender (1996) found that testing procedures which included animation reduced learning, compared with students who received testing using static visuals. If visuals do not change with time or location, they are said to be static visual displays (SVD). Conversely, if motion or change with time is involved, they are dynamic visual displays (DVD).

We located nine studies on visual testing which examined different levels of achievement; achievement being delineated as identification, terminology and comprehension. Two of these studies (Dwyer & DeMelo, 1984 and Dwyer, 1986) showed visual testing had a significant effect upon all these levels. In the remaining studies, three find effects for identification (only) two for terminology (only) and three for comprehension (only).

Different studies used differe nt operational definitions of visual testing and visual formats, making comparisons across studies somewhat difficult. There were also variations across studies between the number and kind of visuals used during testing and instruction. While the results of non-CBI studies are helpful, the use of CBI adds unique elements to testing in its ability to add dynamic visual displays and allow students to repeat all visuals during testing. The results to date suggest that visual testing presently results in elevated skills of identification, while effects on terminology and comprehension are less clear.

Theories With Relevance to Visual Testing

In 1973, Tulving & Thompson suggested that the presence of identical cues during the instruction/acquisition phase of learning and the testing/retrieval phase results in stronger recognition memory. They called this the encoding specificity hypothesis. Earlier, Glanzer & Clark (1963), at the height of the information-processing theories of image acquisition and storage proposed that all information was transformed and stored as a series of words. In contrast to their verbal loop hypothesis, others suggested that in the case of DVD in instruction, studies which employed a structured behavioristic approach yielded more significant results than studies using a cognitive orientation. If true, would the results hold for visual testing as well? The instructional implications across the theories is not clearly delineated.

Paivio (1986) proposed the existence of two separate cognitive subsystems for representing information, one verbal and one non-verbal. Although separate, these systems can be combined and if information is presented in both visual and verbal formats, stronger learning should result. Paivio refers to this as the dual-coding hypothesis.

Several other theoretical positions with bearings on visual testing have been put forward. One theory argues for the importance of a relationship between acquisition and test situations, observing effects for the similarities. This is referred to as the transfer appropriate principle (Morris, Bransford, & Franks, 1977).

Methodology of the Present Study

A multimedia training lesson for Emergency Medical Responders covered the anatomy and physiology of the pregnant female, stages of labor, and preparation for imminent delivery. This field experiment examined visual testing effects on identification, terminology and comprehension skills. The 62 subjects were randomly assigned to a visual testing or non-visual testing treatment. The latter consisted of standard tests while the former included static visual displays drawn from the dynamic visual displays used during instruction.

Findings and Discussion

The visual testing group outscored the non-visual test group on the identification subtest but not on the terminology or comprehension subtests. The finding of significant effects on identification and not the others suggests that visual testing in CBI has similar outcomes to non-CBI studies cited earlier. Perhaps identification, a visual task involving discrimination based on distinctive visual features, is enhanced by graphics at the time of retrieval. Several plausible explanatory hypotheses for further research are discussed below.

Years of non-visual testing may have handicapped learners when it comes to the use of visuals, and retraining or re-orientation will be needed. This is suggested by the research done by Szabo and Schlender (1996) in which student performance in visual tests which included animation was lower than in visual tests using only static displays. Just as students require practice and coaching in non-conventional instructional practices, they may need practice in effectively using visuals during testing to be able to retrieve information.

Related to this is the expectation that classroom performance rarely employs visuals or which employs visuals in a supplementary role to the non-verbal, textual mode of testing. Students' can rely on non-visual cues when being tested academically. A test of this hypothesis would employ the criterion of actual or simulated performance in realistic environments where conventional paper and pencil assessment is not used. Given the performance-oriented nature of emergency medical responders, it is suggested that a further study using performance as the dependent measure be used.

Another possibility is a ceiling effect which limits variability in scoring and thus masks any chance of differences in treatment difficult to be observed. The ceiling effect stems from the high scores required to continue in the program due to a mastery orientation and the meeting of rigorous certification standards, and the high levels of competence needed to preserve human life. It could be argued that students in this study used every strategy available to them to perform well, including visualization and the use of text and visual materials.

The role of overt performance may have a bearing on the situation, where students are able to click and drag, replaying the visual several times, and engage in other overt activities. Perhaps these activities zero in on the identification tasks over the more covert mental tasks associated with acquiring terminology and building comprehension.

Redundancy might also be a factor. Do the non-visual portions of the test communicate or elicit the learning to such an extent that the visuals' added contribution to learning is minimal? Should we test this by conducting research using tests in which no verbal cues are present? This could be argued on the basis that often an EMR professional must deal with non-verbal patients and have to rely extensively on visual cues.

The nature of comprehension may demand more sophisticated forms of visual representation than possible through the use of static dynamics. Perhaps animation would be a more appropriate and fruitful tool to use to assess comprehension skills levels. Students would have to be taught and practice how to extract desired information from the irrelevant cues which may be present in animations, as well as from static graphics.

What is the relationship between the visuals used during instruction and those used during testing? Does it matter if those sets of visuals are identical, similar, or a subset of one another? Must they be present in equal amounts? This latter case is unlikely given the greater length of time spent in instruction compared with testing, with the opportunity for more exposure to a greater variety of visuals in the former.

Concerning practitioners, should expensive visuals be created for learning and testing when the benefits over simpler visuals is an unknown quantity? Should the publishing houses continue to spend heavily on graphics-oriented programs to the exclusion of graphically oriented exams? For theoreticians, this study provides findings which should be factored in to the development or refinement of any theory related to how the mind captures, represents, and preserves visual and non-visual information.

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An Overview of Information Technology and How to Promote Its Adoption

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Information technology presents a critical challenge for colleges and universities. With the rising costs of higher education and the declining quality of graduates, information technology may present a more effective and lower-cost form of instruction (Burke, 1994). This technology has the potential to transfer the mode of instruction in tomorrow's classrooms. Instead of lectures being the predominant mode of instruction, computers and multimedia presentations could augment or even supplement the lectures and redirect the responsibilities of learning to the student. While few people doubt that information technology can enhance teaching and learning, there seems to be missing a sense of urgency to quickly integrate this technology into the classrooms. This paper will examine why this technology has not been as rapidly adopted into the educational arena as people initially expected and discusses steps which can be taken to successfully promote its adoption.

The phrase "Information Technology" (IT) will be defined throughout this paper as: the use of computers, communication networks (including the World Wide Web, also described herein as Web), and audio-visual equipment to help transform the technology of instruction. The definition of IT varies slightly from one article to the next and is sometimes described using one of the following phrases: academic technology, computer-assisted instruction, computer-based training, educational technology, and instructional technology. In this paper, the term IT encompasses or represents a combination of all of these technologies when used to link teaching with learning.

To better understand the reasons behind information technology's limited use and how best to promote it, an overview of this technology will be provided. This overview will include a discussion of how best to develop and implement IT and the benefits and costs associated with this technology.

Implementation and Development of Information Technology

Should IT augment or supplement the traditional method of teaching? This answer will vary depending on the subject area being taught. In areas where the subject matter focuses more on value, meaning, and philosophical ideas, IT will only partially be able to substitute for human interaction. In these areas, IT will, at best, be able to augment or enhance a student's experience; however, in areas which have a high volume of students, standardized curriculum, and factual content, IT will more likely be able to supplement the curriculum and teaching technique. Furthermore, we must continually remind ourselves that technologies such as IT should only be used when they provide new opportunities for students to visualize and understand material.

When creating IT lessons and presentations, it is important to not just computerize or digitize the methods and materials of instruction, but rather investigate how value can be added. To exploit this technology, every attempt must be taken to innovatively reconceptualize new information, not just repackage old information. For example, by just taking a textbook and making it available on-line is simply repackaging old information. Instead, studies and research should be performed to investigate how textbooks can be reconceptualized so that students are not just memorizing information, but rather are engaged in an activity which promotes a deeper understanding of the subject matter.

Who should develop IT? First and foremost, students must be involved in the development of any IT since they are the real experts on what does and does not work. The students should be able to continuously provide feedback to help separate the methods which are successful from those which are not. Student involvement is essential in the development of effective IT.

Secondly, should universities and colleges or should publishers be developing IT? The research has reported that the best approach to IT development involves some form of strategic alliance with higher education and textbook publishers (Stewart, 95). When universities and colleges develop IT in collaboration with publishers, the 1) costs tend to be lower, 2) a more open architecture is created, and 3) a more global representation of the subject material is conveyed.

Benefits and Costs

There are many benefits and costs associated with IT that must be considered when evaluating the overall effectiveness of this technology and the reasons for its limited use. Listed below are some important considerations which must be addressed. For each of these issues, both the potential gains and loses will be examined.

Quality of Learning

The scale used to judge any teaching technique must first consider how the quality of learning is affected. A good approach towards teaching will promote a deep understanding of the subject matter, encourage students to comprehend and synthesize information, and help students improve their written, oral, and critical thinking skills. Many studies have found IT to be as good as, or better than, traditional approaches (Alexander, 1995). These studies have shown that information technology:

1. increases motivation;
2. permits self-paced learning;
3. alleviates computer anxiety;
4. provides instant feedback;
5. encourages self-directed incidental learning; and,
6. provides students with greater control over their own learning.

Well-designed IT allows information to be presented in a user-friendly, easy-to-understand, and visually-simulating format by combining graphics, audio, and video. Lessons which incorporate IT can have an enormous advantage in the educational world since research has shown that people, on average, remember less than 20 percent of what they read; but, they will remember up to 80 percent of what they see and hear (RAD, 1995). Hence, information taught using IT should more likely be remembered.

However, a point that is rarely discussed is that the learning gains can almost completely diminish when the same instructor teaches both a course using IT versus their traditional approach (Alexander, 1995). These results indicate that the learning gains are more likely due to the instructional methods used and not because of the technology; therefore, by simply transferring information from one medium to another, it is possible that no improvement will occur in the quality of learning.

Lesson Preparation

One disadvantage of IT, is the high cost associated with curriculum preparation. While a proliferation of commercial companies are developing lessons for some of the general curriculum courses, most instructors prefer to prepare their own lectures. Preparing multimedia lessons can take significantly longer than traditional approaches such as preparing overheads. This is because instructors must not only create and find materials, but they must also learn new software packages and best determine how to use this technology. Understanding this technology and how to use it can be a very time-consuming process in itself. Furthermore, because most instructors are not trained in creating IT, there is no guarantee of its quality.

On the other hand, lesson preparation offers two of the biggest potential gains to IT. These two advantages are economies of scale and mass customization. Economies of scales implies that after a substantial initial or front-end financial investment, the average cost of usage for additional students decreases. Mass customization allows IT multimedia lessons to accommodate differences in the learning styles and abilities of students. At the same time, new software is being developed which makes it easier to create a complex multimedia environment. Adding movies, sound clips, or other powerful audio-visual materials is now easier than ever.

Bonds Between Students and Faculty

Powerful bonds are often created between students and faculty members, especially at the graduate level. These strong relationships and the invaluable advice which stems from them can have a profound influence on a student's professional development. If these bonds fail to exist under information technology, then it must be questioned as to whether a good foundation for teaching can prevail. However, most initial research has shown that even greater bonds can develop under IT, since faculty spend less time disseminating information and more time advising and collaborating (Dwyer, 1993). On the other hand, some of the bonds between students and faculty may be undesirable. For example, an apathetic teacher who teaches out-of-date information from faded notes may be cheating the students of their due.

Limits of Time and Space

One advantage of information technology is that it can help ease the limits of time and space. When using IT in distributed environments, learning becomes easier and students are provided more freedom as to when and where they are able to work. However, for a student who is lacking connectivity or equipment, the limits of time and space are constrained. To these students nothing could seem more portable than a textbook as they study while doing their laundry!

However, textbooks also have their limitations. For example, textbooks can quickly become out-of-date and often fail to integrate meaningful discussions and explanations with the facts; furthermore, having to use a textbook's linear index to lookup information can be a tedious, time-consuming approach.

Complex Material

In the IT environment, many students find note taking a more difficult process. This is mainly due to the great deal of intangible information in the form of sounds and visuals which are incorporated into these presentations. It has been argued, that while photographs provide a great deal of information, much of the visual data is unrelated to what the student needs to grasp (Pence, 1995).

One simple solution to the note taking problem is for faculty to use less complex images or provide students with hard copies of the lectures. However, this perceived shortcoming of IT may really be a strength. It will force tomorrow's students to learn how to digest complex images.

Hypermedia

Another advantage of information technology is the ability to hyperlink to other information. For example, when IT is developed using the World Wide Web, the Web can serve not only as a delivery medium but also a content provider for enormous quantities of information. Using hyperlinks, complex or difficult phrases and concepts used within a lesson can be linked to definitions, glossaries, biographies, and short essays which describe the phrases and concepts in more detail or from a different perspective. There are also educators who believe that hypermedia improves a student's ability to handle large amounts of data. Furthermore, from a learning perspective, many writers think that the Web and its hyperlinks closely resembles human cognition (Alexander, 1995). That is, this hypermedia environment of associated links is very similar to how humans store information as a semantic network of links. Consequently, some researchers report that learning can improve when the structure of knowledge (such as that found on the Web) closely represents how humans store information.

A final advantage to hypertext information is the ability to provide interactivity and continuous feedback. Feedback is a key aspect of learning, as it helps learners interpret and understand concepts and ideas by associating actions taken with results obtained. However, researchers argue that a hypermedia environment is really not interactive. Instead, it simply allows the learner to follow predetermined paths chosen by the author. Under this argument, to really provide a true interactive environment, learners must become collaborative authors, creating their own hyperlinks in order to create a really useful learning tool.

Currently there are two major shortcomings of IT developed explicitly for the Web. These shortcomings are: 1) the authoring tools developed for the Web are not as extensive as other multimedia development tools; and 2) it is difficult to limit students' exploration on the Web. However, both of these problems are actively being addressed.

Bridging the Gap

To successfully integrate information technology into tomorrow's classrooms, we must first identify the barriers to its adoption and the reasons for its limited use. Once this has been performed, we can consider how to bridge the gap by removing these barriers.

The first step is to understand the reasons for the limited use of IT. Surprisingly, the low rate of adoption is not attributed to faculty discomfort with the technology, nor with faculty belief that IT can enhance the learning process. On the contrary, studies indicate that faculty usage and ownership of information technology is unexpectedly high. Studies have found that 95 percent or more of faculty now regularly use word processing software to support their teaching and research (Geoghegan, 1994). Similarly in the same study, up to 85 percent of faculty agreed that IT can enhance the quality of teaching and learning. Hence, if this is true, then why the slow adoption of information technology? Listed below are some of the reasons of ITs limited use or barriers to its adoption and solutions educators can take to remove these barriers.

Evaluation of Faculty

Barriers. Faculty are evaluated significantly more based on their research accomplishments than in comparison to their teaching performance. As a result, faculty are often less motivated to improve the quality of their teaching. At the same time, when a faculty's performance is evaluated, it is often measured by counting contact hours with students instead of their contribution towards student learning. Using this approach, faculty time is measured like that of unskilled labor - using a time clock. Consequently, teaching has been made to appear both easy and undemanding.

Solutions. Faculty must be encouraged to think of productivity in terms of both teaching and research. Incentives must be created to evaluate faculty's learning accomplishments, similar to the incentives that already exist for research accomplishments. Efforts must also be taken to change the attitude towards teaching to make it look as difficult and demanding as research.

Teaching must be more carefully audited. While most departments carefully evaluate faculty's research, their teaching and learning performance are seldom audited. Departments must begin to evaluate the teaching skills of their faculty, much like individual professors are evaluated by their students.

Institutional Support and Equipment

Barriers. Many colleges and universities lack a formal a plan for integrating computers into the curriculum as well as the financial support for the equipment and facilities this technology requires. Studies have shown that more than 50 percent of all colleges and universities have no formal plan for integrating IT into the classrooms

(Geoghegan, 1994). Similarly, most institutions are not financially in a position to make the large front-end investments needed to fully exploit information technology's potential.

At the same time, many IT models have been focused on the "technically literate" rather than on a cross-disciplinary approach. Hence, non-technically oriented disciplines sometimes lack the support services to assist faculty in developing, creating, and using IT.

Solutions. A solid commitment from the institution is critical for widespread adoption of IT. This commitment should include: 1) formal plans and policies for integrating computers into the classrooms; 2) financial support to allow the necessary equipment and facilities to be obtained; and, 3) support-services and assistance across disciplines.

Lack of a Compelling Reason Barriers. For information technology to really bridge the gap, a compelling reason for institutions to buy must be illustrated. Unfortunately, from this perspective, many of the early prototypes have almost had a negative impact on IT. For example, on the World Wide Web there are currently many sites which claim to provide beautiful examples of instructional technology. One such collection is the World Lecture Hall at http://www.utexas.edu/world/lecture. While a few of the links listed are impressive, a vast majority of the sites merely contain syllabi, textbooks, and articles which have been slapped on-line. These repackaged examples do not allow students to see, understand, and visualize information in ways that were not possible before. In fact, when these pages are browsed using a narrow bandwidth, the time taken to view these pages is much greater and a good deal more frustrating than simply turning pages in a book. Judging from these examples, it is no wonder that the mainstream faculty have not rapidly adopted information technology. To these faculty, the time and effort required to adopt IT is not worth it, if at best, this technology will only barely assist them with their teaching and research tasks.

Solutions. To convince the faculty to bridge the gap and incorporate IT, a compelling example must be created that, when viewed, clearly provides recognizable benefits. This application must either 1) perform a currently existing task more effectively or in less time, or 2) perform a task that was previously unsolvable. The added value of the application must exceed the time, money, and effort needed for its development. Such a compelling example could provide the necessary incentive for mainstream faculty to bridge the gap and more actively integrate information technology. However, we must realized that since teaching performance is not closely evaluated, even a slightly compelling example may go unnoticed.

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A Techno-Pedagogical Approach to Collaborative Distance Learning

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Educational innovations are often driven by technology. Examples include electronic classrooms (computers and electronic whiteboards), on-line instruction (asynchronous learning networks), and live, interactive lecturing (interactive television). Pedagogies different from the classical lecture, or broadcast method, are not specifically supported in any of those settings. Furthermore, interactive CD-ROM, another popular technology, generally emulates one-on-one tutoring for individual study only. Figure 1 shows a typical distance education setup for tele-lecturing with interactive student participation. In such environments, student participation is possible over the bi-directional audiovisual channel; however, in lecturing situations, student participation depends on the skills and objectives that the instructors may have.

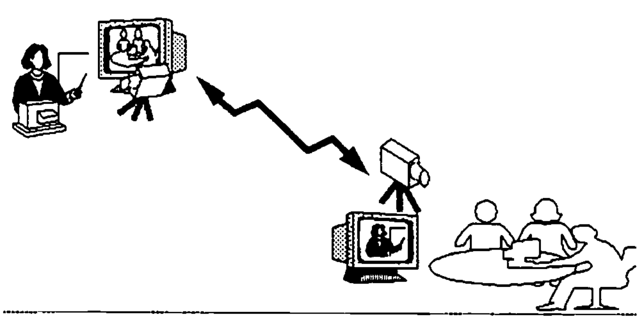

Figure 1. Setup for Interactive Distance Lecturing

In this paper we discuss how a pedagogy for group learning in the classroom, Problem Based Learning (PBL), can be matched with Computer Supported Cooperative Work (CSCW) (Wilson, 1990), to enable its use in distance education. The goal is to enable teachers to remotely engage students in PBL in both asynchronous and synchronous modes to achieve group learning without the need for face-to-face classroom sessions. To achieve that goal, one must support the roles of the instructor and the learning peers beyond enabling remote lecturing and content access. Instructors act as facilitators and thus need monitoring tools and an interactive virtual presence amongst the learning group.

Problem based learning (PBL) differs from traditional approaches in that it focuses on a problem that is presented in a specific context (Barrows & Tamblyn, 1979). In medical education this context is provided by documents and views, simulating a patient in the classroom. Rather than learning facts by rote, students have to apply their knowledge to work on defining hypotheses about the patient's problems, supporting those hypotheses with observation, facts, and background knowledge, and eventually generating solution approaches. Facts and knowledge are thus put into context and can be turned into medical skills (Schmidt, 1994). In the PBL environment of a medical school, the students typically collaborate on a case in groups of up to twelve students. Guidance in the problem-based learning process is provided by medical teachers who act as learning facilitators. The facilitators help students stay on track, provoke lateral thinking, aid in overcoming mental blocks or dead-ends, and prevent students from pursuing improbable avenues too far (Lajoie and Lesgold, 1989).

PBL has conventionally been supported by paper documents or paper patient simulations. Recently, electronic information technology has been embraced to aid in PBL (Schmidt & Bannon, 1992). Systems have been proposed to tackle various problems posed by the PBL process, such as document handling or visualization. There are many multi-media systems that had some success at presenting a high-fidelity patient simulation. The transition to electronic content makes it natural to investigate further computer support for asynchronous and synchronous group distance learning. Noticeably, at the forefront of on-line education is the research on Asynchronous Learning Networks (ALN) sponsored by the Sloan Foundation (The Web of Asynchronous Learning Networks, 1996).

Collaboration technologies have addressed the need to share tools and work environments, the need to communicate using multiple media, and the need to provide seamless user interfaces (Hishii &Miyake, 1994). From the work on sharing text editors and supporting business meetings there have been successful product developments, but none specific to collaborative learning (Nunamaker, Denis, Valacich, Vogel, & George, 1991). Although we find that the needs of distance education are similar to those of remote collaborative work, the content, the media, and the tasks are much more sophisticated than those initially addressed by CSCW (e.g. medical diagnosis vs. brainstorming).

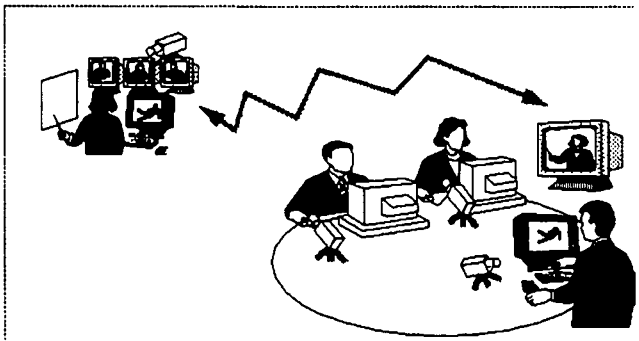

Figure 2. Setup for Remote Facilitation of PBL

We have built an environment for group distance learning which supports PBL with well-matched groupware (CSCW software); see Figure 2. We are interested in matching specific needs such as informal discussion tools and multimedia content sharing, as well as providing a complete environment where teachers can play the role of expert advisors, moderators, lecturers, or content managers, and student peers can play the roles of learners, scribes, reviewers, or teachers. The features we envision for completeness are:

- Multimedia content distribution and sharing with flexible floor control options (e.g. sharing learning and tutoring applications, and distributing updates and reference material);
- Audiovisual communication with options suited to the participant roles;
- Informal discussion tools which allow easy transitions between knowledge creation/input mode and discussion mode, and impose minimal constraints on the material being discussed (e.g. file size, type, source);
- Tools for group monitoring and tracking which are customized to the needs of the facilitator; and,
- Mechanism for session management and control which deals with each session (e.g. agenda, media management) as well as the courses (e.g. syllabus, course logistics).

These features can be implemented in a system composed of teacher and student stations connected to a server over any network with appropriate bandwidth. Although the list above describes individual modules, to be effective, they must be functionally distributed and integrated throughout the system.

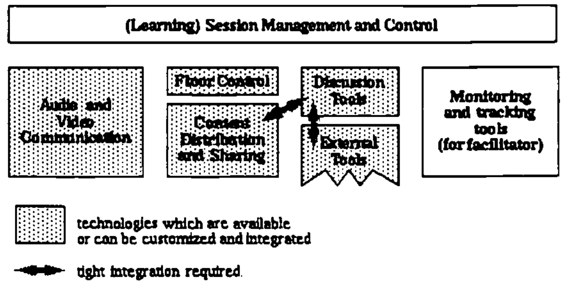

Figure 3. Architecture of a Group Distance Learning System

The architecture of the system is shown in Figure 3. The following sections deal with each of the five main components and the last section provides the closing discussion.

Content Distribution and Sharing

Electronic content creation is a major bottleneck in computer-supported learning. For collaborative learning the problem is compounded by the need to provide content which is suitable for group work and which lends itself to the creation of positive interdependence among participants.

By choosing PBL as a starting point, we secured the suitability of the content. We have also built upon previous work which has created electronic versions of the classroom content for an asynchronous system known as CALE (Mahling, Sorrows, & Skogseid, 1995). CALE makes PBL cases available over the Web, and students can access the system as a group (sharing a terminal), or individually. CALE was not designed for synchronous use; therefore, like many single user applications, to be used by a group it requires a sharing and a floor control mechanism. That way, one student at a time takes control of the application while others watch and give input.

Depending on the type of multimedia content to be shared, bandwidth and performance become issues. We are currently experimenting with distributed and centralized sharing. Distributed sharing is based on synchronizing copies of the content running at each participant's node. Centralized sharing is based on screen replication of a single application running on one node.

Applications which use video and audio are better shared in a distributed manner. Appropriate content update and distribution mechanisms must be available for any type of sharing. Much of the existing content would benefit from flexible sharing which could support synchronization but which could also allow for individual preferences and choices deviating from the original *What You See is What I See* (WYSIWIS) approach. Problems identified with current sharing methods include platform dependency and lack of flexibility regarding individual preferences and environments.

The World Wide Web (Web) appears to be the scenario with the highest potential for broad delivery of content and for the creation of learning environments (Greenberg and Roseman, 1996). This is supported by the way the most important trends in content and usage have been picked up on the Web. The trends from passive to interactive content, from generic to personalized work environments, from individual to group work, and from static to live multimedia are significant examples.

Newly available Internet set top boxes have potential to be combined with interactive TV for distance learning. This is an economic alternative to the more expensive Web access through multimedia PCs.

Floor Control

To interact with a single user application, members of a group must take turns. This is possible through floor control. Round Robin, queuing, and timed-out turns are common methods. The literature on the subject summarizes available protocols as combinations of explicit or implicit floor request and explicit or implicit control granting. For a review on roles and responsibilities in application sharing see (Greenberg, 1990). As we found out, the applicability of those methods needs to be revised for environments in which audio and video communication is also available (i.e. all floor control transactions could be negotiated verbally).

Audio-Visual Communication

Audio and video communication is expected to contribute to the creation of a virtual group. We have investigated to what extent analog audio and video can achieve the results of face to face interaction. We have used an open, full-duplex audio channel of high quality to keep everyone in contact. This is the single most important requirement of this part of the system.

The communication which exists in PBL is rich in subtle clues and gesturing. Furthermore, the facilitator needs to read individual reactions in the group context to detect consensus, confusion, or any needs or non-verbal messages from the group. Experienced facilitators can sometimes detect when a student is guessing or confused by the tone of voice, but with video they can do it more successfully.

We have used a setup in which 9-inch or 13-inch monitors provide near real-size images of head and shoulders of each student. The monitors are arranged in a configurable cluster, in a coordinated array combined with the (optionally spatial) sound channel. The facilitator has a self view, and can be seen by the students in either a large monitor for a co-located group, or in small individual monitors. The setup was designed to achieve the best possible eye contact so that the facilitator would not have the feeling of being talking alone in a room full of equipment, as shown in Figure 2.

Although we used the above setup successfully, many challenges remain. One of them is the quality and bandwidth of a digital implementation. Echo cancellation and calibration of the audio proved non-trivial. More advanced features such as creating the illusion of looking at the same or appropriate points, depending on the focus of attention of the students, would greatly reduce the perceived effort by the facilitator.

Discussion Tools

During problem solving, when there is uncertainty or disagreement as to what to do next, groups go into a free-format, unstructured discussion mode. The students should be able to bring the discussion subject out of the content area and into the discussion tool and to take the results back as applicable; moreover, importing homework, or work created using tools external to the system into the whiteboard is often necessary.

Many multi-user whiteboards and annotation tools are useful for discussions. Seamless transitions may be tricky, especially if data types and formats other than simple bitmaps need to be handled. The user interface of the content application and the whiteboard must be consistent to minimize user confusion. We have used commercial and public domain whiteboards and also tried sharing graphical editors for annotations. Additional programming effort was required for seamlessness.

Monitoring and Facilitation Tools

We have studied PBL facilitation as practiced in the Medical School at the University of Pittsburgh. Using workflow analysis we are currently investigating how to abstract the facilitation and monitoring tasks, and identifying the necessary input data such student feedback, agenda status, audio and floor control activity. As explained before, audio and video help the facilitator to stay in touch with the group and monitor the group. Facilitators need to keep track of students as a group and as individuals. Early observations indicate that the level of perceived effort by the facilitator increases significantly compared to the classroom situation. Our observations and surveys indicate that the facilitator is fully occupied 100% of the time.

Monitoring and facilitation tools should be designed to take some of the load off the facilitator and bring him or her into the action only when it is necessary (e.g. on demand). This may also open the possibility of facilitating more than one group at the same time.

Session Management and Control for Collaborative Learning

In order to create, enter, participate in, and leave a session, users need to have access to information such as scheduled times, participants, resources to be used, and course context. A session status can be defined by three parameters: participants, resources, and tools.

Participants are the end users who are allowed to join the session. Participants can be assigned roles according to certain criteria specified at creation times. A classical example of roles in group learning are facilitator and students. Transient roles such as floor chair and controller (in case the floor control requires them) can also be identified easily at all times.

Resources are abstract entities representing specific activities. Examples of session resources include video communication, audio communication, whiteboards, text editors, Web-sharing mechanisms, and floor control mechanisms. Resources may have a set of attributes which specify the nature of the tool that can be used to provide the resource. Video compression method can be one such attribute associated with a video resource.

Tools are the actual software used to provide the session resources. The reason for specifying tools and resources is that more than one tool can provide a resource thus providing great flexibility. Users may then be able to use their favorite tools as long as they match the resource attributes.

The main functions of a session manager are: session creation and announcement, handling session joining and leaving, inclusion and exclusion of resources, tool attachment and detachment, event notifications to local session tools, and control and status communication across tools and participant nodes. Control privileges are distributed among session owner or creator, facilitator (if different), and students. Session management also deals with work environment persistence (i.e. starting where the group left off) across synchronous and asynchronous sessions.

Discussion

In this paper we have presented an approach to collaborative distance learning which will help to increase the options and quality of distance education. The approach consists of choosing a group-oriented pedagogy first, and then building an architecture using properly matched technology. Off-the-shelf groupware does not match the needs of collaborative learning; the two key components, session management and control and group learning monitoring and tracking are not available. However, it is not recommended to develop systems from the ground up, but to re-use existing technologies as much as possible. Most of the effort will be spent in designing and building the unavailable modules and in achieving an effective and seamless integration of the whole system.

In the current stage or our work, we have implemented a prototype and tested it under laboratory conditions to ensure overall functionality. The next step will be a field test in the Medical School at the University of Pittsburgh. Initial surveys indicate high acceptance by the students when working with remote facilitators. However, facilitators reported an increased amount of effort when compared with the classroom facilitation. That situation is explained because the monitoring and facilitation tools are not fully developed yet, and thus the system creates a cognitive overload on the facilitator. Technical requirements for content sharing and audiovisual communication have also been identified but their discussion is beyond the scope of this paper.

Once remote facilitation is achieved, in the setup shown in Figure 2, the following step is to place the students apart. This will require the creation of a virtual environment which can incorporate the features of virtual worlds such as immersiveness, virtual presence, and social dynamics, to support the socio-pedagogical needs of group learning (Roehl, 1996).

On the issue of implementation of practical systems, analog audio and video communication seems to provide the required quality (the other components work well over wide area networks, intranets, or Internet). Interactive TV systems for remote learning are not likely to disappear in the short term. They could be enhanced by adding live sharing of Web content as an additional resource to foster student participation. For PC-bases systems, lower end facilitator and student stations should be designed which use digital audio and video. Further research and development must be done to achieve acceptable quality under reasonable bandwidth conditions.

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A Multi-dimensional Critique of IT Pedagogy

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Niederhauser (1996) described the need for educators to "reassess what it means to be literate in our society". He proposed a view of an 'information society' which demands critical thinking and problem-solving skills of the individual members of society. Training structures in education would need to be reformed and resourced to provide teachers with the opportunity to develop basic technological skills, subject knowledge and collaborative ways of working in order to integrate information technology (IT) in the curriculum. There are similarities between these aims and the description of 'IT Capability' in the National Curriculum (NC) in England and Wales (NCC, 1990 A1): - knowledge about IT applications and about IT tools; the skill to use appropriate IT skills effectively; an understanding of the new opportunities IT provides; knowledge of the effects and limitations of IT. The National Curriculum view of information literacy describes the ways in which IT - characterised by the storage, organisation, processing, representation and transmission of data - is expected to enable the learner to identify and access information; organise it for analysis and present outcomes to an audience in an appropriate manner.

Niederhauser's view of the process of change is essentially a traditional 'top-down' model of teacher education, in which the provision of resources and the design of courses to integrate IT skills into the curriculum is supposed to bring about change. In addition, the model he offers has features of technological determinism in which "advancements in electronic technology" drive the 'information revolution'. The solution seems simple - teach the teachers, and they will then be equipped to help their pupils ride the wave of progress. This seems to be, for example, the view of Anthea Millett, Chief Executive of the Teacher Training Agency in the United Kingdom (UK), who suggests that in order to promote the use of IT by the teaching profession we need to show teachers, "super programs that go to the heart of what they are trying to do and then say to them: 'Do you like this software? We will show you how to use it.'" (TES, October 18 1996).

This approach is, however, reminiscent of Street's (1993) description of an autonomous model of literacy in which sets of competences are separate from the situations in which they are used. These capabilities of technical skill, thinking and problem-solving are treated as if they can be learned and taught independently of the cultural context. In contrast with the autonomous model of literacy, Street puts forward the ideological model. This view recognises that literacy is not a generalised, culture-free process, but a set of specific practices embedded in particular social contexts. An ideological model would highlight the culture-specific view of information literacy. We argue that it is this perspective which should guide our understanding of how information literacy arises and develops within society and policy making, within the home and school environments, within classroom activities and within the individual's experience of a subject and construction of knowledge.

Literacy, numeracy, and information skills are given priority in current educational policy in the UK, reflecting perceptions of the 'information society' which are associated with images of economic progress, modernity, intelligence, cultural change and power. (Beynon & Mackay, 1993; Bowers, 1988; Chandler, 1995) Such perceptions, however, are not straightforward and the debates about these images and their relative importance are far from closed. For example, critics of the idea of an 'information society' challenge the implicit link that is often made between information processing and knowledge (Roszak, 1994). The image of 'economic progress' is used to both attack educational practice and to justify curricular reforms yet the relationship between education and economic well-being is far from clear (Apple, 1996). In the UK context, now that the National Curriculum has been established, pedagogy itself is challenged by those who would limit the control by the classroom teacher concerning methods of teaching and learning (TES, September 19,1996). Finally, analysts with an interest in discourses of power in the classroom force us to consider the ways in which IT might reinforce and exacerbate social inequalities (Fisher, 1993. Also Bernstein, 1996, provides a relevant analysis of such discourses).

Having acknowledged the wider context in which the use and purpose of IT is perceived, it is important to consider the ways in which IT is taken up and experienced within classrooms and schools. Demands are made of teachers' pedagogical practices and questions raised about 'fitness for purpose' (Alexander, Rose, & Woodhead, 1992) when IT can be used to support a range of learning experiences from individualized instruction to collaborative learning (NCET, 1996, Scrimshaw, 1993). In planning and developing their teaching strategies, teachers need to consider the learning demands of the activities (Galton, 1995) and the role that IT might play in supporting or changing ways of working (Kemmis, Atkins, & Wright, 1977; Crook, 1994)

At the level of particular activities, the features which characterize IT can give insight into the nature of the subject focus itself, changing the experience, construction and representation of knowledge. Mathematical ideas and relationships can be modeled and presented in a variety of ways, from fractal geometry to Fermat's Theorem. The process of writing and crafting a text, from mark-making and editing to restructuring and publication can be supported and extended. Digital data can be used as a medium to represent, manipulate, and transmit meaning in the visual arts (Loveless, in press; Mitchell, 1994).

In this paper we argue that teachers need to be able to interrogate and challenge the purposes for which IT is being used in classrooms in order to locate the children's experience in an ideological, cultural, epistemological, and pedagogical context. This is not to be achieved by simple models of in-service or pre-service training which emphasize 'how-to' competence but overlook the real and direct ways in which the presence of IT can change the experience of schooling for both teacher and pupil.

A Framework for 'Good Practice'

Our aim in the discussion of the definitions of information literacy is to raise questions about the purposes for which we use IT in our work; how these ideas translate into 'good practice' in the classroom and how we might identify effective teaching. Alexander's (1996) model of general pedagogy is helpful in addressing the concept of 'good practice' and contributing to the debate about the purpose and meaning of our work in teacher education. An important theme is that 'good practice' is an aspiration as much as an achievement; about dilemmas more than certainty, compromise rather than consensus.:

> ... good practice, created as it is in the unique setting of the classroom by the ideas and actions of teachers and pupils, can never be singular, fixed or absolute, a specification handed down or imposed from above in the manner charted in the Leeds research ... [It] is plural, provisional and dynamic: there are thus as many versions of good practice as there are good teachers striving to attain it (Alexander, 1996, 71).

Alexander's model consists of five dimensions or 'considerations':

1. Value considerations ..... beliefs and values shaping views of childhood and the child's needs, of society and its needs, and of knowledge, which inform a coherent view of what it is to be educated;
2. Empirical considerations .... evidence about the effectiveness of practice: about the capacity of particular teaching strategies to deliver learning in accordance with a coherent view of what it is to be educated;
3. Conceptual considerations .... a comprehensive map of the essential elements of teaching, learning and the curriculum, and of the relationship between them;
4. Political considerations ...... expectations and pressures from within the professional hierarchy, and beyond it from parents, community, employers and politicians;
5. Pragmatic considerations .... an awareness of the opportunities and constraints of particular school and classroom settings. (Alexander, 1996, p70).

There are two important points to make about this model. The first is that 'good practice' relies on some sort of interaction and balance between all five dimensions. Mere 'practice' is a reflection of the political and pragmatic. The second is that the five considerations are not equivalent and there have to be reasons for preferring one course of action over another. Thus, in Alexander's model, values are central and are expressed in real classroom situations. Empirical considerations are a critical adjunct to matters of value and belief, to enable us to distinguish between the strengths and weaknesses of different classroom strategies. In order for classroom teaching to be effective we must have a notion of what it is to be educated.

This framework can be applied to the use of IT in the classroom. It can be argued that the current situation in schools generally reflects 'practice' rather than 'good practice'. (Watson, 1993, Loveless, 1995). Political considerations lie in the expectations and pressures upon teachers to use IT in response to requirements of the National Curriculum, the demands of parents, and the political policies to promote technology in schools. The pragmatic considerations can be seen in terms of what is manageable with particular resources and classroom constraints and the skills and competency models of initial teacher education.

In order to develop and promote 'good practice', there needs to be an exploration of value considerations - the beliefs and values about the role of IT in our society and the ways in which it supports and extends knowledge; empirical considerations of how teachers develop knowledge and understanding in their teaching strategies and conceptual considerations of the claims of IT to support learning and teaching.

The Teacher Development Project

The Teacher Development Project at the University of Brighton is addressing these issues in the context of art education and the use of IT in primary education. The project is a collaboration between the University, the Arts Council of England, South East Arts and Lighthouse, the Brighton Media Centre; and was prompted by concern that 'political' and 'pragmatic' considerations were driving both policy and planning in schools, without full attention being given to the broader context in which children and teachers used IT in the creative visual arts. In Alexander's terms, IT in the creative visual arts was seen to be stuck at the level of 'practice'.

The nature of the experiences and knowledge which teachers need to develop are being investigated in three areas:

1. Fieldwork in classrooms to observe and question teachers on their beliefs and theories about teaching, learning, IT and art education;
2. The design of initial teacher education subject and professional courses; and,
3. The development of curriculum materials which reflect the characteristics of the digital medium and the cultural environment in which they will be used.

Value considerations are being addressed by exploring the cultural environment in which IT is used in the visual and performance arts and contributes to the experience of childhood in the age of the computer, film, and TV screen. The development of visual literacy in the twenty-first century is embedded in the contexts discussed above. The characteristics of IT and the unique qualities that it brings to artistic knowledge are highlighted. Digital data is a new medium which enables not only the simulation of more traditional physical processes, such as painting, drawing and photography, but also the construction and communication of visual representations in new ways. Computational tools manipulate, transform and process a set of mathematical values in order to communicate meaning in a visual language. The display and transmission of visual ideas on screen and over networks, rather than in fine prints, opens up new ways of interacting with visual art which alter the relationship between the artist and the viewer of the image. The emphasis on the transforming process and the potential for transmission, rather than capture and printing, as in photography, has been described as 'electrobricollage',

> fragments of information that circulate in the high speed networks now ringing the globe and that can be received, transformed and recombined like DNA to produce new intellectual structures having their own dynamics and values (Mitchell, 1994, p52).

Empirical considerations are being drawn from observable practice in the classroom for students and practicing teachers. The context, content, planning, and management of the use of IT in the visual arts is being evaluated in terms of the requirements of the National Curriculum, the teaching strategies used, the learning outcomes for the children and their understanding of the processes and products of the activities. The teachers' experience, interests, confidence and needs are also being evaluated in order to develop models of staff development and support. Although Alexander does not apply his framework to the issue of effecting change and development from 'practice' to 'good practice', we argue that it is through empirical considerations of evidence and evaluation that we can move from an uncritical to a critical pedagogy of IT.

Teachers' views of the role of IT in supporting learning in art education are influenced by their personal philosophies of the nature of the subject, of children's learning, of the place of IT in education and society, and of the pedagogical practices which express these theories and beliefs. An important outcome of the research involves conceptual considerations of the relationship between teaching, learning and the curriculum for art education which will then inform the production of support materials which exemplify 'good practice'.

Again, we present this aspect of the model as problematic, for we are aiming at a moving target; the interaction between what is immediately practical in the classroom, the rapidly changing cultural context in which IT differentially affects pupils' lives, and the wider horizon of technological possibilities that inform our imagination, gives our conceptual considerations a provisional quality. A framework for 'good practice' in the use of IT in art education is complex and difficult to implement. The different aspects of the framework will influence and compromise each other and, as Alexander notes, educational practice is about "dilemma no less than certainty" (Alexander, 1996, p. 68). Our aim is to acknowledge the tensions raised by 'good practice'. The debate about the nature of 'information literacy' must reflect and take account of the challenges and uncertainties of the situations in which children and teachers learn.

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Technological Competencies: Implications for Educational Leadership

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As the use of computers has expanded and diffused through K-12 education, there is movement from learning about technology to using technology as a medium through which learning is augmented (Becker, 1990; Beynon & MacKay, 1993; Blomeyer & Clemente, 1996; Blomeyer & Martin, 1991). Teachers are using an ever-increasing variety of technology in every aspect of the curriculum (Becker, 1990; Blomeyer & Clemente, 1996). This trend is causing some in teacher education to question traditional *computer literacy* and its place in teacher preparation (Harrington, 1993; Novak & Knowles, 1991; Roberts & Ferris, 1994; Todd, 1993; Wetzel, 1993). The purpose of this paper is to recast the existing idea of computer literacy as a *technological competency process.*

The conception or definition of technological competency process (literacy) that we offer here is exemplified when a teacher education faculty member tries, assesses, adapts, and finally adopts or rejects a new instructional technology (or technology-rich learning environment) in his/her course. His/her decision would ideally be based on the technology's suitability or fit to the objectives and content of the particular course within the teacher education curriculum. To support this process-oriented conception of technological competency and illustrate the relevance and potential of this concept for strengthening teacher education, we will: (1) explore a process-oriented perspective on curriculum change and innovation, based on the works of Rogers (1983) and Fullan (1991), and (2) present case-based examples using their frameworks as a vehicle for evaluating the descriptive or heuristic potential of technological competency process as a focus for organizing and implementing new interactive technologies in teacher education.

Diffusion and Institutionalization of Innovations

E. M. Rogers: Organizational Change and Innovation

Rogers offers a developmental model representing the *Stages in the Innovation Process in Organizations..* Within this model, the earlier stages or initiation of organizational change cannot be preceded by the latter stages of implementation, including: (a) redefining/, (b) clarifying, and (c) routinizing. Individual initiative, including the individual choice to adopt or reject the innovation are critical to success in organizational adoption.

Strategic Planning and Institutionalizing Change. Strategic planning to support technology in teaching and learning should initiate development of an organizational infrastructure in which instructional technologies can be supported. Typically these plans address the first three stages in Roger' s model for organizational innovation:

1. *Agenda-setting* involves all the "information gathering, conceptualization and planning" (p. 363) required to assess the perceived needs for instructional technologies within teacher education programs and identify those technologies that may be of potential value in addressing these needs;
2. *Matching problems with solutions* involves fitting specific technologies with organizational and instructional needs. This often involves identifying hardware requirements (including replacement and maintenance schedules) and acquisition and deployment of hardware and software for administrative and instructional use;
3. Because most instructional technologies are complex bundles of inter-related technologies (i.e., hardware, software, operating manuals and training), it is often necessary to *redefine or restructure* the components of tight technology bundles to fit particular programmatic circumstances and curricular needs;
4. *Clarification* of a new instructional technology is crucial in the organizational innovation process where the new technology first becomes used by faculty and teaching staff in an education program. This stage is particularly important because it is the juncture where adoption decisions by individual faculty and staff are necessary for organizational success; and finally,

5. *Routinizing* the use of instructional technologies would involve incorporating them into daily instructional activities to the degree that the innovation looses its unique identity within the context of teaching and learning.

Strategic planning for technology integration in curriculum is not adoption and does not constitute curriculum change. It is however a compass that can point to identifying the next stages in the planning process.

Fullan on Enabling Change

Fullan (1991) characterizes and describes the complex process of implementation at the micro level and provides a theoretical framework that can guide curricular integration as faculty members incorporate new technologies (this may take three to five years) into teacher education curriculum.

Fullan offers ten assumptions about change which are a philosophy in action that can enable and guide efforts to integrate technology with teaching and learning. Applied to technology in teaching and learning, they are:

1. The innovation and change as conceived by the originators will be modified by those who implement it;
2. Persons implementing change will come to their own understanding of the innovation over time by using it;
3. Change in practice will result in conflict and disagreement among those implementing the innovation. These experiences can be a sign that things are changing;
4. "People need pressure to change." (p. 106) Therefore, institutional infrastructures should provide incentives that encourage and support change (e.g., technical assistance, opportunities to talk with other implementors);
5. Incorporating change is an example of "development in use" (p. 106). People grow developmentally as they embrace change, each in his/her own time;
6. There are many reasons why implementation may not occur. "Do not assume that the reason. . .is out right rejection" (p. 106);
7. Not everyone asked to implement an innovation will change;
8. Plans developed should consider the above assumptions and "knowledge of the change process" (p. 107);
9. Because implementation is a complex process "no amount of knowledge will ever make it totally clear what action should be taken" (p. 107); and,
10. "Assume that changing the culture of institutions is the real agenda, not implementing single innovations" (p. 107).

Illustrating Technological Literacy as Process

Fullan (1991) and Rogers (1983) address change as an ongoing process. Since instructional technologies are continually changing technological competency is demonstrated when individual faculty members assess and adapt appropriate new technologies to the core of the teacher education curriculum or reject technologies that do not fit with either the instructional objectives or learning environment in a particular institutional setting.

The research and practice supporting sample episodes includes a *needs assessment* concerning technological use in teaching and learning (Blomeyer & Clemente, 1994), a statewide survey concerning technology use in Indiana's K-12 schools (Clemente & Blomeyer, 1996), and case-based examples constructed from the teaching and program development experiences of the authors.

While teaching graduate level classes on technology in the schools, by listening and sharing our students experiences, the authors have discovered that the technical, human, and procedural hurdles to technology integration that are faced and overcome by educators at all levels of the educational system, are extremely similar. Educators from K-12 schools should not be surprised to discover that many public schools are more advanced with respect to integrating and diffusing technology in curriculum than many teacher education institutions across the country.

Clarification: Increasing technological complexity enables curricular change. According to Rogers, *clarification* provides a means by which innovations are formatively evaluated based on their impact to the university. It is through this process that problems may become apparent and solutions sought and carried out. A possible example of clarification examines the extension of Internet connectivity to the microcomputer instructional laboratory shared by the Elementary and Secondary Education Departments. The College of Education has a fifteen person Macintosh™ instructional lab primarily scheduled to support undergraduate and graduate courses in elementary and secondary education.

All Macintosh™ microcomputers in the lab were networked. Although the LAN in the instructional lab enabled demonstration and practical application of basic networking concepts, lack of an interconnection between the campus network and the local network made it difficult to show or teach about extending connectivity. One workstation in the lab was connected via the modem port to the university mainframe computer by a simple serial line connection. This workstation was often used to show the use of mainframe resources by using an external LED display device on an overhead projector.

As telecommunications and connectivity beyond the confines of the classroom became an important teaching and learning issue, the needs were first met by using shared university terminal rooms. The terminal facilities were scheduled for use with classes as needed. There, the students used the university mainframe system to experience (a) the mainframe mail utility to send and receive e-mail, (b) the mainframe Gopher client, (c) WAIS information servers, (d) Usenet News Groups, and (d) the Lynx™ mainframe client to browse the text-only version of the World Wide Web.

Currently the faculty who teach technology classes as part of their instructional load have an unchallenged monopoly over use of the microcomputer lab in the College of Education. Few of the other faculty members who teach the core teacher education courses had asked to schedule the lab. The most common core courses using the microcomputer lab were teaching methods or instructional media classes coming into the lab for one class session on educational uses of instructional software.

As competition between first comers and a predictably larger group of early adopters for access to the microcomputer laboratory in the College of Education might predictably increase, the role of microcomputers and Internet information resources in teacher education curriculum will continue to clarify and expand. Expansion of demand for access will lead to calls for the expansion of existing microcomputer labs in the College of Education; or possibly for installation of 10Base-T ethernet as an instructional resource in College of Education.

Achieving stability for new informational technologies in teacher education will amount to the establishment of an infrastructure to support and aid in the assimilation of new technologies and other curricular innovations. When any new instructional technology or idea clarifies its role in curriculum, it eventually becomes invisible and commonplace.

Illustrating Fullan's' Assumptions: Micro Level Initiatives

As the conception of technological competency process is modified and refined by successive iterations of changes in both new interactive technologies, and in the stated expectations for instructional competencies as articulated by local school officials, instructional practice that brings new uses for interactive technologies into teacher education will continue to evolve. The locus of curricular change in the teacher education program will be the individual classes that comprise the teacher education curriculum.

No Solutions are Absolutely Clear: No Blue-print or Road Map to Change

One of Fullan's (1991) most interesting caveats is his assertion that: "no amount of knowledge will ever make it totally clear what action should be taken." (p. 107). He cites Louis's and Miles' *evolutionary planning* regarding the inherently chaotic environment surrounding and within school organizations.

No specific plan can last very long, because it will either become outmoded due to changing external pressures or because disagreement over priorities arise within the organization. Yet there is no reason to assume that the best organizational response is to plan passively, relying on incremental decisions. Instead, the organization can cycle back and forth between efforts to gain normative consensus about what is to become, to plan strategies for getting there, and to carry out decentralized incremental experimentation that harnesses the creative energy of all members to the change effort. (Fullan, 1991, pp. 108-109)

An example concerning the use of evolutionary planning is illustrated by considering a possible curricular use of e-mail and-based informational technologies in courses. Of the newly available technology systems that have apparent potential to influence teacher education curriculum, these telecommunications applications have great potential to augment existing instructional practice.

Monitoring the implementation and integration of informational technologies by teacher education faculty is one response that seemingly fits with Louis' and Miles's evolutionary planning model (Fullan, 1991). Collecting and sharing descriptive, case-based accounts documenting faculty members efforts using technology in teacher education would be a possible strategy for reducing unnecessary duplication of implementation strategies within a programmatic context (Blomeyer, 1991; Goodson & Mangan, 1995a).

Necessary Roles for Faculty and Administration: Integrating Technology in Teacher Education

To realize integration of technology in teaching and learning changes in the role of faculty, traditional teacher education curriculum, and leadership priorities are critical. Primarily faculty must model technology integration in teacher education classes. To achieve this, staff development should empower faculty to achieve technology integration in their own classes. The teacher education curriculum must address issues concerning the fit of particular technologies to pedagogy and curriculum within discipline-based courses (content and general methods).

Teacher education programs should identify faculty and staff who already have the training and experience necessary to use new instructional technologies. Technology-competent faculty could work with less experienced faculty to collaborate and diffuse the expertise necessary to realize appropriate technology integration in the teacher education curriculum. These technology resource persons could be supported and rewarded within the academic system of promotion and tenure.

This collaboration between technology and curriculum must be more than simply showing colleagues how to use a new model of computer or how to navigate the World Wide Web. It must include (a) exploring and trying new technologies for possible applications to specific classes, (b) rigorous and objective assessment of the potential these technologies for improving instructional systems, and (c) ultimately collaboration on decisions to use or abandon new technologies as components of particular classes.

The technological competency process that we propose here is a complex process having indefinite and possibly unpredictable outcomes. We propose that teacher education faculty consider a wide range of technological devices and software for possible use in discrete curricular niches within individual discipline-based courses. Harnessing this technological competency process to achieve discipline-based integration of interactive technologies in teacher education is a creative act. We believe that this development in use (Fullan, 1991) will result in unique instructional applications that will fit the intent and local context of teacher education programs.

The sophistication, complexity and risks associated with this proposed conception of technological literacy is much greater than those previously associated with computer literacy. Encouraging the integrated use of instructional technologies in discipline-based teacher education classes requires that we no longer delegate teaching about technology to specialists. Faculty in content and general methods courses must become the models for technology use in the teacher education curriculum.

The simplistic teaching and learning strategies that have characterized computer literacy are unsuitable for integration with content and general methods courses and field-based clinical experience. Our work is the training of teachers. Complex tasks require sophisticated, long-term solutions. Although the suggested path to an appropriate integration of interactive technologies in the comprehensive teacher education curriculum is seemingly long and difficult, it is a solution matching the difficulty and complexity of the task at hand.

Note: For the whole text see Blomeyer, & Clemente. (in press). Toward a new paradigm for technology in teacher education. In R. L. Blomeyer and D. C. Martin [Eds.] (in press). *Teach, train, and transform*. Philadelphia: Falmer Press.

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Implications of Constructivism for Teacher Technology Training

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Discussion of constructivism is wide-spread in our literature. However, little discussion has occurred regarding the question—what contribution might the constructivist perspective make in the area of technology training for teachers at the preservice or inservice levels? This discussion explores possible answers to that question.

Constructivist Perspectives

Those attempting to gain a meaningful understanding of the implications of constructivism for teaching in any curricular area face a challenge at the start. This is because the literature reflects wide-ranging views. Most agree that constructivism holds that "... we construct our own reality through interpreting our experiences in the world" (Jonassen, 1996, p. 12). However, many authors fail to agree at a fundamental level as to what constructivism encompasses. Existing views hold that constructivism is a theory (Jonassen, 1996), a collection of theories (Driscoll, 1994; Newby, Stepich, Lehman, & Russell, 1996), an instructional model (Roblyer, Edwards, & Havriluk, 1997), and a philosophy grounded in values (Lebow, 1995). Others offer extended discussions aimed at teachers regarding the nature of constructivist approaches in the K-12 classroom (cf. Henderson, 1996; Brooks & Brooks, 1993). These diverse perspectives are useful in providing educators with ideas regarding how constructivism may improve teaching and learning in various fields; however, yet more specific advice relating constructivist approaches to specific subject areas is needed.

Some of the general guidance in the constructivist literature seems applicable in the technology arena. In the remainder of this discussion, I draw upon that literature and my teaching experience to derive some strategies for use in technology courses for preservice and inservice teachers.

Constructivism: A Matter of Balance

While some argue that constructivism has usurped cognitivism (Gredler, 1997), others argue that constructivism and cognitivism complement each other (Henderson, 1996). In this regard, Roblyer, Edwards, & Havriluk (1997) compare directed instructional methods with constructivist ones. They suggest that the two approaches should be merged so as to benefit learners and teachers. Their view is consistent with that of Smith and Ragan (1993). The latter authors, distinguishing between supplantive and generative instructional strategies, also suggest that the decision regarding which approach to employ is "... like a balancing act" (p, 153). A supplantive strategy provides for explicit coverage of the events of instruction. A generative strategy, on the other hand, is less explicit and encourages students to construct individual and unique meaning. Smith and Ragan suggest a balanced approach. They suggest requiring students to exert their mental effort in support of generative learning on the one hand while providing explicit instructional support to avoid information overload in short-term memory on the other.

Experience bears out the importance of striving for a balanced approach in technology courses. In covering a skill such as how to set up a spreadsheet, the instructor can begin with a directed approach. This might involve presenting a demonstration and providing some written guidance as to the steps and concepts involved in the process. Subsequently, students can independently apply preliminary learning by taking on a bigger related challenge, perhaps of their own choosing, such as setting up a gradebook. This allows them to elaborate upon the preliminary instruction and to increase meaningfulness and relevance by developing a spreadsheet they can use in their work or studies.

Focusing on Learners and Their Needs

The constructivist view places the learner at the heart of the instructional enterprise. Just as K-12 teachers are urged to employ a learner-centered approach, so too should university instructors of technology courses (see Rodriguez, 1996). Current instructional design literature further reminds us to involve would-be learners when planning for instruction (Wilson, Teslow, & Osman-Jouchoux, 1995).

Discussing the reinvention of instructional systems development, Davies (1995) suggests that instructional designers focus on increasing clients' personal productivity. Davies' comments — centered on corporate training applications — seem germane to constructivist instructional approaches with most adult learners. Davies' recommendations include the following:

- Provide instruction that explicitly recognizes learners' needs;
- Make a priority of learning activities even if content coverage suffers; and,
- Focus on action learning whereby learners work on real problems in real time and can measure the results of their efforts.

These recommendations stress the criticality of keeping students engaged through active participation and maintaining students' sense of relevance concerning course activities.

What other steps can a technology instructor take to focus on the learner? Ideas include adjusting course scope and content based upon students' entry skills and providing flexible learning goals based upon students' needs. Experience shows that some students in technology courses lack even basic computer skills. These students should be encouraged; they may be able to be "brought up to speed" via on-line tutorials or one-on-one assistance provided by peers and the instructor.

Focusing on the Essence

Experience suggests that "less is more" in the technology applications arena. Consider the above situation of students trying to learn how to develop a spreadsheet. It does little good to expose students to huge spreadsheets or lengthy procedural guides in introductory instruction. A simpler approach is in order. "Learners of all ages are more engaged by concepts introduced by the teacher and constructed by the learner from whole-to-part . . . " (Brooks & Brooks, 1993, p. 48). The simplicity provides building block upon which students can elaborate as they move toward personally meaningful problem solving. The instructor would thus demonstrate the construction of a simple spreadsheet consisting of perhaps a few data cells and a single computational formula. Grasping the essence, students can then literally construct more complex spreadsheets with the instructor's guidance, thus developing their understanding as they grapple with more complex problems (cf. Driscoll, 1994).

Applying the idea of spaced-practice — that is, revisiting foundational material on a regular basis over time — should support understanding of core course content. For instance, a one-shot demonstration of how to access and use an electronic mail program is not likely to foster true understanding or skill. The instructor should also use learner assessments, perhaps in the form of authentic tasks, to verify understanding of a given concept or procedure as the course progresses.

Social Negotiation

Driscoll (1994) points out that learning under the constructivist view is a communal activity. The idea of social negotiation has to do with learners making meaning through personal interaction and discussion with each other as they attempt to solve a given problem. Social negotiation and related meaning making among students require more than traditional cooperative learning approaches. Collaboration supersedes cooperation in that it requires students to reflect upon their actions and to share insights and solutions among the group (cf. Henderson, 1996; Driscoll, 1994). Students benefit through the increased power of "pooled minds" and the opportunity to understand each others' perspectives.

As with other constructivist strategies, balance is in order. Young adults in technology courses need time to develop skills on an individual basis. At the same time, they often enjoy providing informal assistance to each other. Culminating group projects can be worthwhile if the challenge at hand lends itself to a collaborative effort where tasks can be subdivided among the group. Examples here might include group projects to develop a series of related pages for the World Wide Web or to develop a series of multimedia lessons. Collaborative projects are useful because they promote social negotiation while reflecting what it is like to work as a part of the team in the real world.

Nurturing Reflexivity

A final strategy for technology instruction concerns reflexivity — learners' awareness of their role in constructing knowledge. Driscoll (1994) sees reflexivity as akin to metacognition while pointing out that the notion of reflexivity implies more than awareness of one's thinking and learning processes:

> With reflexivity, a critical attitude exists in learners, an attitude that prompts them to be aware of how and what structures create meaning. With this awareness comes the ability to invent and explore new structures or interpretive contexts. In other words, when learners come to realize how a particular set of assumptions or world view shapes their knowledge, they are free to explore what may result from an alternate set of assumptions or a different world view (p. 370).

In related discussion, Lebow (1995) suggests that learners be encouraged to explore their errors. The goal of such activity is to strengthen the learner's ability to apply and manipulate knowledge while working on authentic tasks.

Experience does suggest that students should be aware of their learning process and the causes of their errors. If, for instance, a beginning student is unable to save a file to a floppy disk, showing the student how to do it may not promote true understanding. To acquire the skill, the student must choose to reflect upon the problem, understand that the floppy disk must be specified as the destination for saving the file, execute the procedure, and then practice it. The instructor's role becomes one of engaging the student via questioning and prompting so that the student assumes responsibility for acting to solve the problem. Reflection and action, then, support construction of new knowledge.

Final Thoughts

I was somewhat chagrined while forming the panel associated with this paper to find that some university instructors are at a loss to articulate constructivist elements of their teaching efforts. I heard comments like, "I'm not an expert on constructivism — ask someone else," and "I have no idea how what we do with students could be considered constructivist!" These comments may be attributable to the difficulty we all seem to face in trying to derive concrete constructivist strategies from the somewhat scattered and still developing related literature. There also seems to be a paucity of related research.

In the end, much of what might be called constructivist strategies are ideas that good instructors employ as a matter of course. The present discussion was an attempt to explicitly link ideas about constructivism with ideas about how to best instruct adults about technology. Of prime importance, constructivists hold, is the need to move away from a view of instruction as an information transmission enterprise. Instead, we may now choose to view instruction as an opportunity for instructors and learners to work together to generate and construct new meanings and knowledge with the individual learner placed at the heart of the effort.

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MAKING CRITICAL CONNECTIONS

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In his 1983 book, *Frames of Mind: The Theory of Multiple Intelligences*, Howard Gardner proposed the theory that there are multiple ways or "intelligences" by which people acquire knowledge (Gardner, 1983). When this theory was introduced, Gardner, defined seven intelligences: linguistic, logical-mathematical, intrapersonal, spatial, musical, bodily-kinesthetic, and interpersonal. He has recently added an eighth intelligence, naturalist, to the list (Gardner, 1995). It continues to be his assumption that these separate intelligences develop at different times and in different ways in different individuals and that learners may have a preferred intelligence.

Many educators share Gardner's belief. Thomas Armstrong and David Lazear have written extensively describing how Gardner's theory can be applied to K-12 schools (Armstrong, 1987; Lazear, 1991). Sue Teele, Director of Education Extension at the University of California in Riverside, and Dr. David Thornburg of the Thornburg Center for Personal Development in Palo Alto, are co-founders of the Renaissance Project. The Renaissance Project is a research project aimed at helping students improve their potential to learn by addressing all of the intelligences (Davis, 1991). Barry Morris, Visiting Assistant Professor in the College of Education at The University of South Florida in Tampa, encourages his students to strive to be "gifted model" teachers rather than the "disease model" teachers in the twenty-first century schoolhouse. He instructs students in the development of lesson plans that include brain-compatible activities involving all of the intelligences (Morris, 1996).

Despite the amount of research and writing done since Gardner's theory was first proposed, many K-12 educators continue to plan instruction which typically only addresses the first three intelligences - linguistic, logical-mathematical and interpersonal. Believing that school doesn't have to be the way we remember it, a workshop was offered called Making Critical Connections: Bringing Gardner's Multiple Intelligences and Multimedia Together to Bring Out the Best in your Students. This paper will describe the workshop and discuss ways that technology can be utilized to activate the various intelligences.

Origination of Workshop

A one day workshop, Making Critical Connections, was offered through the UCF/DOE Multimedia Training, Research and Development Center (MTRDC) to teachers in the state of Florida in October, 1995 and June, 1996. The MTRDC is housed on the campus of the University of Central Florida in Orlando and was established to support school improvement efforts related to technology in Florida's public schools. It is funded by a grant from the Florida Department of Education, Bureau of Educational Technology and is made possible by the continued support of many business partners, Florida schools and school districts.

Faculty members in the College of Education at the University of Central Florida were encouraged to offer workshops relating technology to their particular subject areas. I was encouraged to create this workshop since I was teaching a course on how to help students develop their higher order thinking skills in our undergraduate teacher education program. I invited an intermediate multi-age teacher to work with me, as well as the Director of Faculty Technology Development for UCF College of Education.

Workshop Activities

The workshop had to be multi-sensory and fun. It opened with a brain teaser (Logical-Mathematical) to demonstrate each participant's preferred learning style. Participants sang and danced (Musical) about higher order thinking skills with a parody to Hot Hot Hot by Buster Poindexter. They participated in hands-on lessons with laser disc players, scanners, CD-ROM players and drawing tablets (Bodily-Kinesthetic). They explored the Internet alone (Intrapersonal) using a World Wide Web browser and they viewed a presentation on multiple intelligences (Spatial) using presentation software. They created their own multimedia interdisciplinary student projects in teams (Interpersonal) using authoring software. At the close of the workshop all participants returned to their schools with a notebook of materials (Linguistic) to use and share with others at their school sites.

Workshop Materials

Every participant was given a notebook of handouts which included a variety of references for future use. The notebook included:

- a template for designing multi-modal lessons;
- a listing of classroom activities to activate each intelligence;
- a multiple intelligences summary sheet;
- a weekly checklist for multiple intelligences;
- a listing of multimedia tools which can be used to activate each intelligence; and,
- an authoring software preview disk.

Connecting Technology to Multiple Intelligences

The truly exciting aspect of the workshop was the exploration of the multimedia tools which are available in most Florida schools that can be used to activate each intelligence. The following is a listing of each intelligence and the tools which can awaken, amplify, or teach each intelligence. This list was developed by the Florida Diagnostic and Learning Resource System (FDLRS). FDLRS/TECH operates as a Specialized Center in the Florida Diagnostic and Learning Resources System Network through General Revenue funds administered by Brevard County, Florida. FDLRS/East serves Brevard and Volusia Counties and is funded by EHA VI-B and State General Revenue.

Students with a High Degree of Linguistic Intelligence

think in words;
learn by listening, reading, and verbalizing;
benefit from discussion;
enjoy writing;
like word games;
like books, records and tapes;
like tape recorders, typewriters, word processors, label-makers, and printing sets;
have a good memory for verse, lyrics or trivia; and,
enjoy outings to such places as libraries, bookstores, and newspaper bureaus.

Students with Linguistic Intelligence May Benefit From:

word processors;
prompted writing programs;
label-making software;
crossword puzzle generators;
programs with speech output;
word game programs;
programs which require them to read and answer questions; and,
programs which ask them to create poetry, and other literary forms of expression.

Students with a High Degree of Logical-Mathematical Intelligence

think conceptually;
reason things out logically and clearly;
look for abstract patterns and relationships;
enjoy computing arithmetic problems in their heads;
like brain teasers, logical puzzles, and strategy games;
like to use computers;
like to experiment and test things out;
enjoy science kits;
like to classify and categorize; and,
enjoy outings to science museums, computer fairs and electronics exhibitions.

Students with Logical-Mathematical Intelligence May Benefit From:

database programs;
spreadsheet programs;
problem-solving software;
programs that teach reading in a logical way such as word patterns;
simulations which allow them to experiment with problems and observe results;
computer programming software; and,
strategy game formats.

Students with a High Degree of Spatial Intelligence

think in images and pictures;
like mazes and jigsaw puzzles;
like to draw and design things;
like to build models;
like films, slides, videos, diagrams, maps and charts; and,
enjoy going to art museums, architectural landmarks, and planetariums.

Students with Spatial Intelligence May Benefit From:

draw and paint programs;
graphic production software;
reading programs with visual clues, i.e., a rebus method or color coding;
programs which require them to solve mazes or puzzles;
programs which require them to create a picture and then write about it;
programs which allow them to see information as maps, charts, or diagrams; and,
hypermedia.

Students with a High Degree of Musical Intelligence

think in tones;
learn through rhythm and melody;
play a musical instrument;
remember melodies of songs;
may need music to study;
notice nonverbal sounds in the environment;
learn things more easily if sung, tapped out, or whistled;

can use metronomes, percussion instruments as aids for learning rote material; and,
enjoy concerts and musicals.

Students with Musical Intelligence May Benefit From:
programs that combine stories with songs;
reading programs which associate letters/sounds with music;
programs which use music as a reward;
programs which allow them to create their own songs;
programs designed to teach music concepts and skills;
hypermedia; and,
programs which add music to their computer presentations.

Students with a High Degree of Bodily-Kinesthetic Intelligence
process knowledge through bodily sensations;
communicate through gestures;
move, twitch, tap or fidget while sitting in a chair;
learn by touching, manipulating, and moving;
like role playing, creative movement, and any physical activity;
demonstrate skill in crafts such as woodworking or sewing;
enjoy fixing machines, building models, and hands-on art activities; and,
enjoy outings such as sporting events, swimming, hiking trails.

Students with Bodily-Kinesthetic Intelligence May Benefit From:
software requiring alternate input such as joystick, mouse, touch window;
keyboarding/word processing programs;
instructional games, especially arcade format with fire buttons;
graphic programs that produce blueprints for making 3-D models;
science and math programs with accompanying manipulatives and probes;
driver education programs;
software which includes animated graphics; and,
programs which allow them to move objects around on the screen.

Students with a High Degree of Interpersonal Intelligence
understand and care about people;
have a lot of friends;
like to socialize;
learn more easily by relating and cooperating;
enjoy playing group games;
are good at teaching other children;
like to be involved in clubs, committees, after-school programs; and,
enjoy outings of any kind when allowed to socialize.

Students with Interpersonal Intelligence May Benefit From:
telecommunication programs;
programs which address social issues;
programs which include group participation or decision-making;
games which require two or more players;
programs with a simulation or adventure format;
any program that turns learning into a social activity; and,
guidance programs.

Students with a High Degree of Intrapersonal Intelligence
display a sense of independence;
like to be alone;
seem to be self-motivating;
learn more easily with independent study, self-paced instruction;
prefer individualized projects and games;
need their own quiet space;
enjoy such things as the solitude of their rooms, and long quiet walks; and,
enjoy movies and books about heroes.

Students with Intrapersonal Intelligence May Benefit From:
tutorial software;
programs which are self-paced;
instructional games in which the opponent is the computer;
programs which encourage self-awareness or build self-improvement skills;
any program which allows them to work independently; and,
researching on the Internet.

Students with a High Degree of Naturalist Intelligence
observe nature and make sense of it;
enjoy learning about ecology and the environment;
think about the problems of society, the shrinking world, the future of the planet;
care about the hole in the ozone layer, and the destruction of the food chain;
fight to protect wildlife and the rain forest;
enjoy cooperative learning activities; and,
volunteer to be in charge of the class recycling project.

Students with Naturalist Intelligence May Benefit From:
simulation programs which ask them to solve environmental problems;
programs involving social issues;
Internet locations dealing with outdoor education and global education; and,
programs related to consumer education.

Can This Really Make A Difference?

The true success of the workshop, Making Critical Connections, can only be measured when participants return to their classrooms and apply the ideas they experienced. It is hoped that these K-12 educators will approach important skills and concepts in eight different ways - linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, interpersonal, intrapersonal, and naturalist. An important lesson shared will be applied when these teachers select technology for their classrooms. They were encouraged to examine not only the skills a particular computer program develops, but the intelligences through which it operates as well.

After the teams of participants presented their authoring program projects at the end of the workshop, they were asked to chart the five most important learnings of the day. I close with these five suggestions on how to optimize learning opportunities through technology for all students:

- select software which offers a variety of approaches and formats;
- select software which gives students the opportunity to learn critical curriculum skills and concepts through their learning strengths;
- provide activities related to software programs which engage a variety of intelligences;
- assist students in identifying their learning styles; and,
- help students learn to select software which helps them use their learning strengths to insure success.

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Conjoining Product Technologies with Multiple Intelligence Theory: Rethinking Teacher Preparation

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There stood a log cabin made of earth and wood,
Where lived a country boy name of Johnnie B. Goode...
He never ever learned to read or write so well,
But he could play the guitar like ringing a bell.
— Chuck Berry

Johnnie B. Goode, an American child of the 1950s, was a mediocre student. One might assume that because his linguistic intelligence was not his area of strength, he was somewhat limited in showing his teachers what he had learned. His teachers may never have given him the opportunity to show his knowledge through his area of genuine strength, his musical intelligence. If his teachers had, they would have recognized his intelligence, adjusted their instruction, and possibly motivated him to "read and write" better.

Today's Johnnie, an American child of the 1990s, should not have to face the same problems as the 1950s Johnnie because many educators, and even parents, have broadened their views of what constitutes intelligence. Intelligence is no longer traced to verbal and nonverbal categories, but instead is understood as being reflected in various modes of expression and behavior (Gardner, 1983; Gardner, 1991; Gardner, 1993; Sternberg, 1990); furthermore, information is now available to assist teachers with addressing multiple intelligence in the classroom (Bennett, Tipton & Bennett, 1996; Campbell, Campbell & Dickinson, 1996; Gardner, 1995; Mc Clasky, 1995; Smagorinsky, 1995), and even popular literature references ways for parents to be aware of and tap into their children's intelligences (Blumenthal, 1996).

Despite the seemingly widespread dissemination of these less restrictive views of intelligence, questions arise as to how well classroom teachers understand and truly use multiple intelligences as a guide to classroom practice. As with the initial appearance of any innovation in educational theory and/or practice, multiple intelligence theory might be dismissed by some teachers as a fad or viewed as a threat to their personally held beliefs about learning which were nurtured in preservice education programs.

Assumptions and Purposes

We believe that knowledge can be represented in different modes, and that students process knowledge in a variety of ways. One way we actualize this developmental perspective is through Gardner's multiple intelligence (MI) theory. As teacher educators we subscribe to the proposition that Gardner's multiple intelligence theory is a form of*idea* technology as described by Hooper & Rieber (1995). Idea technologies, unlike tangible product technologies such as computer hardware and software, are systematic, intangible theories that guide a process. Examples include cooperative learning, problem-based learning, and simulations as well as many others. MI Theory, as an idea, undergirds our instructional and assessment decisions as we teach our undergraduate preservice education students at La Salle University in Philadelphia, Pennsylvania. We believe that inter- and intrapersonal, spatial, musical, and kinesthetic intelligences are true intelligences like their more traditionally accepted mathematical/logical and linguistic counterparts. They are not merely *talents* or *aptitudes* (Armstrong, 1994).

In addition, we hold that product technologies are natural complements to MI theory because they enable learners to access and apply their natural learning styles or preferences more readily, which Armstrong (1994) suggests emanates from one or more of their personal intelligences. Thus, by conjoining MI theory with a variety of product technologies, we believe that we are more likely to engage our students and assist them in comprehending course content.

The purpose of this action research (Kindsvatter, Wilen, & Ishler, 1992) is to hold a mirror to our own practices regarding the manner in which we operationalize our beliefs about MI theory. In addition, we raise questions regarding the appropriateness and effectiveness of infusing both MI theory and product technologies in so-called "non-technology" teacher education courses. The following two questions guided our investigation:

- In what ways, if any, has Multiple Intelligence theory, an idea technology which we espouse, informed our everyday classroom practice in teaching non-technology teacher preparation courses?
- To what extent do the product technologies we incorporate into our classroom practice interact with Multiple Intelligence theory?
- Ultimately, through this examination, we hope to improve the teaching and learning taking place in our courses.

Procedures

During the 1996 Fall semester, we collected data from our three respective undergraduate courses — Educational Psychology, Foundations of Education, and Developmental Reading. The Educational Psychology course, intended for second year education majors, is open to non-education majors; whereas, the Foundation of Education and Developmental Reading courses intended for third year students typically enroll education majors who do student teaching within the year. Each course enrolls twenty-five to thirty students in a fifteen-week semester. Classes are held twice per week, one one-hour, and one two-hour period.

Although our individual format for data collection varied, each of us, for each class session, classified the entry strategies we employed. Unlike traditional entries that focus upon attention-getting, review, or preview techniques (Kindsvatter, 1992), Gardner (1993) describes five specific entry points which "help the teacher introduce new materials in ways...that...can be easily grasped by a range of students...so they have the chance to develop...multiple perspectives..." (p. 203). It is in the context of Gardner's view that we classified our entries. Next, we inferred, through careful reviews of lesson plans and post-instructional analyses, the types of intelligences we addressed. Finally, we noted the type and frequency of product technologies we incorporated into our instruction. From our logs and notations we subsequently refined and formalized a *Multiple Intelligence & Technology Checklist* (see Figure 1) which helped us develop a more systematic and comprehensive overview of the instructional technologies that we used.

Data collected was analyzed by examining the frequency and distribution of responses — first for each researcher, and then for the aggregate group — listed for the three categories contained in the *Multiple Intelligence & Technology Checklist*. Where appropriate, we debated individual interpretations of classifications until agreement was established.

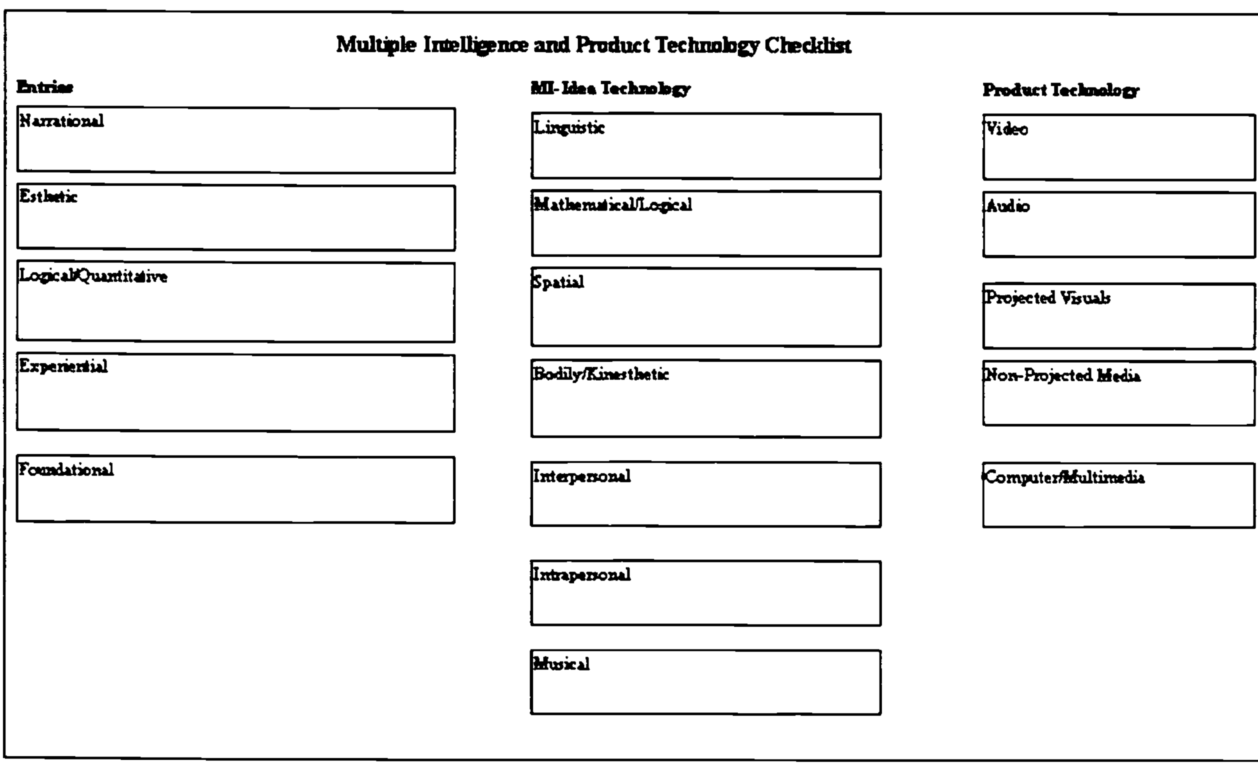

Figure 1. Multiple Intelligence and Product Technology Checklist

Results

In Table 1, five entry points, or modes of addressing a concept, are identified (Gardner, 1993). Collectively, we used *narrational* entries — that is, story or historical approaches to topics, most frequently (25%). This was followed closely by *foundational* entries (24%) which examine philosophical or terminological aspects of concepts; *logical/quantitative* entries (22%) which emphasize numerical or deductive reasoning; and *experiential* entries (20%) which employ hands-on approaches. The least frequently used type of entry was *esthetic* (8%) which highlights artistic, sensory, or surface features of concepts.

Table 1.
Entries: Frequency and Type

Entry Points				
Narrational	Esthetic	Logical/ Quantitative	Experiential	Found- ational
52/209	17/209	47/209	43/209	50/209
25%	8%	22%	20%	24%

Total Number of Entry Incidences (n = 172)

Linguistic intelligence (26%) was the most frequently inferred use of MI-idea technology (see Table 2). This was followed by *mathematical/logical* (20%), *interpersonal* (19%), *intrapersonal* (18%), and *spatial* (12%) intelligences. There was a precipitous drop in the reported incidence of addressing *bodily-kinesthetic* (3%) and *musical* intelligences (less than 1%).

Table 2.
Idea Technology: Frequency and Type

Multiple Intelligences						
Ling- uistic	Math/ Logical	Spatial	Bodily/ Kines- thetic	Interper- sonal	Intra- personal	Musical
73/279	56/279	34/279	9/279	54/279	51/279	2/279
26%	20%	12%	3%	19%	18%	>1%

Total Number of "MI"/ Idea Technology Incidences (n = 279)

The most frequently used category of product technology (46%) was *non-projected media* which included the use of handouts, the chalkboard, comic strips, realia, flashcards, puppets, books, dolls, etc. (See Table 3). The *projected visuals* category (29%) ranked second with the overhead projector being the predominant hardware that was used, supplemented with the occasional use of a 16 millimeter film projector. There was a pronounced drop in the remaining three categories: *computers/multimedia* (13%), *video* (10%), and *audio* (2%).

Table 3.
Product Technology: Frequency and Type

Product Technologies				
Video	Audio	Projected Visuals	Non-Projected Media	Computers/ Multimedia
17/172	3/172	51/172	79/172	22/172
10%	2%	29%	46%	13%

Total Number of Product Technology Incidences (n = 172)

Discussion

Entries and Idea Technology: Doorways to Learning

Gardner's (1993) concept of different types of entry points provided us with a way to examine how our instruction provided conceptual gateways for our students. We had anticipated our across-the-board use of narrational, experiential and foundational entries; however, we were surprised by the relatively low citation of use of the esthetic entry. We discovered that one of the authors used the esthetic entry significantly more often than the other two. Teaching the Educational Psychology survey course, he found that the students were not sufficiently engaged with the material. Over the years he has developed a repertoire of esthetic entries designed to foster and increase interest and motivation. For example, when introducing the concept of psychoanalysis the instructor began his class by asking his students, "Who can remember and share with us what they dreamt last night?" The other two instructors who teach upper division courses for the majors used this entry less frequently and on a more limited basis, for example, one just used comic strips and newspaper ads which elicited strong learner responses.

Assuming that our entry classifications were accurate, we inferred which of the seven intelligences were being promoted either by the initial lesson entry or transitional entries within the class session. The higher incidences of addressing linguistic, interpersonal, and intrapersonal intelligences confirmed what we encounter in an academic context, namely — the university. Language is a wonderfully efficient tool that we, as teachers, rely upon to convey abstract information, probe the depths of our students' understanding, and share insights about that understanding with others within finite amounts of precious classroom time.

Interestingly, we were heartened by the relative frequency of our addressing mathematical/logical intelligence. This higher incidence proceeded from our understanding that this form of intelligence was not limited to pure numerical quantification, but included opportunities for analytic reasoning as well. Instructor use of concept maps, such as top down, hierarchical branch tree diagrams, proved to be one such entry tool used to promote deductive and comparison-contrast reasoning. Visual in nature, concept maps also provided "doorways" for spatially oriented learners.

Overall, we were not surprised by our lack of attention to bodily/kinesthetic and musical intelligences. Although we had realized individually that we did not address these intelligences, seeing the combined frequencies in print really jolted us into recognizing that we may not have provided a sufficient number of pathways for students who might have benefited from learning opportunities using these intelligences. Possibly, if we had implemented more esthetic entries, we might have been able to address these students' needs more effectively.

Product Technologies

Our preponderance of the use of non-projected technologies did not strike us as extraordinary. Curiously, we discovered that two of us did not even tally some of the non-projected technologies; for example, chalkboard and handout usage. Two of the authors discounted these tools because they were not readily perceived as forms of product technology. Hooper and Reiber (1995) might argue the reason for this lack of awareness is because chalkboard and handout usage has been so well integrated into their instruction that these two authors took such media for granted. Ironically, without these forms of product technology, they would have found it difficult to be as effective.

Computer use was cited more frequently than we thought due to one author's sole use of presentation development software. Upon reflection, it was discovered that this was due to her renewed enthusiasm upon resumption of full-time teaching and access to a multimedia-ready classroom. In contrast, one author did not use the computer due to general lack of familiarity and expertise, while the other author, who possesses considerable expertise, did not have convenient access to the electronic technology.

Recognizing video as a convenient, user-friendly product technology, we were somewhat intrigued by its relatively infrequent use. Again, one author used video frequently in his Educational Psychology course to motivate as well as to instruct. In the Developmental Reading course, video was used strictly to demonstrate procedures; whereas, in the Foundations of Education course, video was used to present models of schooling that were then analyzed. Audio, also readily available, remained the least frequently used product technology and its use was limited to demonstrate linguistic issues or present dialogue, never music.

Idea and Product Technologies Conjoined

We believe that the varied entry points employed throughout the semester afforded us opportunities to address most but not all of the multiple intelligences to which we espouse. Obviously, we will need to review our individual lesson entries and actions to see how, when, where and if we should adjust our current practices to provide more consistent gateways to target bodily/kinesthetic and musical intelligences. To what extent did product technologies provide us with these perceived MI Theory "hits"? A review of the types of technology used underscored how specific product technology fused with MI Theory as an idea technology. It also identified gaps.

Multimedia presentations, video, projected and non-projected visuals helped to provide entries for students with linguistic, logical-mathematical, and spatial intelligences. Video case study presentations and demonstrations also resonated with those students who possessed strong interpersonal and intrapersonal intelligences. Non-projected visuals and materials may have assisted learners with spatial and bodily/kinesthetic intelligences. Unfortunately, our audio products addressed linguistic perspectives rather than music. Johnnie B. Goode would probably fare no better in one of our courses than he did in the 1950's hit song.

Implications

We were propelled into this investigation during the hazy, lazy days of summer 1996 by irreverent questions posed by one member: "Do we really believe in this MI stuff, or do we just teach it because it's something our students need to know? If we do buy into it, how do we really practice these beliefs?" What started as an informal discussion sparked a full fledged investigation into what we think we know about MI Theory, how we operationalize it and how it complements the developmental theory that is the hallmark of our education department's programs. We all agreed that we were disciples. But what did that really mean? Again, what started out as a review of our current practices to see whether or not we actually employed elements of MI theory in our courses has turned into the mythical Hydra. Each time we thought we finally understood an MI Theory concept and its relationship to our actual beliefs and practices, another more startling or disturbing question would rear its head to mock our understanding. Rather than just answer our two proposed questions, we found that we raised a myriad of new ones.

Our study prompted us to recognize the overlapping nature of Gardner's seven intelligences. We came to appreciate that these are not discrete, self-contained entities but parts of an interwoven tapestry. This fusion and cross-nurturing of the intelligences can best be understood as a synergistic fusion reflecting a Vygtoskian infrastructure, wherein one intelligence has the potential for promoting another. A prime example of this fusion was when one author in teaching educational philosophies simulated "Ryan's Coffee House" wherein students informally argued the merits of various philosophies underpinning school policies and operations. Here, a student's interpersonal intelligence acted as a catalyst in priming both linguistic and bodily/kinesthetic intelligences to argue the benefits of a particular position which ultimately led to a fuller understanding of how educational philosophies function.

Teacher educators need to go beyond cursory explanations of Gardner's seven intelligences. Our experiences this fall reaffirmed our assumptions that we must not only explain what is meant by multiple intelligences and overtly model how they can inform planning and instruction, but also demonstrate —even in "non-technology" preparation courses — how, by incorporating a broader use of product technologies, we can increase the likelihood of reaching the next generation of Johnnie B. Goodes.

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SEMIOTICS AS A SOCIO-CULTURAL TOOL FOR A "SOUNDBYTE AND SOFTWARE" SOCIETY

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Winston Churchill once said "The empires of the future will be the empires of the mind" (Toffler, 1990, p. 1). Ironically, philosophers and psychologists have made similar observations over the centuries, but their words have often remained buried in the discourses of their respective disciplines. The thawing of relations with the former Soviet Union has unearthed the works of psychologist Lev Vygotsky. Vygotsky's observations were unique because he crossed over professional disciplines of psychology, philosophy, and sociology to explore a key component of the mind, consciousness via the mind's activity functions. He did so using the tools of those activities: symbols (Davydov and Radzikhovskii, 1985). Vygotsky's research has presented opportunities to approach individual mental processes as determined by one's historically developed activity, both on a physical level, through labor, and on a mental level, through the use of "psychological tools" (Wertsch, 1985).

In this study, I reviewed the translated research of Lev Vygotsky and compared his use of the term "psychological tools" with research in the areas of metaphors and semiotics to see if metaphors and semiotics could be considered "psychological tools." If so, could these semiotic "psychological tools" be included in media soundbytes and in computer software design to mediate consciousness? Since my research interests reside in the area of instructional technology, my intention was to explore psychological theories, like those of Vygotsky, to see how instructional technologists might use these theories to design innovative technology programs that could have positive and dynamic effects on learning activity.

Vygotsky's Legacy

The body of research initiated by Vygotsky offered the basis for a culturally grounded theory of cognition, with common units of analysis that could even transcend the limitations of professional and political boundaries. His concept of "mediated tools" linked culture to the functions of consciousness (Wertsch, 1985). His theory of the "zone of proximal development" (Vygotsky, 1978) provided a foundational underpinning to constructivist philosophy and to the field of education. It also offered insight that would later become beneficial in instructional technology because that "zone" has evolved beyond the "zone" of proximal human development to what is now "virtual" infinity. Vygotsky also shed light on the need for the expansion of the field of socio-cultural studies so that social and cultural influences could be viewed across professional, as well as national, boundaries.

The traditional dictionary meaning assigned to the word "tool" is "anything, which, held in the hand, assists a person to do manual or non-manual work. (New Lexicon Webster's Dictionary of the English Language, 1989)." Vygotsky used the word "tool" in a similar context, assigning it meaning in relation to work. But Vygotsky's "tools" consisted of metaphors, symbols, and semiotic representations of communication, like auditory/vocal and visual expressions; body talk (kinesthetics); touch (proxemics); and prostheses (extensions of limbs); and, while Vygotsky was very precise in his use of verbiage and definitions, by his definition, "tools," would include current technological instruments (Wertsch, 1985.)

Metaphors

Metaphors are figures of speech which attribute a similar quality or name to something which is not literally applicable to it (Webster, 1989). By reasoning through metaphors, anchoring of information can occur that facilitates understanding of new ideas (Gallini, Seaman, & Terry, 1995). Metaphors are verbal, so the stories told as metaphors, along with speech patterns and method of story delivery, all play a part in the successful understanding of the metaphor. Metaphors conjure up images and emotions, i.e., bittersweet thoughts of love from the metaphor of the lemon tree that, while beautiful, bears sour fruit. Making sense of metaphors can vary, even within the same social group, depending upon the culture of both the narrator and the listeners (Gee, 1990). Vico pointed to the metaphor as the crucial factor in the development of language. Even B.F. Skinner felt that metaphors had a strong impact on society and included them in his overall theory of verbal behavior (Verene, 1993, Danesi, 1993). Vygotsky used a metaphor to illustrate his philosophy of knowledge: the metaphor of two vines: the vines of cultural, environmental knowledge; and the vines of disciplined, authoritative knowledge. The child's spontaneous concepts, one vine, grows upward as language and experience develop; instruction and scientific concepts cause the second vine to grow downward, with abstraction moving to a more concrete level (Fernlund, 1995).

"Metaphoric Language Programming (MLP)" was a term initiated in the early 1950's when Karl Buhler began collecting data on how subjects paraphrased proverbs (Buhler, 1990). The results of these early studies encouraged a plethora of additional studies supporting hypotheses that metaphors were not alternatives to literal language, they were already embedded in iconic thought. MLP research explored "frozen metaphors," metaphors that had been absorbed into daily language; bodily reaction responses to metaphors; and the processing of image schemata. Studies of the era also looked at the impact of metaphors and the implications of how humans respond to metaphors. These types of studies began to pose that metaphors involved iconic thinking, filled conceptual gaps; and could become absorbed into society, taking on a literal quality as a part of that culture. The metaphor has become acknowledged as a tool that utilized creative language to provide a universal conceptualization of basic human tendencies (Danesi, 1993; Verene, 1993). A metaphor can shift prevailing public attitude with its persuasiveness (Turbayne, 1962).

Semiotics

Semiotics is the study of patterned human communication behavior, including auditory/vocabulary, facial expressions, body talk, touch (proxemics), signs, and symbols (Webster, 1989). As socio-cultural tools, the signs and symbols of semiotics take on enriched meaning, affecting the functions of human consciousness as well as their environment. Ultimately, everyday language and discourse come under the scrutiny of this discipline since it becomes a metalinguistic descriptor of ordinary communication (Dant, 1991). Ordinary language identifies and uses written material and verbiage to communicate and express meaning. It also uses these "tools" to construct meaning and, in some psychological schools of thought, i.e., the structuralist school of thought, analyzes these tools in order to study the social context of language.

Levi-Strauss took this analysis one step further, incorporating more intimate terminology. He stated that "terms are elements of meaning...however they acquire meaning only if they are integrated into systems" (Levi-Strauss, 1970). He posited that if forms are recognized as the same for both ancient and modern minds, as the study of the symbolic functions indicates, the unconscious structure underlying customs and institutions need to be studied to "obtain a principle of valid interpretation" generically applicable across cultures (Dant, 1991). There are proponents of semiotics who pursue the meaning of culture on a deeper, metalinguistic level. On the opposing side, there are also semioticians who ignore "insignificant" semiotics of every day life that are laden with meaning and social and political significance (Dant, 1991). These "insignificant" phonema often contain inspired rich meanings that fill in the gaps of information and help define cultural, and, in particular, socio-cultural, trends.

Signs and Symbols

A "Sign" is defined as "a mark or gesture which conveys an idea or meaning; something having symbolic character; a mark or gesture adopted as a method of recognition (Webster, 1989)." Vygotsky defined the sign as "the basic unit of communication" (Turner, 1993, p.121). A sign is divided into two components: the signifier (the narrator) and the signified (the receiver). Much of the conveyance of the signifier will be affected by whether the sign already has a symbolic connotation, for example a sign of a dove or a peace symbol will generally receive a positive, or at least neutral, response. Conversely, a swastika or skull will generally receive a negative response since there are already existing negative connotations for those signs (Turner, 1993).

Vygotsky termed "signs" one of the "psychological tools" used in mediating with consciousness. He elaborated examples of signs as language, counting systems, algebraic symbols, writing, diagrams, maps, conventional signs, etc. He stressed the importance of signs, noting that "the analysis of sign meaning is 'the only adequate method for analyzing human consciousness'" (Wertsch, 1985). Vygotsky identified two primary sign symbolisms: the first kind denoting actions or objects, i.e., pencil dots on a paper used to denote running; the second kind denoting written signs, i.e., an "F" for failure, or a "green light" to symbolize permission to proceed. "Understanding of written language is first effected through spoken language, but...(later) disappears as the intermediate link. Written language becomes direct symbolism perceived the same way as spoken language" (Turner, 1993). Symbols are important, Vygotsky held, because of their use as "instrumentalist tools for the creation of meaning" (Wertsch, 1985, p.232). This opinion is contrary to many contemporary views of language, which hold that language is the tool from which meaning is derived and constructed (Wertsch, 1985; Davydov & Radzikhovskii, 1985). Vygotsky also held that meaning was not a result of language; instead, he felt the revolutionary activity of meaning-making was the precondition for language-making (Newman & Holzman,1993). Symbols can also disrupt meaning. Ironically creativity, particularly of children, can precipitate new symbols and, ultimately revolutionary, cultural changes. "It is the revolutionary activity of children — their meaning-making, their 'disruption' of the societal organization of signs and symbols — and sounds — that makes their adaptation to societal organization possible (Newman & Holzman, 1993)."

A deeper meaning of symbols can capture the essential features and structures of modeled activities. Some contemporary psychologists have adopted the retentive and exponential qualities of symbols and integrated those properties into behavioral activity. This activity has been called "symbolic transformation" because it uses the resilient aspects of symbols to encode desired modeled behaviors and affect transformative behavior. Moreover, these modeled activities can be transformed into images and verbal symbols to serve as "guides for subsequent action" (Bandera, 1994).

Technology and Culture

Much of the current research on technology has been influenced by the writings and research of Marshall McLuhan (McLuhan, 1976) who felt that, ultimately, the medium is the messenger of information for society. Ultimately, the medium itself becomes the message...of the shift it has processed through society and the evolution of that society into a new culture. "This insight contains an element of truth easily grasped by anyone: most simply, just that the radio is different from the book, and one senses the difference in the experience of either" (Neill, 1993). In a mere hundred years, radio and electronic media changed the world and all of the cultures of that world into a new culture. McLuhan also held that communication was a form of social action best studied as a process of creating and managing social reality, rather than just a technique for describing it. McLuhan believed cognition was patterned after language, and language was a form of action, therefore that action, in communication of language, influenced cognition. Traditional communication had focused on the transmission of objective, external, information from "experts", scholars, educators, journalists, to the "non-experts"; in doing so, focused on source-using, not constructing, behavior. Technology altered culture by changing the way things were done and the way information was communicated. McLuhan noted: "the use made of it (radio) and of speakers, like Hitler, had been noted...the extraordinary success of Hitler in Germany, (was) won by a faculty of speech" (Neill, 1993, p.86). Hitler's speeches affected his own society enough to spread a war of hate that ultimately impacted the entire world. McLuhan supported the psychological view that the dominant medium of communication fundamentally effected changes in the human psyche, and in social and political acts. He noted that Newton's *Optics* established a correspondence between inner and outer worlds, between the forms and textures of the world and the faculties of perception and intellection, which has affected the practice of every poet and painter since his time (Neill, 1993).

McLuhan also believed, however, technology was changing more quickly than the mind, which could only process "x" bytes of information. In time the technology would far outpace the mind, which would short circuit the mind with the overload. He suggested pacing the technology as a way to side-step this overload, or face the consequences of a "future shock" (McLuhan, 1976; Toffler, 1970).

Metaphors in Media and Technology

"Life is like a box of chocolates, you never know what you're gonna get...(*Forrest Gump*, Zemekis, 1995). Metaphors become more graphic when combined with several sense "tracks." In the "*Forrest Gump*" example, the metaphor for chocolates, combined with the sound "score" (a term describing the auditory tracking technique in film as well as the traditional written rendition of written musical notes), and a visual picture of "Forrest" holding the box of chocolates, all provide a multi-sensory metaphor. "The series of events in a film (or television show) all enact the same metaphor (Whittock, 1990)." Recurrent metaphorical patterning is multi-dimensional, being repeated not only in the script theme, but in the symbolic references, the elements of lighting, like that of film noir, which reflects a cold fearful world of shadows, and repetitive haunting strains of the music score (1990, p. 35).

Today's journalist uses words, signs, and symbols to convey sounds, images, and contents. "The journalist, not the candidate or other 'newsmaker,' is the primary communicator (Del Rio & Alvarez, 1995)." The exigencies of field reporting in conflicts like the Vietnam War, and later the Middle East Conflict necessitated short reports of events, the style of which continued afterwards as the "preferred mode" of news, along with other types of reporting and entertaining. The media "soundbyte" has particular relevance because it is designed to elicit an emotional response in twenty seconds (Brown, 1992, p.522). Each segment is scripted, footage made, editing done, and the final edited message culled to be conveyed in twenty seconds. Because this type of short programming is less expensive to produce and allows interruptions for advertising, it has grown to become the preferred delivery style in all media, including "The Internet" (Wertsch, 1995).

Computer metaphors often use some of the same metaphors as movies and television. "The mind is a computer" is a popular foundational metaphor in the computer language. the general description, "writing is software" would be another example of a metaphor.

Patterning metaphors, similar to media, exist as well in software, with the names of the software indicating their contents, and their contents, in turn, reflecting symbolic references, "Scripts" (programs), and graphics that repeat the general theme of the software design. The titles basically describe what the programs do, and each program reflects its metaphor. Even games are now played in "virtual reality."

Socio-cultural Influences of Soundbytes and Software: A Discussion

Vygotsky foresaw a need to approach psychology to accommodate the dynamics of a rapidly changing culture. He believed that "...a cultural content emerges in which the development of cultural systems results in decisions (that) become a kind of symbolic action...we can legitimately consider these new psychological designs based in the cultural operators to be 'cultural theories of mind" (Del Rio & Alvarez, 1995, p. 232).

Space and time no longer exist in the same linear way as in the past . Globally, people watch CNN (Cable New Network), e-mail each other while listening to music on their digital audio systems, they look up information on their electronic encyclopedias, get stock market quotes on the World Wide Web, and fall asleep to videotaped movies. To McLuhan, modernity is repositioning time from linear chronology, due, largely, to the influence of electronic media. Time, as a linear descriptor of events, is being replaced by a "home page" of simultaneously presented information which can come from the past, the present, or predict the future. With the Internet, and ever newer technology, "the unceasing relocation of information in time and space (has changed)...the co-ordinates of time and space have vanished" (Stevenson, 1995). This "simultaneous" relocation of information into a "communal mosaic"(p. 122) is generating a more internationally based public sphere that exchanges information across the boundaries of hierarchies, of nations, and will, ultimately, create a new global culture.

If socio-cultural influences exist in a dynamic relationship between integration and historicism, as research cited in this study suggests, then "soundbytes and software" may become a future legacy of contemporary culture. It is my opinion that Vygotsky was correct, that consciousness must be observed and measured through its functions of activities in interaction with culture. The "functions and activities" (Vygotsky, 1978) of our culture must include more studies on the psychological effects of electronic media, including software, not just in measurement of how much data or material is presented, or how fast it is processed; rather, the studies should be conducted across the multiple domains of science, academia, commerce, and everyday life. Without finding a way to "surf" through the oceans of information bombarding mankind, it is difficult to get a "big picture" of long-term socio-cultural effects. In addition, "soundbytes" and software could be evaluated through collaborative research across academic disciplines. This would enable psychologists, philosophers, sociologists, as well as instructional designers, to get a perspective of how consciousness will adapt using technological "mediation tools." Ultimately, cross-academic and cross-cultural studies would help provide reflective data on the impact of technological innovation and electronic media upon both culture and society.

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Thematic Approaches to Developing Technological Management Skills of Educational Administrators

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Computers and computer applications have become a necessary component of almost every occupation—business, government, entertainment, sports, medicine, education, telecommunication, etc. As a result, students need to be exposed to computers and computer applications throughout elementary, junior high, high school, college and/ or university to become better prepared for real-world experiences.

During the past ten to fifteen years, computer technology has been gradually integrated into the regular classrooms. Some teachers have eagerly implemented this technology into their teaching techniques and curriculum. However, Clark (1992) found that more than 70% of educational administrators surveyed in the state of California felt unprepared in computer technology. Handler (1993), on the other hand, found that approximately 90% of "educational administrator programs offer some opportunity for computer training" (p. 147) for their preservice school administrators. According to McKeown (1992), an individual who is computer literate has "an understanding of what a computer can and cannot do and ability to make the computer do what is desired" (p. 14). Although many university programs are offering computer training, a large number of school administrators are of the belief that they need more knowledge. If computers are indeed an important technological tool for school administrators, clearly more must be done to prepare them to be confident in their use.

This article addresses three concerns: (1) administrative purposes for which microcomputers can be used by school administrators; (2) microcomputer training that is available to school administrators and can be offered in educational administration programs; and (3) educational administration institutions' future role for providing adequate and meaningful computer courses for present and future administrators.

While it is well established that much emphasis has been given to the use of computers in the classroom in the form of Computer Assisted Instruction (CAI) and Computer Managed Instruction (CMI), more emphasis should be given to providing meaningful computing skills to school administrators. Educational administrators face many challenges in U. S. schools. With increasing demands placed upon educational administrators, it is essential to determine both the quality and effectiveness of programs being offered to individuals in pursuit of becoming successful educational administrators. It is, therefore, imperative that educational administration programs, which now provide limited generic computer instruction courses as electives, should continue to evaluate and enhance their computer training programs for prospective administrators.

Administrative Use of Educational Technology

Although many school districts have been influenced by the introduction and use of microcomputers with the classroom teachers, school administrators have not yet fully recognized their potential utilization for administrative tasks. Many school administrators are either unaware or are skeptical of the possible benefits offered by microcomputers, while others are unwilling to capitalize on this technology. Additionally, many educational administration programs seem to have neglected the provision of courses that are solely designed for school administrators.

Olson (1985) contends that two schools of thought exist with respect to the use of computer technology, both of which have implications for training programs. According to Alson (1985), "one school of thought views that the computer is a tool; the other that the computer is a means of creating or innovating" (p. 11). Shalvelson and Salomon (1985) further contend that computers should be considered from both perspectives.

If used as a tool, computer training should be application-based (Lockheed & Mandinach, 1986). The time-consuming, routine and ritualistic tasks which consume the administrator's day, as well as the more sophisticated tasks like resource allocation, could be handled by appropriate software. Training would require a certain level of knowledge, such as learning to use the elements of basic computer software. These might include acquiring a certain level of competency or computer literacy and learning certain skills such as how to develop and use templates, as well as procedural skills.

Such application-based computer training should foster high cognitive skills, by encouraging the generalizing of these skills and fostering a positive attitude toward change and self-improvement. Moreover, Olson (1985) attests that by learning to communicate with the computer, one becomes more literate, merely through the process of making one's meanings explicit. The computer can be used not only as a tool, but also as a tool for the utilization of various types of simulations.

Need for Formal Training

The second school of thought considers computer technology as an opportunity for educational administrators to "blend school effectiveness, leadership, and management development into a program of revitalization" (Mojokowaski, 1985, p. 45). Rather than just automating, the leaders should be asking "what if..." questions, using the computer for simulations and solving problems.

This school of thought recognizes the entrepreneurial role (Mintzberg, 1975) of the manager, that is, the educational administrator. It might be difficult, however, to determine what type of professional development activities would be appropriate to encourage administrators to become more creative, innovative, and risk-takers. According to Alson (1985), "they should become reasonably competent with computer software in order to manipulate the software to suit their own programmatic needs" (p. 12). Alson further contends that administrators must acquire a positive attitude toward change in general and a confidence that they and their staff can create a future of their own choosing. Regardless of the process, of importance is that educational managers use computers to accomplish the range of tasks for which they are responsible, not only routine and maintenance tasks, but also solving problems and completing the unique tasks that come their way.

Regarding the first concern, the administrative uses of microcomputers are classified in various ways. One general plan uses five categories of administrative applications:

1. School Facilities - Software used for this purpose performs the function of an electronic filing system adopted to the task of cataloging equipment and other fixed assets, inventory, textbooks, and other items. Each software package contains predefined items of data to be kept on each item in the electronic file. Filing, sorting, searching for, and reporting of inventory are tasks that data management components of integrated systems perform well.
2. School Finance - These tasks, which often involve rows, columns, and tables of numbers, that can be performed efficiently with an electronic spreadsheet. Applying the design of the task to the spreadsheet will require learning and may be time consuming, but the ultimate time savings and improved efficiency will be worth it.
3. Student Affairs - A student record system will store and retrieve basic information concerning each student. Commonly found items of data include student's name, gender, ethnic group, student identification number, age and birth date, parent's or guardian's names and addresses. A well-designed student record system will permit one to access students by using any of a number of criteria or variables. The payoff for storing student data on a microcomputer is the speed, and convenience, and accuracy of retrieving information from the system.
4. School Personnel - This software primarily performs the tasks of filing, sorting, searching, and reporting. Such data as educational training, certification areas, certification expiration dates, inservice education activities, as well as personal data, are easily retrievable.
5. General Applications - A word processing software is an example of a general purpose program. Word processing software makes it possible for a small administrative center, such as a school office, to produce professional correspondence documents. In producing documents using word processing software, school administrators can utilize graphic software to add such features as bars, lines and pie charts. Other types of graphics software will help to improve reports, brochures, newsletters, and other applications through a variety of performed designs.

Despite all the advantages of using computer technology to aid educational administrators as listed above, the literature notes that few principals are using the technology (Corbett, 1982; Sturdivant, 1986; Sununu, 1986). Corbett, (1982) provides some specific reasons why educational administrators, as a group, do not seem to be making extensive use of this technology. Those reasons given are: a) computer hardware and software are too expensive, especially for poor school districts; b) lack of personnel with necessary expertise; and c) lack of proper university training. Sununu (1986) noted that few school districts developed policies on how they planned to use the technology, yet this aspect is fundamental to the change process.

Regarding the second concern of this paper, microcomputer technology is ideal for students entering the principalship or other entry-level positions for administration. A microcomputer technology class is necessary so that beginning principals can become computer literate and able to personally use microcomputers for administrative tasks. If these students do not possess such level of knowledge and skill, they should be provided with the opportunity to acquire the expertise through educational administration training institutions. These institutions would then build on this competency by teaching administrative uses of computer technology and introducing students to specialized management software.

Educational administration training institutions must incorporate instructional courses specifically designed for school administrative use. Recently prepared administrators tend to use microcomputers to a greater degree than incumbents who received their preparation in administration prior to the advent of microcomputers.

Future Role of Educational Administration Institutions

Finally, it is the responsibility of educational administration institutions to provide more intense courses specifically designed and geared toward meeting administrative microcomputer uses and to provide meaningful inservice computer workshops that are specifically designed for school administrators. As the number of professors in the training institutions who use microcomputers increases, a greater emphasis on microcomputer use in educational administration programs should be emphasized. At present, it seems microcomputer instruction in most educational administration institutions is offered as an elective for most students and most of these courses do not provide sufficient depth to give students the competency to use the microcomputers for administrative purposes.

According to current available literature and personal observations and experiences, there are relatively few school principals who are personally using microcomputers for administrative purposes. The number of software applications available for administrative tasks is equal to, if not greater than, that of classroom computing or instructional management. If the claims of computer technology as a tool for administrators are valid, then much work remains to be done to better prepare school principals and others to be more comfortable and competent with the use of the computers.

In the immediate future, educational administration programs should continue to evaluate and enhance their instruction pertaining to the administrative use of microcomputers. What part of the instruction that should be provided in computer courses and what part should be in conjunction with existing administration courses should be determined by educational administration training institutions. Of course, educational administration faculties must also continue to grow in their own understanding of microcomputers so that they are able to offer meaningful instruction. Students in principalship programs cannot ignore the need to take computer technology courses that are specifically designed to meet their administrative needs. In addition, educational training institutions should develop and improve courses that are specifically geared toward meeting the needs of the students in school administration programs to keep up with the ever growing technology. College professors in these training institutions should also personally continue to grow in their computer technological knowledge so that they can model computer use and mentor their students in becoming technologically able to administer.

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Hypertext, Hypermedia, and Nets as Tools for Learning: The Case of Argentina

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First we will try to give a perspective of Argentina facing the challenge of technologies in multiple environments : economic globalization , education and Mercosur. In our opinion, this political moment implies certain decision taking that are strategical for the country's future. Although we will not present a deep view of globalization (our topic is technology and education) we can't deny the effects of this process into local economy, affecting the rates of unemployment and the access and continuity of children in the school system.

Latin America in general is going through the same problems because of the implementation of the same policies, so is urgent to construct new categories and paradigms to research and transform this reality. There are regional similarities beyond this, such as the need of articulating efforts in economy , marketing, communication and education represented by MERCOSUR : a political frame that resembles the concept of NET, and the education nets themselves such as TelAr (Argentine School Network) and RIU (Argentine Universities Net). As we can see in Columbia's Home page, the "Institute for Learning Technologies is guided by an understanding that, by and large, the defining characteristics of the modern school precipitate from the implementation constraints of the information technology that enabled and supports them. As we enter a time when networked digital technologies are fast becoming the prevailing technologies for communication and for information retrieval, processing and creation, the Institute seeks to identify new ways to realize various pedagogical principles — ways that are enabled by this shift in dominant technologies. The educational principles and practices the Institute advocates have historically found expression in diverse philosophical contexts, and they have implications for the whole of the educational enterprise — for schools' size, schools' physical structures, schools' temporal structures, teachers' roles, curriculum, methods of curriculum design and development, teacher training, and so on. My interest in Canada is focused in this country's experiences in New Technologies, specially in Montreal in McGill's Faculty of Education, Department of Curriculum and Instruction, AMEQ, and Columbia University who have long ago become aware of the need of dealing with new technologies. Since 1990 it is noticeable the increasing interest in this matter in all areas involved in Canadian education. Canada is developing projects such as SchoolNet, TeleLearning Network of Centers of Excellence and the National Network for Learning which are useful for us to research due to the need of apply successful innovations in argentine's education. This points constitutes the basis of my project.

Argentine School System

Argentine School System can be defined with a single word: CRISIS. As oriental philosophy settles, a crisis can make a person or an institution remove what has to be given away, and search what has to be improve. The taking of decisions in institutions and in the government seem to be decisive factors in this process. From 1930 Argentina's educational system suffered the combination and application of different paradigms due to the political changes which drifted between democracy and authoritarianism. From positivism, rationalism, conservatism, theories of development, to the few but important experiences of the "New School" based in democratic topics and a special perspective of child ' construction of knowledge, Argentina's Education became a mosaic in which it is combined parts of all paradigms. The paradox is based in that this heterogeneous thoughts produced an homogeneous way to teach inside classroom , where the institution appears mostly as a bureaucratic place, designed vertically. Curricular designs are not assented to by the actors of the Education Scene , so relationships between professor and student trend to be traditional in the sense of centre (the knowledge) and preripheria (the non knowledge). An unidirectional situation which the context is left out. Another problem is the lack of organized postgraduate studies and formation for teachers of all levels, plus the low salaries which make a break to proper formation and constitute a cause for curricular splitting. The other cause happens to be unequal access to hardware and software.

The world of communication have changed into networked digital technologies that fastly become prevailing, this fact is well known in Argentine's educative system, which focus this topic, mainly, in the incorporation of computers workshop. During our observation in 1994 and 1995 within a Project of Investigation and Development in Technology and Education we could see that computers, beyond its presence at school , represent an objective approach to the future, but are sub-used in tis potential because of the mixed policies we explained before. Almost every secondary school in Argentina has "the machines" but at the same time are immersed in an asynchrony. Either the access to merely the techniques or the lack of suitable epistemological views make a point of inflection in investigation. In our opinion it is urgent to research: a) the construction of knowledge mediated by hypertext and nets. b) the reconfiguration of subjectivity and scholar roles c) the construction of suitable school tools for students into a new labor market. d) the experiences in other countries such as USA and Canada

Nevertheless, there are in Argentina valuable pedagogical experiences with technologies , but without a common frame that make these experiences useful for other people. Neither the uses of hypertext, hypermedia nor Internet is used , up to now, as a profitable resource in the construction of knowledge, but each principal , director or teacher is concerned about them. We could indentify worries in acquiring proper formation in the uses of this technologies. The New Federal Law of Education No 24195 gives technologies a central place in curriculas , both as a. subject and as a transversal permeation into the contents of educative structure. In spite of the fact of the progressive application of the law, we could detect some gaps between teachers and students facing the reality of having to deal with new technologies with out a solid theoretical and practical background. The Law encourages the rational, organized, planned and creative use of the material resources in order to prepare students for the needs of a changing labor market. So it is defined that teachers formation must be a priority. The ideas of competence, optimum quality, efficiency are strongly remarked. Perhaps this point could be another paradox , because the Law declares this goals as priority but cant offer guaranties in the assignation of budget to support these changes.

1. Exploring the Concepts of Hypertext, Hypermedia, and the Net.

The concept ofhypertext is defined by Theodore Nelson in the 60' as a non sequential text , a text that devises , and let the reader make his own choice in the route of his reading. hypertext can be enjoyed in an interactive screen. It is a serial of text units linked by connections that allow the reader to make different roads. It lies on the concept of hypermedia, or multimedia in which information, animation, sound, graphics , text, movies, video and audio can be combined in an interactive way, by an active user. The non sequential structure of hypertext is based in the possibilities of connecting "lexias" through electronic connections (links). Moulthrop says that any way of narration requires from us the possibility of going back to the net of the text : it tries to capture us in its inexorable energy. In the case of electronic writing this desire of the narrative, can be satisfied in ways unpracticables in the traditional matter. The cognoscitive model proposed byhypertext links the concept of social meaning construction , in opposition to that concept that conceive knowledge like atoms each person has to bind in an imaginary necklaceHypertext performsr communicative function that encourages the creation of other texts for the human comprehension. We propose to search and construct another way of production and appropriation of knowledge. David Bolter observes that hypertext incarnate the postestructuralist idea of open text. Something that is unnatural in written text becomes natural in the electronic media, and in a short time, it won't be necessary to explain it, because it will be shown.

1.1. The Potential of Communication Technologies for Inquiry and Investigation at School.

Inquiry and investigation are the most important aspect of learning. However, its difficult for teachers and student to carry along this activities. Hypermedia technology (hypertext and multimedia), as regards both hardware and software, is arising a great interest in the use of applications for education. Researchers, teachers and students may place themselves as mere users navigating through an already developed application, or as generators of their own applications. We think that we should adopt hypermedia methodologies and teach our students, on the one hand, how to navigate, across the ocean of information, and, on the other hand, how to build up expert outlines. Bearing this in mind, our proposal shall be a knowledge-based integrated representation system for creation and re- creation of expert knowledge scripts for multimedia applications.

1.2 Changes in Interaction Models, Subjectivity and Communication: Reconfigurating Teachers' and Students' Roles.

Paul Virilio outlined the speed of communication as the most important characteristic of our relationship within nowadays technological context (3). Audiovisual speed is in Virilio's thought the one who makes a reflex revolution , as it lies on images. A change in memory is being held by images and speed: today we are increasingly accustomed to ocular memory rather than to the old mental representations. Representation capability, though, is an important skill students must not avoid, as it is one of the main characteristicas of human being, but we must say there is a changing of shape in the nature if human representation as we pass from a text to an hipermediated culture. Textsbooks have been central in traditional school, with theirs units, chapters. They were unable to allow an unexpected path, the implicit assumption were that the role of teachers were to teach, and the role of students were to study. But nowadays digital culture, has reached our students earlier than us, so, they instinctively know very much about images, due to their exposure to them, since they were babies. Later, the personal computer makes another gap between adolescents and adults. As Virilio adds, children are accustomed to an audiovisual speed we can't stand for too long. As regards roles, Hypermedia Technologies seem to agree with Cloutier's communication model "EMIREC" . In this frame, the teacher is viewed not as the ruler of the game, but as a partner who eases the work by giving the right resources. Teachers are at the same time, learners. Vertical institution's designs becomes horizontal, so students stop hearing in a passive way and become an strategist. Teacher and students can in this frame, become a team. The roles of teachers in these essential schools are reconfigured just as much as the curricular structures are. Whereas, in the comprehensive school, staff members have highly expertise specific duties, in the essential school each and all have a collaborative responsibility for the whole. What's more, as the raw materials of the curriculum increasingly become electronic ones accessed via digital networks, the range of skills required of teachers is broadening rapidly. All this change points to a need to rethinking the processes of professional development for educators. The work that constitutes their profession is changing and so must their training. The Institute is currently conducting work in this area as well, investigating ways to align the findings and the prescriptions of various standards organizations with new needs that flow from what is enabled by the implementation of networked digital technologies in the context of the essential school.

2. Learning and Knowledge: Epistemological Outlooks.

The main theories of learning are basically represented by behaviorism, consructivism and cognitivism. It's necessary to make a deep analysis about the concepts of individual, society and learning in each one , trying to lace them with epistemological views such as open and close systems, auto-organized systems and theories about the end of total paradigms.

3. The Virtual School Community: The Cases of Schoolnet, Telelearning Network of Centres of Excellence, the National Network for Learning and Columbia's Projects 3.1. The Virtual School Community in Argentina: TELAR AND RIU

These will be the main topics focused in the research. Electronics technology these days allows us to build virtually any kind of communication device that one might wish. One special characteristic of the 90s is the increased number and variety of new communication technologies that are becoming available. Further, and more important, is the nature of how these new media function in society and the theories which tries to build categories to explain the relationships in the "virtual community". We find that there are many paradigms to explain the changes in human relationships in the era of telematics. Elizabeth Lane Lawley assumed that most studies of computer-mediated communication have focused on conceptions of the technology as a tool, rather than as a constructed environment. This is not surprising, given that the bulk of research about computing in general has taken this tool-oriented approach. Pierre Bourdieu's work in the sociology of culture has been widely quoted in recent years in the fields of anthropology, sociology, philosophy, and communication. Computer-mediated communication as the process of sending messages—primarily, but not limited to text messages—through the direct use by participants of computers and communication networks. In our opinion, these concepts can be useful in the field of Technologies and Education. In his recent book "The Virtual Community" (1993), Howard Rheingold lays out the aspects of computer-mediated communication over bulletin boards and other computer conferencing networks (including, but not limited to, the Internet) that have led him to consider that medium as constituting communities, and beyond that, culture. Rheingold says "Most people who get their news from conventional media have been unaware of the wildly varied assortment of new cultures that have evolved in the world's computer networks over the past ten years." Media technologies provide us - as McLuhan said- with "a window to the world," and as a result we know more about distant events than we could ever experience directly. We can be part of the virtual community and make it profitable for education. Argentina has started few but very important projects of networking we' d like to improve. TELAR net is a Local Area Network (LAN) settled in Puerto Madryn. In 1993 the national Ministry of Culture and Education and the I EARN WORLD NETWORK Argentina (International Net of Resources and Communication) gave TELAR the opportunity of contact other nets in more than 25 countries. Argentina has not very log became aware of the possibility of promoting new educational policies which go beyond the traditional uses of new technologies. RIU (University Interconection Net) tends to establish the link of every argentine university. Its funded by the Secretaria de Polìtica Universitaria and the Banco Internacional de ReconstrucciÛn y Fomento. The University of Rosario has recently started to build a local net which will link all academics units. The projects TEL AR and RIU mark several goals achievements to begin a generation of students who can deal with the converging computing and telecommunications

AIMS: -To get in touch with USA's and Canadian projects such as SchoolNet, TeleLearning Network of Centers of Excellence, the National Network for Learning and Columbia's University Programms -To exchange Argentinian experiences of hypertext and hypermedia technologies as a pedagogical tool, such as TelAr (Argentine School Network) and RIU (Argentine Universities Net) . -To attend to lectures, courses and seminars on that matter, if possible. -To begin collaborative research on the field of hypermedia and net education between any of these institutions

Impact of the Collaborative Search Work Contribution to Scientific Knowledge Advance and Significance to Human Resources Formation

Related to the Course - A cooperative research like I propose will be profitable for university teachers coming from several colleges (Social Communication, Psychology, Educational Sciences, Anthropology and others) and researchers interested in collaborative research with USA's and Canadian experiences in this matter. - High School teachers eagerly claims for proper formation to dealing with technology. Workshops can be offered for them. - Primary school teachers could also get advantage from this course, as in Argentina, Computer Workshops have long ago being functioning. -This can moreover encourage interdisciplinary investigations.

Significance to Social and Economic Development

Quantitative and qualitative diagnosis of Argentina and Canadian education centred in communication technologies will be useful for public and non public institutions.

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YOUNG CHILD

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Though teachers of young children have typically been among the first among educators to implement innovation in their classrooms, they have been among the last to embrace computer technology for personal and professional use. The roots of this hesitancy to use technology originate from a number of possible sources. First, the writings of Piaget which have influenced the field of early childhood significantly focused teachers on children's use of physical objects in classrooms (Ginsberg & Opper, 1988). One of the signs of a good preschool continues to be the existence and hands-on use of many colorful manipulatives in child-directed centers. Secondly, uses of the computer in mainline early childhood journals often caution the reader on how not to use the computer (Elkind, 1986) instead of focusing on opportunities for growth using the computer. Third, many people's image of the computer as a sophisticated machine which needs sophisticated users does not fit primary school children. Finally, it is argued that young children cannot properly care for or use the potential of such an expensive machine.

Since young children are often not expected to use technology, the teachers themselves don't have much exposure to the machines. As a consequence, this lack of familiarity with technology retards teachers' use of computers for their professional growth. In some preschool or primary classrooms computers remain unused or children simply run a program without much attention from the teacher. In other schools, computers are only used in computer laboratories where there is typically little integration of topics of study in the classroom with topics of study using the computer.

The authors of the papers in this section have taken on many of the above challenges in their search for using technology for teachers of young children. I have grouped discussion of the papers in this section of the annual into three parts that may help organize a range of issues teacher educators are involved in. The first section focuses on general issues in the use of technology especially those opportunities and problems originating from teachers. The second section centers on the use of technology to learn professionally about early childhood education including the description of the integrated role technology plays in two teacher education programs for young children. Teacher's use of software in their classrooms points out many needs for teacher development in the third section. Finally, in view of the research that exists in this section on teacher education in early childhood using technology, directions for future research are suggested.

General Issues of Teacher Use of Technology for Young Children

Chang, Rossini, and Pan comment on a number of issues concerning teacher education and early childhood including using appropriate software, use of the World Wide Web, and the use of difference between structured and more open-ended software. Also, they help us focus with a summary of advantages computers have in the early childhood classroom. This paper finds e-mail to be a source of information on techniques of using technology.

The second paper in this section deals with a range of issues of teacher education of early childhood and the use of technology that takes more of a teacher perspective. In a survey of teachers at a wonderful new model early childhood lab school in Corpus Cristi, Texas, Rodriguez confirms many of our suspicions about teacher's needs for software, support, and information regarding integration of use of technology into their goals for children and for their own professional development.

Uses of Technology to Provide Professional Information to Teachers

The next group of three papers deals more directly with the subject of teacher use of technology for professional learning. Bohn & Rhodes discuss a study they performed analyzing student use of a computer program and an accompanying laserdisc of child development. They found a variety of differences of teacher education students' use and lack of use of technology outside of class and discuss the motivational differences that may lead to more student use of technology resources. One of the most interesting findings described how integration of the content conveyed by the technology was a vital factor in making sure students use the technology. It seems that importance of the perceived payoff for the extra effort students put in to use of technology can never be overemphasized.

The next two papers take a more programmatic view of the use of technology to educate teachers of young children. In both programs, one at Southern Georgia and the other in Queensland, Australia, the projects attempt to solve enduring dilemmas of teacher education by allowing campus-based students to view early childhood classrooms in the field. There is a sense of immediacy and meaning students feel when they ground theory into real classroom practice they are interacting with in schools.

With a new grant from the Georgia University System System's Office of Information and Instructional Technology, Downs & Rakestraw describe a fully integrated distance learning program in which graduate students as classroom teachers welcome campus-based undergraduate students in to their classrooms to view "real life" classroom via two way interactive video. At the Queensland University of Technology, Yelland, Grieshaber, Stokes & Masters describe the learning of preservice and inservice students connected with four separate classes at Queensland University of Technology in Australia. Using audiographics, class members to have remote access to classroom situations. Other early childhood university classes address important issues of familiarity and becoming critical about software.

Software Issues in Teacher Education

A number of papers discuss software and it's relationship to the teaching and learning of young children. Since much of the software is written for the home market, the purposes of the software and the pressures of marketing that surround them make them questionable resources for teachers. DeVoogd & Kritt discuss the importance of teacher guidance and examination of the interaction between children and software. This paper looks at specific examples of how software does not achieve the purpose they were designed to teach.

Snider & Gerstner examine groups of kindergarten students using structured software, open-ended software and a control group; they found that children using open-ended software scored higher on tests of verbal creativity measures. What's more interesting is how students who learned cooperative techniques using structured software also achieved high creativity scores. This would seem to indicate the importance of establishing social routines and procedures in the classroom promoting cooperation instead of promoting classroom routines and practices which keep students from sharing with each other.

Bornas, Servera, Llabrés and Mata have built on their past work (Bornas, Servera & Llabrés, 1996) developing models for handwriting to develop software that provides children with the ability to learn from models of mathematical processes. They argue that much of the difficulty and failure in schools results from poor modeling and lack of student access to interactive modeling. Their software, VISPRO.Càlcul, provides dynamic modeling to students and frequent modeling for students. Their program improves on the teacher's limited ability to be available for students and on the static models provided by printed materials.

When teachers have trouble finding good software or it is too expensive, they can construct their own. Teachers creating learning centers, printed media, and pictoral media is a tradition in early childhood. Gore and Broussard begin a discussion of research on teacher's creation of new media using the computer and its effects on students. They found positive effects for a teacher-made program on the topic of patterning were found only in the top half of the class, and not for the bottom half. Was the finding partly a result of the developmental level of children and their inability to understand the level of abstraction represented by the computer? This is certainly a fascinating topic that returns us to the heart of questions about the developmental appropriateness of computers for young children.

Future Areas of Study

When I get home I usually ask my third grade daughter what she read in school that day. Sadly, I often find that she doesn't read at all but watches videos. Perhaps the school my daughter attends is different from most, but I would venture to guess that videos are playing an increasingly large role in the classroom education of young children and yet none of the papers in this group focused on the use of television as a topic for educating young children. Although there is a small body of research in the area of the use of television and videos for the education young children in schools, there is less in the area of teacher education and television watching. How do we help teachers use video to promote our goals in education? Are there ways teachers can build on the knowledge base of the 25-35 hours of television watching preschoolers do weekly (Clements & Nastasi, 1992)? How can teachers learn to work with parents to make that television watching more effective? What are the understandings of beginning early childhood teachers who create and view video as a method to improve practice? These are areas of study that may prove to be appropriate topics for study in future years.

There is also much to be done in other areas of technology and teacher education. Since many of the papers above describe programs using technology for the education of teachers of young children just newly started, we shall look forward to hearing the progress of these programs. The interesting studies introduced in this annual at Queensland University of Australia, Southern Georgia will certainly have follow-up studies that focus on different aspects of educating teachers of young children using distance learning and forms of technology. Teacher's understanding, use, and development of software and its appropriateness for young children is an area many authors have touched on, but also an area which needs a great deal more examination.

Although there is still a great deal of work yet to be done, progress has been made outlining areas of study for the teacher education of young children. Progress has also been made in terms of designing teacher education programs that can be studied and replicated in different contexts. Perhaps there is also a need to explore what makes early childhood teachers special and different from other classroom teachers and teaching contexts.

As a section in the SITE annual, we are only a few years old. There are so many possibilities, it seems as though we are just beginning. And like so many of the children and teachers we work with, there is a sense of optimism, joy in the future, and promise. May we all enjoy our exciting beginnings!

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Perspectives on Computer Use for the Education of Young Children

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Chin (1984) predicted that all the children in preschools would have access to computers by 1989. However, the growth rate of computers in early childhood classrooms seemed very slow by 1991 when approximately 25 percent of early childhood programs had children using computers (Haugland & Wright, in press). Though the high cost of software and hardware contributed lack of use, lack of staff development, and administrative support have also hindered the implementation of technology in classrooms as well. The use of the computer in an early childhood classroom remains limited and controversial. Although there is a growing trend in early childhood classroom to invest in technology as a means to facilitate teaching and learning, many issues remain unclear to early childhood educators and deserve a careful examination.

One of the major concerns about using computers in early childhood education is whether computers can fit in the early childhood practice and facilitate young children's learning. Some researchers have found that using computers with young children was developmentally appropriate. Other early childhood educators, such as Elkind (1987) claim that computers need to be used as teaching machines—offering drill-and-practice activities—because a child's cognitive development cannot rely on some open-ended software programs.

Teachers' readiness in using computers has posed another serious concern. Teachers' attitudes about computers and about using computers to teach young children vary widely. Some of them feel excited about computers, while others feel intimidated (Hoot, 1994), thinking that they themselves do not know how to use the computer, not to mention how to teach young children how to use the computer to learn. Other related issues include what software is appropriate, how young children can start learning with a computer, and how software should be integrated into the early childhood curriculum. Since there is plenty of educational software on the market, some early childhood educators feel at a loss when considering practical issues of what software to use and how to use it, and how to assess the effectiveness of computer activities in the early childhood classroom. Finally, the crucial issue centers on the developmentally appropriate practice (DAP) of using computers in the early childhood classroom. Although there are many exciting and successful examples of using computers to inspire young children to think and to learn, there are also some teachers using computers simply as a reward for completing teacher-required schoolwork. From our frequent supervisory visits to the schools, we know that some teachers even consider the computer time their "break" time.

The purpose of this paper is to provide some insights to these concerns. The information presented here is based on case studies and other current research, position paper published in journals, classroom observations from our work in preservice teacher education, and on-line (ECENET-L@POSTOFFICE.CSO.UIUC.EDU) listserv discussions with early childhood teachers and educators.

Find Appropriate Software

Children are very likely to learn more or better when working with appropriate computer software. As Wright & Shade (1994) put it, "the effectiveness of computer learning depends critically on the quality of the software" (p.33). Although there are many software titles available on the market and the quality of these titles improved over the years, still, finding appropriate software is a difficult task.

By 1994, 75-80% of software on the market is still drill-oriented (Morgan & Shade, 1994). The other 20-25% encompasses some excellent open-ended, discovery-oriented programs. According to the curriculum guidelines that National Association for Education of Young Children (NAEYC) stipulated in 1991, the use of drill-and-practice software is inappropriate because it limits young children's thinking. Such programs exert centralized control over young children's development and emphasize memorization providing them with few opportunities to interact with people and objects around them (Haugland & Wright, in press). The use of structured software (such as drill-and-practice), therefore, should be minimized.

To help children acquire knowledge effectively, it is the teacher's responsibility to select appropriate software. One preschool teacher in our area, for example, selected the Kid Pix program, a children's paint program for her children. After three months' use of the program, the teacher found that her children's confidence and competence had been greatly increased. A program of this type is open-ended, similar to the blocks that teach children shapes, sizes, angles and balance through active exploration (Haugland & Wright, in press).

As with any curriculum resource for young children, teachers should have a proper developmental approach to choosing software for young children (Haugland & Wright, in press). Teachers need to know how to separate the software wheat from software chaff as stated by Dublin, Pressman, Barnett, & Woldman (1994). Dublin et al. found that after taking the cost factor into consideration, one needs to look for "consistency between the software and your own instructional strategies of choice" (p. 61), for software that can provoke students' thoughtful action, that furnishes feedback for incorrect answers, that provides variables that children can control, and that "can adjust to different students at different levels of ability, intellectual, or computer skills" (p. 61). Other researchers added that appropriate software also can offer opportunities for children to solve problems while interacting with computers and can promote cooperative learning (Dublin, et al, 1994; Haugland & Wright, in press; Wright & Shade, 1994).

Haugland and Shade developed a software scale to identify software that is developmentally appropriate for young children in 1995 (Haugland & Wright, in press). Having common threads that run through the NAEYC guidelines, this Developmental Scale contains many crucial criteria that may contribute to the successful selection of proper software, including age appropriateness, control by the child, clear instructions, expanding complexity, independence, non-violence, process orientation, use of real world model, technical features, transformations, multiple languages, universal focus, mixed gender and role equity, and respect for people of diverse cultures, differing ages and abilities, and diverse family styles.

With more programs for young children's cognitive growth on the market, sometimes it is not an easy job for a teacher to choose appropriate software, especially when the teacher is overwhelmingly surrounded by pages and pages of commercial advertising.

Freedom of Exploration vs. The Teacher's Assistance

Most people agree that computers can function as powerful tools to help young children learn better. However, there appears to be controversy concerning the teachers' role when young children use the computer about whether children should be left alone to explore on their own at the computer or the teacher ought to assist them at the computer.

Some people argue that children need to be provided with great freedom and the teacher should leave children alone at the computer. In this way, children are given a sense of control—a sense of autonomy, competence and enjoyment. Hoot (1994) states that the major advantages of having children work at the computer alone include 1) they are in sole control of the interaction; 2) working on their own enables them to interpret immediate feedback; and 3) there is less pressure on the children. Moreover, children perform best when they have a chance to interact with a responsive system that provides feedback and encourages further investigation (Wright & Shade, 1994).

A teacher from Kuwait commented in the Internet Listserv discussion that he found his students aged 3-5 were very good at budgeting their time on the computer without too much help from him. A teacher from the States agreed with that comment by expressing that she allotted great freedom to her children when they explored the computer by themselves, and this worked very well. Both teachers came to the same understanding that if their children were not provided with such freedom, they would feel frightened or anxious for not being able to locate or find correct answers or to press correct keys and commands they were required to master. The freedom to explore the computer allows children to develop a positive attitude toward computers at a young age that may result in being willing to learn more complex uses of the computer at an older age.

Moreover, in some early childhood classrooms, young children were placed to use computers without intensive adult attention. Many teachers are occupied by many routines and events such as attending to individual needs. Only when teachers have taken care of most other routines and events will they come to observe young children at the computers. They then sit with children and ask questions like "Where does this go?" "How did you find that?" "What are you supposed to do here?"

When some children encounter problems or become stuck, their teachers tend to direct them to seek solutions or help from other children. The teachers provide help only when no children can solve the problem. They claim that children can thus develop necessary skills by acting as resource persons for one another, by communicating effectively, and by problem solving via inquiry.

However, leaving children totally free to explore computers may result in negative effects. For example, young children in many classrooms, from our observations, were left unattended, wondering what to do on the computer, or trying something that does not make any sense to them. They become bored and frustrated very soon. This kind of computer experience is fruitless and can do more harm than good to young children. Actually, if used properly, good software can greatly enhance young children's learning. Some timely adult guidance can also help children consolidate their learning experience with computers.

A Head Start teacher suggested in the Internet discussion that teachers should consider the children's familiarity with available software, the level of difficulty which the software provides and the individual's computer knowledge and skills before making the decision if he or she should offer help. This teacher suggests that teachers be with children while they explore at the computer so that teachers can observe children's reaction to a program and offer appropriate feedback.

How Young Can a Child Play at the Computer?

A question was posted to ECENET-L soliciting individual cases of young children using computers. From the cases reported, the youngest age working at the computer is six months old. The baby started with the programs like Babykeys and Ian's Game. Most children start to play with the computer at the age of 3-4 (Dublin, et al, 1994; Haugland & Wright, in press; Hoot, 1994; Wright & Shade, 1994).

Because most younger children do not possess good literacy skills, they cannot communicate effectively with others in writing. Some people believe that it is more appropriate to engage young children in some concrete activities such as playing with blocks, dramatic play, using manipulative, etc., rather than computers. Still, there are other points of views. For example, Buckleitner (1996) states:

> Most experts recommend that children wait until at least age 2 1/2 before sitting down at a computer; it's at about this age that kids begin to develop the hand-eye coordination necessary to use a mouse. Parents should plan to spend a lot of laptime with youngsters during this time. By the age of four, children can sit still long enough to benefit from more computer activities on their own. (p. 28)

Apparently, some early childhood educators consider computers an appropriate tool for older children, but not for young children who should spend time playing in playing centers.

Internet and Young Children

The Internet has provided an exciting platform for children to explore. The following are some examples of using the Internet with young children. One parent shared her experience that with her four year-old daughter, they together surfed the World Wide Web driven by the girl's interests and explored a lot about the Disney site and other sites that contain images of her favorite books and movie characters. They learned a great deal about how Disney put together *Pochahontas*, the person behind the voice, etc. Furthermore, the parent and the child also used e-mail to communicate with their relatives, especially the child's cousins and grandparents who live across the country. The girl got the concept that her mail could be replied to the next day by her relatives. Some teachers, as another example, organize a pen pal system for young children to communicate with each other by sending electronic mail on the Internet.

Advantages of Using Computers in the Early Childhood Classroom

The computer is commonly regarded as a "productive tool" and as a medium to enrich teaching and learning. With other tools (especially varied play experiences), computers may be devoted to more productive pursuits and have a potential to further develop young minds (Hoot, 1994). The advantages of computers in the early childhood classroom are as in the following:

- Computers can provide great opportunities to inspire young children to learn (Dublin, et al., 1984). The computer helps develop children's cognition. For example, children are able to use computers to compose their own stories with the Storybook Weaver and Kid Works. When computers are used appropriately with discovery software and teacher guidance, children can be encouraged to develop their freedom and creative thinking (Clements, 1994).
- Computers can capture young children's interest and stimulate their imagination and creativity. Teachers can provide interesting information by using computer programs that introduce new topics, stimulate discussion and debate, and launch a lesson that can encourage children to continuously do the relevant activities off the computer (Dublin, et al., 1986).
- Computers can enable children to learn from each other, i.e., cooperative learning. Children prefer working with one or two partners rather than working alone (Clements, Nastasi, & Swaminathan, 1993; Rhee & Chavnagri, 1991). Students tend to perform better in settings that foster cooperation than in those that foster competition. They can also learn to share information, to contribute ideas, and to respect each other when using computers. Thus, they are able to develop a high

level of communication and cooperation skill, problem-solving skills in a collaborative manner, and higher order thinking skills (Clements, 1994).

- Computers can satisfy individual students' needs. Some young students are more mature than others. Computers can help children master concepts at their own pace. Individual students may choose to repeat a certain task several times until they feel comfortable about the intended tasks.
- Computers can be used as effective tools for teachers to communicate with parents. Some teachers collect all the printouts that are done by all their students and date them. The dated students' works record their progress across a period of time in school.

Suggestions

Although the debate about the use of computers in children's constructive acquisition of knowledge is still underway, many early childhood educators agree that computers can help enrich children's learning if the approaches to using computers are appropriate (Alloway, 1994; Clements & Nastasi, 1993; Guddemi & Fite, 1991; Haugland & Wright, in press; Hoot, 1994; Shade, Nilda, Lipinski, Watson, 1986; Wright, Shade, Thouvenelle, & Davidson, 1989). Having discussed the use of computers in early childhood classrooms, we make two suggestions for concerned educators in the early childhood field:

- Find appropriate software: The most appropriate software fits your instructional strategies and goals, provokes and stimulates students' thinking, furnishes appropriate feedback, provides a sense of control and develops students' autonomy, and encourages collaborative learning.
- Provide developmentally appropriate guidance wherever needed: Make an effort to pay attention to the children at the computer, to observe and listen to them in order to provide appropriate help and enhance their constructive learning.

The area of children learning with the computer needs to be researched further in order to develop a better understanding of how computers can be appropriately conducive to children's cognitive development and their growth in other aspects as well.

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Early Childhood Development and Technology: A Case Study

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The recent opening of the Early Childhood Development Center (ECDC) at Texas A & M University-Corpus Christi (TAMU-CC) affords a unique opportunity to investigate how young children and their teachers use technology in the classroom. The purposes of this discussion, then, are to briefly review related literature and to present some preliminary findings about how teachers have begun engaging students in technology-based activities. Related problems and opportunities that the teachers reported will also be discussed.

The Context

Opened in August, 1996, the ECDC houses a public school of the Corpus Christi Independent School District which presently serves 88 students drawn from throughout the district. Students currently include three year old through first grade students. Current students will proceed to second and third grades in the next two years: a new group of three year olds will enter each year, as well.

The school features a dual-language approach, offering instruction in both Spanish and English. Counselors, nurses, and academic diagnosticians are also an integral part of the ECDC staff. By design, sixty-five percent of the students are of low socioeconomic status as defined by their eligibility for the federal free or reduced-price meal program.

The ECDC staff has targeted use of technology and five other curricular themes as follows:

- creativity;
- academic excellence;
- cultural heritages;
- life skills;
- multi-language communication.

These themes provide a rich array of curricular foci within which to embed technology applications. Each classroom houses eleven current Macintosh computers with hard drives. All computers are tied in to the University's network which provides Internet access.

Young Children and Technology

Developmentally appropriate practice (DAP) stands as a hallmark of early childhood education. This orientation is built on the idea that children learn best through active, hands-on learning (Santrock & Yussen, 1992). The DAP orientation further holds that both children's social and cognitive development should be addressed. DAP, in essence, ". . . is education based on the knowledge of the typical development of children within an age span (age appropriateness) as well as the uniqueness of the child (individual appropriateness)" (Santrock & Yussen, 1992, p. 482). The National Association for the Education of Young Children (1991) offers specific recommendations for strategies deemed developmentally appropriate in early childhood education.

Gardner's multiple intelligences provide another useful guiding framework. Gardner (1993) suggests that children's capacities are diverse and include abilities in the following areas: logical-mathematical, linguistic, musical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal. Such a multi-faceted view of children reminds us that children possess a range of capabilities. The microcomputer can provide diverse multimodal experiences to address and develop an individual student's unique capacities (Wright, 1994). Wright suggests that the multiple intelligences framework can sharpen our insights into the ways that children interact with computers.

Wright has also identified a number of areas that can be pursued by children on a computer with appropriate software. These include the following:

- telling stories;
- making art;
- designing things;
- writing stories with pictures;
- understanding the mechanics of a computer system;
- thinking logically;
- building microworlds.

These general types of activities require appropriate hardware and software and teacher planning and support. They provide an interesting starting point for using computers as more than a means of delivering commercial instruction, which is desirable.

A final outlook on the role of computers in early childhood education is also noteworthy. Under this view, technology is conceived as a knowledge medium and construction material rather than as an instructional delivery system. Technology, in this light, may serve as a bridge between hands-on activities and symbolic knowledge and as an amplifier for curricular concepts (Apple Computer, n.d.). These views stand in contrast to the widely held view of computers and other technologies as a means of delivering commercially produced instructional software (Wright & Shade, 1994).

Teachers' Uses of Technology and Related Needs

In an effort to identify teachers' perceptions regarding uses of technology and related needs, the author held two group interviews. The four participating teachers, currently instructing three year old through first grade students, also completed a questionnaire. Following is a summary of major findings.

Uses of Technology

Teachers predominantly use the computers as a means of delivering commercial CD-ROM programs, especially "living books" such as *Just Grandma and Me* (Broderbund, 1990). The titles were included in an early childhood software bundle available from Apple Computer. Other reported activities included using *KidPix* (1989) and a bilingual writing program. On the whole, teachers indicated that students use computers at designated times during the day instead of in an ongoing manner throughout the school day.

When asked which kinds of computer-based activities students find most appealing, teachers indicated that children enjoy opportunities to explore and to be creative. Other appealing qualities included software that is highly interactive and that allows students to develop a tangible product as with the program KidPix.

Teachers' Technology Skills and Related Needs

Involved teachers were asked to rate their current computer skills. This is a crucial issue because teachers must be capable computer users if they are to guide students in technology applications. The majority indicated need to learn more about using the World Wide Web to obtain instructional resources. The majority also expressed desire to learn more about electronic mail. Other areas of interest included strategies for integrating computer activities into the curriculum and use of HyperStudio (1995).

Success Factors and Related Needs

The teachers were also asked to report factors and needs which affect their ability to successfully use technology with the children. Responses were diverse. Two teachers indicated a need for additional technical support. The majority indicated the need for new software, as students are losing interest in the current software collection since they've used it extensively to this point.

Other concerns the teachers identified include the following:

- need for more knowledge of technology integration strategies for young children
- need for support group for the teachers in the area of technology applications
- need for in-class assistants to guide students in use of computers

The teachers' perceptions will guide the author in designing a series of professional development opportunities that will focus on addressing the apparent needs.

Conclusions and Future Directions

Given that the ECDC has only been in operation for a short time, teachers are doing an excellent job of engaging students in meaningful uses of technology. However, teachers have expressed some clear needs which must be addressed if they and their students are to continue to progress in applying technology in developmentally appropriate ways and toward useful ends. This discussion, truly a work in progress, has reported on some key concepts in the literature and on teachers' perceptions of their current progress. As such, this effort provides issues for discussion, direction for future staff development activities, and a start down the long and winding road toward fuller integration of technology in TAMU-CC's Early Childhood Development Center.

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Factors Associated with Preservice Teachers' Use of Interactive Media

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Research into interactive media for preparing preservice elementary teacher education majors has traditionally been concerned with program design features and content acquisition by students. For example, Bitter (1994) describes how interactive multimedia can be used in training elementary mathematics teachers; Vitale and Romance (1992) report on its use in an elementary science methods course. Carlson and Falk (1990-91) discuss the results of a study on concept learning through interactive video and present a model for using the videodisc in teacher education. Bosworth and Welsh (1993) describe an interactive multimedia primer on group process skills. Peters and O'Brien (1996) report on an example of multimedia development carried out by preservice teachers themselves.

In each case, these studies make the directed use of multimedia by preservice teachers an integral facet of the research design. If preservice teachers did not use the technology, there could obviously be no research on how they used it. As part of an analysis of interactive multimedia learning environments for teacher education, Ladewski (1996) does include the larger learning context within which the multimedia system operates. However, each of the four environments considered in the analysis assumes students will participate and contains specific tasks in which they will engage.

In contrast, this study is an investigation into factors that appear to govern student use of an interactive multimedia instructional program when students can choose not to participate fully and tasks are not specified. Although program design may influence student reactions to program content and features, non-program factors, namely instructor emphasis and student orientation toward preprofessional teacher preparation, seem to be more significant determiners of usage in the institutional context under study.

Interactive Program

The interactive multimedia program in this study, "Early Childhood Growth and Development", has been designed for elementary teacher education majors in a child growth and development course in the Department of Curriculum and Instruction at Illinois State University. The program utilizes film footage from an existing linear video disc available as a contractual supplement to the standard human development text. The 30 minute video was originally part of a public broadcasting series that illustrated development throughout the life-span. The videodisc on early childhood development has been "repurposed" for interactive instructional purposes with permission of the text-book publisher. The multimedia workstation is a "dual monitor" system that consists of a personal computer and its monitor, a laserdisc player and a separate video monitor.

The emphasis in the program is on observing child behavior, reflecting on what is observed, and comparing the results of the observation with material from the course text. The program has 94 separate "pages" or screens, with videos related to general child development issues and on specific developments in six stages from 5 months to 3 years. The program incorporates features that are widely accepted in the design of interactive multimedia for adult learners, such as, meaningful application of content; choice of alternative learning sequences; optional information segments; and informational feedback.

There are 18 separate video segments that may be replayed or paused from the computer keyboard with controls that duplicate functions of a conventional VCR or laser disc player. There are 9 "advance organizer" pages previewing what is to follow; 9 "choice pages" in which the user can choose how to proceed; and 20 "self-assessment" multiple-choice questions that users can choose to answer and receive feedback on any or all responses selected. Hypertext buttons provide additional information if desired and the program is "personalized" in that users are addressed by their first names throughout.

The program has been designed so that students can complete it about 40 minutes. They need not do all the segments in one sitting and can spend as much additional time as they wish. During the 40 minutes, students are able to do some video replay, select more than one answer on the more difficult self-assessment questions and choose to see optional hypertext information. The length of time each students takes to complete the program is recorded, as are choice of segment type and viewing sequence, hypertext selection, control of video disc player, and response(s) to self-assessment questions. Usage data are available to instructors upon request. The work station is located in the media resource center of the library and the program is available to students during library hours.

Procedures

This interactive multimedia program was first implemented in the Spring semester, 1995, in 4 sections of the child growth and development course with two instructors and approximately 100 students. Participants were primarily elementary education majors with some from special education and a very few general students. Students were tested on program content by one of the instructors and usage was checked by both. Student response questionnaires indicated high overall satisfaction with program features and also pointed out some technical difficulties that were subsequently remedied.

In fall semester, 1995, the program was made available to 9 sections of the course (about 260 students) taught by 6 instructors. An analysis of the tracking data revealed considerable differences in students usage, especially among sections taught by different instructors. Students differed by course section with respect to amount of time engaged in the program, in number of program sections completed, alternative answers selected, and video segments replayed. Virtually all students from some sections used the program; only a few from other sections did so, though the opportunity was available to them.

It was difficult to believe that these differences in student usage were primarily a function of program design. In order to determine if the result from fall 1995, were anomalous, the program was again implemented with 8 sections and 5 instructors (about 230 students) in Spring, 1996. The same results were evident, i.e., wide variations among the amount and type of student usage in sections taught by different instructors.

These differences were the subject of specific inquiry during the fall semester 1996. Nine sections of the course were taught by five instructors with 276 students enrolled. One of the instructors held a tenure-line position; the others were part-time instructors or graduate teaching assistants. The departmental undergraduate program coordinator "strongly suggested" that the interactive video program be incorporated into each instructor's course syllabus, and it was made so. Students had the opportunity to use the program for 15 weeks of a 16 week semester, though the content was most applicable in the first four weeks of the course. The five instructors were interviewed to determine the nature of their assignments related to the program, any instructions given students on how to proceed through it, and the extent to which students were held accountable for knowledge of program content.

All instructors "required" that students use the program, but the nature of the requirement differed for each instructor. Instructor A told students she would "check the printout" to determine if they had "successfully" completed the program; completion was worth 3% of a student's total grade. Instructor B said she would determine if a student had finished the program and take that into consideration as part of the student's total "participation" grade. Instructor C "assigned" the program and said she would provide some "points" toward the final grade for students who evaluated it as a learning device. Instructor D told her two sections she would check to see how much time a student spent on the program, and include that in the participation grade for the course. Instructor E indicated she would determine if all questions in the program were answered and emphasized the relationship of program content to the text material on which students were tested. None of the instructors gave any directions for using the program or mentioned specific features such as hypertext or video controls.

Results

Table 1. shows for each instructor the number of students in sections taught, percentage of those students using the program, average and median usage time, and percentage of students using the program who also took advantage of hypertext information-buttons or video replay.

Table 1.
Student Use of Multimedia Program

Instructor	Students	Used Program	Average Minutes	Median Minutes	Hypertext Use	Replay Use
A	62	35.5%	22.04	19.0	41%	41%
B	32	59.4%	24.50	24.5	16%	32%
C	61	62.3%	25.05	25.0	45%	29%
D	61	67.7%	27.78	27.5	39%	34%
E	28	92.8%	32.5	33.0	35%	42%

The results are quite similar to those from the previous two semesters: considerable variation among usage by students with different instructors. Although the program was "required," no more than two-thirds of the students in any of seven sections of the course had used it after 15 weeks. Only a few more than one-third of the students in the two sections taught by Instructor A used the program as contrasted with more than 90% of those in Instructor E's section. Instructor E's students also spent, on the average, 10 minutes longer with the program than students from Instructor A's sections.

In the absence of specific directions from the instructors, including Instructor E, students did not make extensive use of optional hypertext information sources even if these sources illustrated and elaborated portions of their course text. In none of the sections did half of those students using the program take advantage of the hypertext information and video replay capabilities.

The results confirmed what was suspected: the principal factor associated with student use of the interactive multimedia program was the type of emphasis given to the program by their instructor. Instructor A incorporated program usage directly into her course grading scale, but gave it minimal importance. Instructor C also minimized the importance of the program content for her students. For instructors B and D, program usage was to be included as a rather indefinite element in the students' participation grades, though Instructor D had said that she would check on how much time her students spent with the program. Only in the section taught by Instructor E, where the importance of the program was emphasized and content related to unit tests, did more than 90% of the students use the program. She did not, however, give any special importance to the hypertext information and video control capabilities; her students did not use those features to any greater extent than did students in other sections.

Discussion

It is clear that the preservice teachers in this study used the interactive multimedia program primarily because their instructor was prepared to enforce, in some way, the requirement to do so. Why is it that many students did not take full advantage of this relatively new instructional technology, regardless of the course requirements an instructor might have? It is not because they had grown blase about the instructional mode, as "Early Childhood Growth and Development " is the first and only interactive multimedia program used in the undergraduate teacher education sequence. There are at least five possible interrelated reasons, all candidates for testing through further inquiry.

The most plausible reason in the institutional context under study is that students did not take advantage of the opportunity afforded by the technology because they view themselves not as preservice teachers but as college students. These students may be said to have a "collegian" instead of a "pre-professional" orientation to their course work. In their role as collegians, teacher education students do not take the educational initiative when they are not given specific directions about how to use the program and what is expected of them. If the interactive multimedia program does not have a high priority with their instructor, it will not have a high priority with them.

These students apparently do not see themselves as preprofessionals with responsibilities beyond those established in the course syllabus by their instructors. It may be, as Fuller and Bown (1975) pointed out some two decades ago, teacher education students can relate easily and realistically to the student role but can identify with teacher role only in fantasy. Kagan (1992) concludes from a review of research on professional growth that preservice teachers' self-images are largely a product of their prior experiences as students, and that conventional teacher education course work has little effect in changing these perceptions.

A second and related possible reason is that student interpret the content of the interactive media program as declarative knowledge rather than procedural knowledge. Although the interactive program is designed to enhance students' observation skills, in the absence of input from the instructors, a student could interpret the program as simply adding more information to the store already contained in the course text. According to Winitsky and Kauchak (1995), a fundamental issue in learning to teach is the translation of declarative knowledge to procedural knowledge. Without instructor assistance or direction, teacher education students with a collegian orientation would see no reason to attempt such a translation.

A third reason for lack of participation may be the students' perceptions that content in teacher education courses is irrelevant to a teacher's actual work in a school. In a study of preservice social studies teachers, Ross (1987) found that respondents perceived teacher education course work as "artificial" and separated from the reality of the classroom. Kagan (1992) also argues that course work in child growth and development will not provide the kind of knowledge that preservice teachers will internalize. Although the interactive media program documents visually the growth and development of real children in real families, the use of such technology may still be perceived by students as essentially artificial and unrealistic.

Fourth, many students in the institutional context under study may consider teaching to be simply a job that they will work at for a limited period of time, or as something to fall back on (Darling-Hammond, 1990). In a study of preservice teachers, Serow (1994) found that some 55% of the teacher education majors in his study regarded teaching as something other than a personal "calling", to use his term. Serow's sample over-represents secondary majors, but his findings may be relevant to the situation at hand. If prospective teachers view teaching as merely a temporary occupation rather than a life-long personal vocation, then they will have little motivation to go beyond course requirements if not forced to do so.

Finally, teacher education majors in the institutional context under study may have come to believe that the locus of control (Rotter, 1966) over their success in obtaining a teaching credential is external. After all, the formal courses they take and clinical experiences in which they participate are specified for them in great detail. Their grades will be determined by instructors whom they can not choose and who have no standardized evaluative criteria. In their coursework, as in their plans of study, they are not in control. They believe that their success as preservice teachers resides with their instructors, not in themselves.

Why then did not more participate as they were apparently "required" to do? One could speculate that because the course instructors were virtually directed to include the multimedia program in their syllabi, perhaps students were able to detect that using the program was not related to their success in the course: instructors did not actually care if they participated or not. If the instructors were merely complying with external directions, why should preservice teachers exercise internal locus of control? It may be that both instructors and students perceive that the locus of control over their success as faculty and preservice teachers in the institutional setting under study is not explicitly internal.

Without more information about the individual and collective orientation of students to their preprofessional study, it is difficult to know how to proceed with more effective implementation of the interactive multimedia program on child growth and development. Efforts along the lines suggested by Manning and Payne (1989) in developing cognitive self-direction on the part of preservice teachers, and by Dart and Clarke (1991) in helping teacher education students become better learners, appear to be warranted.

In addition, multimedia programs can be produced with features that emphasize how a teacher's professional decisions impact consequences in schools. There are such programs for professionals in health care settings (Byers & Rhodes, 1996) and the designs could be adapted to teacher education. One program of this type has been developed by Overbaugh (1994; 1995). He describes a sophisticated interactive video classroom management simulation program. Preservice teachers are able to analyze common classroom problems, select solutions incorporating basic management principles, view the results, and determine the efficacy of the solutions chosen. The preservice teachers in his study did exhibit professional growth in their orientation toward teacher responsibilities.

Though classroom management skills loom large in the minds of preservice teachers, there are other important components in teacher preparation. Interactive media simulations with teaching and learning scenarios could help instructors and students benefit from the significant impact that multimedia can have in preparing teachers. These program would have designs that clearly focus on a preprofessional orientation and give the preservice teacher a "proactive" role (Rhodes & Azbell, 1985). For example, teacher education students would be able to observe, determine, and reflect on the consequences of correctly assessing a child's level of cognitive development in lesson planning. If such programs exist, descriptions and accompanying research studies are not readily accessible in the professional literature.

In summary, we can say at the least that implementing instructional technology in the form of interactive multimedia in an undergraduate teacher education program is not simply a matter of content relevance, program quality, simplicity of use, timely availability, and institutional support. The quality of the interactive instructional design, specific design features, and program accessibility do not appear to have been major factors governing student usage for students in this study.

For reasons yet to be determined, the traditional factor of instructor emphasis is the key factor determining student usage in the institutional setting as described. The matter of instructor emphasis is apparently related, in some undetermined fashion, to the students' orientation(s) toward preprofessional study. To make effective use of instructional technology in the future, we will have to rethink our protocols for integrating interactive multimedia into the undergraduate teacher education curriculum, and consider once again the problem of how to convince students that they have a responsibility for their own learning.

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Connecting Teachers and Technology: Campus-Based Students Engage in Real Classrooms

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Often technology can be used in ways to address enduring dilemmas in teacher education. Below we describe a future project which will uses technology to: (1) provide campus based undergraduate students with real examples and problems of education from real classrooms; (2) provide teachers in different places access to a graduate education they may not otherwise have access to without the use of distance learning technology; and (3) use various forms of technology as tools for learning.

Description of the Project

This project is the result of a grant from the Georgia University System's Office of Information and Instructional Technology (OIIT) to support innovative approaches to implement technology into the curriculum. The purpose of this project is to incorporate technology in a unique way that will team students in a graduate level education course with students in an undergraduate pre-service course. The graduate and undergraduate students will team in the implementation of technology into the pre-kindergarten through fifth grade social studies curriculum.

During the winter 1997 quarter, graduate students enrolled in the Early Childhood Education (P-5) program at Georgia Southern University, who will take the course titled Problems in Social Studies (EC 851), will participate in the first phase of the project. The course will be redesigned to incorporate all aspects of the proposed technology implementation project. The course will be offered over the Georgia Statewide Academic Medical System (GSAMS) which is a statewide distance learning system established by the Georgia Public Service Commission. The GSAMS system is currently used at all levels of education in Georgia to provide distance learning opportunities through out the state.

The second phase of the project will occur during the Spring 1997 quarter in the course titled Early Childhood Social Studies (EC 453). The graduate students who were enrolled in EC 851 during the winter 1997 quarter will be asked to participate in the second phase of the project by collaborating with the undergraduate students in EC 453 activities during the spring term. In addition, other master teachers (identified in advance by the project director) who have access to GSAMS distance learning facilities in their school buildings will be asked to team with the preservice undergraduate students enrolled in EC 453.

Description of the Courses

Problems in Social Studies (EC 851) is a graduate course designed for Early Childhood Education teachers as an in-depth study of the social studies curriculum. It is offered primarily as a course for people seeking the Educational Specialist degree. The goal of this graduate course is to develop the teachers' expertise in the area of social studies curriculum planning at the prekindergarten through fifth grade level, to increase knowledge of social studies content and methodology, and to develop their abilities to research and acquire information related to their teaching.

Early Childhood Social Studies is an undergraduate methods course designed to prepare students for teaching social studies at preschool through the fifth grade levels. Students are expected to become knowledgeable of the content of early childhood social studies, and are expected to demonstrate competence of appropriate teaching methods, materials, and organizational techniques.

Reason for Course Selection

There is a need to provide greater integration of technology into teacher preparation programs. The technology is available, but university faculty generally do not have the time and resources required to investigate effective ways to integrate technology and redesign teacher education methods courses. Public schools in the state of Georgia also have the technology, but again have not had the time or resources to implement its integration adequately. Inservice teachers, teacher educators, and preservice teachers need to address the issue of integrating technology into instruction. A social studies methods course and a graduate course seem ideal for orchestrating a "full circle" effort to investigate ways to integrate the technology and to demonstrate and share with each other in the process.

The social studies content area is ideal for investigating and experiencing the integration of new technology. Technology will allow effective and flexible modes of communication between teachers, students, and educational sites through the use of electronic mail. Access to the Internet will provide extensive research capabilities and information retrieval for use in instructional planning and teaching activities. The opportunity to interact with teachers and students in classrooms throughout the state, and even the world, and to obtain information about other people and places will enhance multicultural awareness and cultural studies, a major goal of social studies instruction. The distance learning technology is available throughout the state of Georgia providing (a) greater access for teacher education in public school classrooms and (b) greater access for public school students to the world outside their classrooms. The use of the GSAMS system to connect the college classroom with various prekindergarten through fifth grade classrooms will benefit teacher preparation and bring innovative teaching practices using technology into the early childhood classrooms. The Georgia Southern University College of Education and the school systems throughout Georgia have available computer technologies, laserdisc technologies, and instructional software that are demonstrated but are not often used to capacity through full integration into instruction. These resources are typically high-quality and should be used to provide individualized instruction and to motivate in-depth learning. These technologies will be integrated into instruction, thereby sharing these resources between all of the distance learning sites.

Technology can improve the delivery of these two courses by providing avenues for professional interaction, modeling, and field experiences through a live connection with elementary school classrooms in action. Technology also supports the delivery of information related to the curriculum content through the software, CD ROM, and laser disk resources. In addition, the integrated use of technology helps develop competence in technology/computer skills, and instructional planning for integrating technology into learning experiences that teachers need today.

Integration of Technology into the Graduate Course Design

The redesign of Problems in Social Studies (EC 851) will incorporate extensive integration of technology in all aspects of the course. The course delivery will utilize distance learning to model a primary source of information delivery. Students will be located at one of three sites in southeast Georgia. Each site is located at an academic location and contains monitors, cameras, and microphones in a classroom environment. The GSAMS distance learning system incorporates two-way interactive compressed video. The voice-activated system allows all members of a class to hear and see the individual who is speaking. Participants in the Problems in Social Studies course will observe a variety of teaching strategies that maximize the distance learning environment including various presentation techniques, demonstration schemes, and interactive group activities. Students will also be required to actively participate in the course which will assist them in becoming familiar and comfortable with the distance learning system. This is an essential aspect due to the fact that distance learning is a technology that is available to all school systems in Georgia. The distance learning system can provide valuable resources to teachers trying to expand their social studies curriculum.

Social studies computer software and video disks will be incorporated to demonstrate integration of various media into the social studies curriculum. This project allocated funds for increasing the social studies content software and equipment available to participating teachers. The intent of expanding the technology collection is twofold. First, some of the software and equipment will be utilized in the course structure. This will include demonstrating some media to make teachers aware of the variety of materials that are available to support the social studies curriculum. Some of the software will be integrated into the course structure as an integral part of the course content. Students will be asked to participate in course activities that are supported by the content of the software.

A second aspect of the computer and laser disk technologies identified in this project will be to send the media into the classrooms of the course participants. The additional software and equipment purchased with the grant funds will be available for the students in EC 851 to use on an experimental basis in their classrooms. These teachers will be expected to select software and laser disks that match their curriculum and implement the materials into their classroom structure. Teachers will borrow the software and new equipment from the College of Education Instructional Resource Center for the purpose of previewing, utilizing, and evaluating the content of the media. The media will then be returned to the Instructional Resource Center so that it will be available for other class participants to utilize. Through this process, the teachers will have an opportunity to observe the application of new technologies and implement the technologies into their own classrooms without the barrier of funding.

Telecommunications will play an integral role in the redesign of Problems in Social Studies. Students enrolled in EC 851 will use e-mail to communicate with each other, the instructor, other early childhood teachers, and individuals and organizations that could support the course objectives. The participating teachers will use the Internet as a resource to support social studies content and teaching strategies. The students will use the Internet to research topics related to various aspects of the early childhood social studies curriculum. The students will use the Internet as a resource to locate materials and lesson plans designed for the prekindergarten through 5th grade social studies curriculum. Students will locate bulletin boards and other sites that offer interaction among P-5 educators. In addition, students will learn how to incorporate the Internet into their classroom as a meaningful resource for the social studies curriculum. Participants will demonstrate competence in the knowledge of available technology and its integration into social studies instruction. By teaching this course through distance learning, incorporating e-mail/ Internet activities, and computer technologies as an integral part of the course, meaningful applications of technology will be modeled as an integral part of the course design.

Integration of Technology into the Undergraduate Course Design

The teachers who participated in EC 851 will be asked to use the distance learning system to model effective planning and teaching in "real life" classroom situations for the undergraduate students. These lessons will be taught to prekindergarten through fifth grade students in a distance learning classroom. The undergraduate students in EC 453 will observe these lessons in the distance learning classrooms on the Georgia Southern campus without having to leave the university campus. This will allow the undergraduates to observe several different classrooms throughout the region. The distance learning system eliminates the barriers that course schedules and travel time ordinarily present. This will give the preservice teachers the opportunity to observe a variety of grade levels and provide interaction with elementary students in a content focused learning situation through planned observation of classrooms throughout the southeast Georgia region. In return, the preservice teachers will be expected to demonstrate components of social studies lessons over the distance learning system to various prekindergarten though fifth grade classrooms in the region. The teachers and the undergraduate students will participate in panel discussions on course-related topics for the class over the distance learning system. This will give the undergraduate students interaction with practicing teachers regarding course related topics and issues and modeling of technology utilization and the integration of technology in social studies instruction in the college and elementary school learning environments.

Telecommunications will be used extensively as a resource for the undergraduate participants. Students in EC 453 will be expected to use e-mail to communicate with the course instructor, with their mentor teachers, and with other students in the course. The students will be required to utilize information from the Internet as a resource for information that can be used in the social studies content. This would include researching selected social studies topics over the Internet and evaluating the information to determine validity and reliability of the content. The students will also utilize the Internet to locate resources that can be included in instructional activities in the prekindergarten through fifth grade social studies curriculum. This will include providing students with World Wide Web addresses where they can locate lesson plans and teaching activities related to the social studies curriculum.

Teaming Graduate and Undergraduate Students

A key component to this course development project is the interrelation of graduate and undergraduate students, connecting master teachers with preservice teachers. During the Spring 1997 quarter, the project will connect undergraduate students in EC 453 with students from EC 851 and their elementary classes throughout the region. Teachers who participated in EC 851 during the Winter 1997 term will be asked to collaborate in the undergraduate course activities.

There will be several levels to the interactions between the graduate and undergraduate students. The undergraduate students will have the opportunity to observe the graduate students teaching social studies curriculum in the school environment through the GSAMS distance learning system. The undergraduates will team with one of the classroom teachers to present a segment of a social studies lesson. This will be evaluated and discussed in conjunction with the classroom teacher.

The distance learning system will be used to present panel discussions which will allow the undergraduate teachers the opportunity to discuss various aspects of social studies instruction with the classroom teachers. Interaction will take place through shared class sessions and conferences via direct distance learning classroom links and telecommunications. This will provide mentorship and modeling by experienced teachers who have proven competent in the subject matter, the technology, and effective teaching strategies. In addition, other master teachers (identified in advance by the project director) who have access to distance learning facilities in their school buildings will be asked to participate.

Project Evaluation

This project includes several evaluation strategies. Course evaluations will occur at the end of winter and spring 1997 terms. Graduate and undergraduate students will be asked to evaluate the course content and instruction. An attitudinal survey of the participating prekindergarten through fifth grade students will also be conducted and used in the evaluation process. At the end of spring term, team members will assess the courses, the project in general and make recommendations for improvements and idea/activity extensions. They will also develop a list of suggestions and inferences on how these course designs could transfer to other methods and graduate teacher education courses.

Evaluation of student learning will be conducted formatively and summatively using performance-based assessments. Participants will demonstrate (a) knowledge of the technologies presented and used in the course, (b) competence in instructional strategies that provide for the integration of technology to meet students' needs individually and collectively, and (c) competence in using the technology for instructional purposes. Students will be evaluated on how well they can use technology to communicate and retrieve information in order to enhance the interactive learning environment. Students will also be evaluated on how well they can relate the available technology with the goals of the prekindergarten through fifth grade social studies curriculum.

Summary

This project involves the redesign and development of two Early Childhood Education courses, EC 453-Early Childhood Social Studies and EC 851-Problems in Social Studies, as distance learning courses that will incorporate e-mail communications, Internet activities, and the integration of computer technology into classroom instruction using a variety of software and laser disc technologies. The development of the two related courses, one undergraduate and one graduate teacher education course, both dealing with the social studies content area, will be the first to attempt full integration of the technology and provide instruction in a non-traditional and innovative manner. A key component to the course development project is the interrelation of graduate and undergraduate, connecting master teachers with preservice teachers. The two courses were designed to provide extensive interaction between classroom teachers (graduate teacher education students), their elementary students, and the undergraduate/graduate course instructor, and the preservice students.

This project is the result of a grant from the Georgia University System's Office of Information and Instructional Technology (OIIT).

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Integrating Technology, Teaching and Learning with Early Childhood Professionals

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Current literature suggests that teacher education institutions are failing to provide courses that equip students with the skills to incorporate the use of information technology into their teaching (Downes, 1993; Handler, 1993; Oliver, 1994). The body of this literature also proposes that there is no transfer of information technology skills from personal computing contexts to the classroom use of these skills (Dunn & Ridgeway, 1991; Wild 1995). This paper discusses how the deficits exposed in these studies are being addressed in the education of early childhood professionals at Queensland University of Technology (QUT). Four examples of areas where technology has been integrated into the structure of the course are explored; a foundation elective, a core unit in Mathematics Education, an elective unit entitled *Technology and the Young Child*, and the utilization of audiographic technology in graduate units.

Wild (1995) proposes the following principles for teacher training courses to encourage beginning teachers to incorporate the use of technology into their teaching: integrated lesson planning; the value of incidental learning, time for students to interact in a number of different software environments; modeling of desired practice by course leaders; a maximum of hands-on time; group work to encourage verbalization; generalization to other learning contexts; the content of programs to be focused narrowly; students be allowed to develop a sense of ownership, opportunities for reflection be provided; and the use of content-free software to create courseware that is directly transferable to the classroom context. Many of these factors are in keeping with an interactionist approach to teaching and learning (Laurillard, 1993) and are incorporated into the contexts we will describe in this paper.

A Foundation Unit in Information Technology for Preservice Teachers

Within the newly structured Bachelor of Education (Early Childhood) at QUT, students can select from a number of foundation units, of which information technology is one of eight. The foundation unit gives students global understandings of the impact of information technology on society and in doing so allows them to develop their personal computing skills. These skills are designed to lay the foundation for their professional life. A second information technology unit involves the students in a sequence of interactions with software currently being used in primary classrooms, taken from a curriculum delivery perspective.

A major focus of the unit concerns areas of change within society brought about by rapid technological development and discussions about the impact that these changes may have on education. The areas identified are: the changing face of publishing; telecommunications; access; information literacy; and, ethical issues pertaining to technology.

Throughout the readings, students are made aware of the metaphors, similes and analogies that authors use to discuss issues concerning technological change. In their first piece of assessment students are encouraged to engage in personal meaning making by stating and developing a personal metaphor for technology.

The importance of modeling has been noted in several studies and we have endeavored to promote its application in the design of teaching and learning experiences in the course. Both technology units have their own World Wide Web (Web) sites where lecture notes can be accessed and links are maintained to other areas of pertinent information on the Web. In tutorial sessions the use of video projectors allows demonstrations of skills that the students are to implement in their computer workshops.

E-mail activities in which students act as editors for each others work are an integral part of the first assignment. In this the students create a document where they reflect on their learning in light of the readings presented to them and their personal computing experiences. Students are also able to access QUT's on-line library catalog, and perform ERIC CD-ROM searches for their main piece of assessment, a literature review.

Whilst studies note that there is little transfer from personal computing skills into classroom use the foundation unit provides skills and understandings for the students to develop a critical attitude towards technology. These activities develop skills necessary for professional practice. Indeed, the skills and understandings lay the foundation for student exploration of the way that software can enhance curriculum delivery.

Applications of Technology for Early Childhood Professionals in the Pre-service Program

In the third year of their program the students take a course that is entitled *Early Mathematical Processes.* The philosophy of the course is grounded in the belief that it is essential for children to be provided with opportunities to develop their abilities and interests by using a variety of learning modes. We attempt to engage our students in learning about the foundational concepts in mathematics and the exploration of ways in which teachers can develop appropriate learning opportunities to encourage and foster their development in young children. One of the major ways that this can occur is via the active exploration and manipulation of concrete materials via play. The role of technology has become increasingly important to the process of learning and understanding, and the creation of learning environments that are based in the new information technologies can facilitate the transition from concrete to abstract thinking in the mathematical domain.

Applications of technology are included at each stage of the teaching/learning process as students discuss the ways in which learning opportunities, based on effective pedagogy, can be developed for young children. For example, to illustrate the ways in which literature can provide a catalyst for the discussion of mathematical content, interactive story books are used as well as traditional texts. The students create and share a curriculum web to illustrate the ways in which the content of a book, such as *Just Grandma and Me*, can be extended across all areas of the curriculum and then engage in a specific focus on mathematical thinking. Implicit in the book is the idea of spending a day with a close relative of the family on the beach. Children may collect data about the number of members in their family, where their favorite beach is located, how long it takes to get there, the location of train/bus routes. This data may then be represented in various types of ways in a graphical format. In a similar way beach activities may be categorized and "equipment" appropriate for the beach can be used to collect liquids which may be compared or for capacity tasks.

Another basic content area of this unit pertains to the teaching of early number concepts. We have used both *Millie's Math House* and*The Playroom* to reinforce number concepts in different ways. In one game of *Millie's Math House* the child is able to construct a creature with body parts of up to 10 in number. As they arrange their creation, the software is able to tell them how many of each part they are using. In another game, the children have to decorate cookies with a specified number of chocolate chips or can decide how many should go on a cookie of their own creation. The stimulus pictures in*The Playroom* can provide a good starting point for discussing the number of items that are both located on a page, or created by the child. Such two dimensional manipulation of items provides a useful and complementary activity for the creation of sets with three dimensional materials, and constitutes a valuable transition phase between such activities and more abstract work in traditional paper based mathematical activity.

The elective unit *Technology and the Young Child* is also based on the belief that young children need to explore in order to make sense of and learn about their world. The experienced early childhood educator organizes learning opportunities to make use of a range of materials and create contexts for learning that support the child's natural curiosity and interests. Within this context applications of technology are becoming increasingly relevant to the education of young children as they afford the opportunity to engage the child in topics and ideas in innovative and challenging directions that were not previously possible. We believe that knowledge about the various applications of technology and their role in the learning process, will enhance the teacher's knowledge base and enable them to develop creative and effective teaching and learning experiences. This course is designed to provide early childhood educators with the opportunity to explore the potential of technology for their programs. They create technologically based projects which are tested by children from a local primary school.

While students enjoy the process of investigating the ways in which commercial software can be used in an educational context, the construction of their own programs seem to promote the greatest understandings of the potential of technology to enhance learning. Last semester, the students were asked to reflect on their experiences. It was evident from these reflections that the process of constructing an application was a new, and often enlightening, experience. As one student stated:

> This assignment was quite a learning experience in that we were working with an alternative medium to the traditional written assignment. It was a fun activity and yet I found I was learning vital concepts, processes and attitudes concerning learning in the early childhood years. This learning was of the deeper level of understanding, not just surface level often encountered in traditional modes of teaching. . . .. In the past, incorporating technology into the classroom was not as real to me as it is now due to the closer encounters with technology through *Microworlds*. (Student reflection, Semester 2, 1996)

Other students reported their first taste of that thrill of achievement those of us who dabble with computer programming know well.

> In the beginning I didn't think I would be able to include a melody (as I am not musically talented) but after I got my dog to run I decided I could achieve anything! (Student reflection, Semester 2, 1996)

Collaboration was also encouraged in a problem-solving environment. Students indicated that the problem-rich (and often frustrating) climate was far less daunting when tackled through team-work. A student wrote:

> Help from other students was really important when writing the program as the sharing of problems and solutions was the way most of my learning occurred. Because of this I have now realized how beneficial computers can be for children as a social tool, in promoting interaction with others and to encourage cooperation in problem -solving. (Student reflection, Semester 2, 1996)

Although this system of working together was supported by the lecturer as an authentic problem-solving strategy, it was not formally structured through the formation of pairs or groups. However, the students obviously found it to be beneficial to their learning:

> Actually, I thought it was great the way other students helped each other and went out of their way to assist their friends. We worked really well as a team. (Student reflection, Semester 2, 1996)

Finally the experience of having children work with their programs demonstrated to the students that they had produced *real* teaching tools that would be useful assets to the classroom. This was supported by statements such as:

> I was greatly encouraged when I saw the children using my program. It stimulated talk and discussion about the issue of being healthy. The children enjoyed clicking on all the different people and objects to see what they would do. The teacher of the class even specifically sent over two boys because he knew it would be beneficial to them. This excited me as I knew the program I had created was specifically teaching a child in an enjoyable and memorable way. (Student reflection, Semester 2, 1996)

Additional feedback from the students indicated that the unit represented a useful context for learning about technology in early education because it fulfilled the learning objectives that early educators often set for young children. It offered a nurturing, constructivist environment in which tertiary students could explore new concepts and be creative, it catered for individual learners with a wide range of skills and talents and finally it promoted social, collaborative strategies for problem- solving.

Pedagogical and Technological Issues in Using Audiographics Conferencing for Graduate Students

In the graduate program, audiographics conferencing is used to link off campus graduate students with students in classes on campus. The simultaneous linking of computers and teleconferencing has been used to facilitate seminar teaching and dialogic learning for students formerly unable to access study at the masters level. Attempts to provide equity of access were based primarily on the increasing number of women working in early childhood contexts, seeking higher degree study, but precluded because of the distance from metropolitan areas and university campuses (Halliwell, Perry, MacPherson, Grieshaber & Ballantyne, 1994).

Use of conferencing technology has shown it is possible to create conditions where students and lecturers become a 'class' with shared agendas, engaging in the critical analysis of existing knowledge and each others' ideas. Staff felt strongly that students, particularly those who were isolated, should have opportunities to engage in critical debate. The resultant community of learners included urban, rural and geographically isolated students. In the first year of the project, technological issues dominated and staff tended to be in 'survival' mode as far as teaching was concerned. During the next year the project moved beyond technological problems and concentrated on the pedagogical climate of the electronic classroom. Most recently we have developed a model for the professional development of university staff interested in using audiographics conferencing for teaching (Halliwell, Grieshaber, MacPherson, Perry & Rossiter, 1996).

In extending access to higher degree study to students outside the metropolitan area via this process, a number of technological and pedagogical issues have arisen.

Technological Issues

Initially, a great deal of time was spent ensuring each site was successfully connected with both and audio and data links before the sessions commenced. Additional time was necessary for the preparation of graphics which attempted to encapsulate conceptual ideas for critical analysis in each class, and downloading these to the sites throughout the state. Technical faults such as data lines 'dropping out' during class time were frustrating, as they interrupted the flow of the session and connections took up to fifteen minutes to be restored. Several 'drop outs' in sessions meant severe interruption, although staff and students became adept at continuing to discuss ideas while the data link was restored. Audio links appeared to be a little easier to re-establish than data links. Experience with the technology enabled staff to become more confident with its use and more competent in initiating the required action if a problem occurred.

Over time, staff and students learned the communication protocols associated with teaching and learning in this electronic environment. Students were encouraged to use the on-line facilities to communicate with participants at other sites during sessions to reinforce an idea, or consolidate a point. Initial use of these tools began with students typing and drawing greetings and farewells at the beginning and conclusion of sessions. Techniques for increasing participation in conversations and the lack of non-verbal information from those in isolated locations were other challenges for both staff and students. Timing, pacing and the length of sessions also needed attention in audiographics conferencing, and participants had to become accustomed to the slight time delay characteristic of this type of communications technology. As staff become more confident with the technology, the temptation to fill the gap by speaking, gradually waned.

Technical support staff were essential, particularly from the Production Assistant who worked with academic staff in the production and downloading of graphics as well as assisting with the set up of each session and being available to assist when connections were lost.

Pedagogical Issues

Audiographics conferencing technology provided the vehicle for creating the 'virtual' classroom. Staff experience and familiarity with the technology influenced the nature and depth of discourse. Those staff using the approach for the first time stated that they felt the "discussion was more superficial than in face to face situations and that students were less inclined to make uninvited comments or to engage in extended dialogue" (Halliwell, Perry, MacPherson, Grieshaber, Lidstone & Rossiter, 1995, p. 1). More experienced staff reported higher levels of discourse and observed that students were making links with associated readings and conceptual frameworks underpinning the ideas discussed.

Student empathy for the lecturer's position seemingly promoted a sense of group identity and collaborative effort. All teaching staff using audiographics conferencing have made comments about how group dynamics were quite different from prior teaching experiences (Halliwell et al 1995, p. 2). One explanation for this is that often participants interact on two levels. On one level, students participated in the whole group shared discussion. On another level, at times students at a specific site engaged in a local conversation, perhaps exploring an issue in more depth or in a different way from the whole group shared conversation. Use of the 'mute' button made this possible without interrupting the whole group discussion and the occurrence can be equated to student conversations which occur "on the side" during a conventional class presentations. Unsolicited sharing of local conversations with the whole group made it possible revealed the depth of such conversations.

For all staff involved in audiographics conferencing, the issue of the relationship between technology and pedagogy has now been resolved. Once staff were comfortable with using the technology, they found it an effective tool for enhancing pedagogy and used it as they would in a traditional teaching context. In addition, staff came to the understanding that audiographics conferencing has particular attributes which can be "exploited pedagogically" (Halliwell, et al 1995, p. 7).

Student Responses

Students' oral and written responses were obtained for each year the project. Although students reported that they valued the frequency of interactions, some students said that they would have liked the sessions to be more interactive. Most students found the broad range of issues discussed and the opportunity to share and consider ideas at this level very appealing. The students did however, indicate a sense of disappointment about the intrusive nature of problematic technology. Minimization of technical difficulties was considered a priority.

As might have been expected, students in non-metropolitan and isolated areas showed a greater appreciation of the opportunity to study at this level than their counterparts on campus. On campus students felt that they were advantaged because of the presence of the professor, although for much of the time, staff were focusing on interacting with students in isolated areas. All students stated that they appreciated meeting their peers through the technology, and valued the diversity of experiences, situations and perspectives members brought to the sessions. The diversity of teaching approaches and techniques used in the sessions was also appreciated by students.

Open learning creates new challenges for staff and students. Students working in the open learning mode acknowledged the importance of self motivation and understood the importance of independent management of their study. Other comments indicated that students felt the role of staff had altered to become one of mentor and guide, one who shared learning rather than provided information (Halliwell, et al 1995, p. 15).

Despite conceptualizing audiographics technology as a pedagogical tool for facilitating seminar teaching and dialogic learning, infrastructure changes needed for this approach have created teaching dilemmas that are not easily solved. Technical support for academic staff needs to include a professional development approach whereby staff are provided with opportunities to learn at their own pace in a small group of people who have similar needs (Halliwell et al, 1996). Pedagogically, protocols, formats, strategies and techniques for the desired teaching approach continue to be refined.

Conclusions

Technology permeates many aspects of our lives and provides us with an opportunity to enhance learning for children in our schools. It is evident that we need to prepare early childhood professionals to appropriate technology as a tool for learning as well as to realize its potential for global communication and access to information in remote places. Exposure to technological applications should begin in preservice teacher education programs and permeate core and elective courses so that students are confident and competent to use a variety of technological tools. Applications of technology also need to be utilized in graduate programs so that practicing teachers become used to viewing technology as a valuable part of their lives and learning and may be stimulated into incorporating it into their own teaching programs. This paper has presented some examples of ways that we have attempt to achieve this at QUT.

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Computer-mediated Instruction For Young Children: Teachers and Software Missing the Zone

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Following the Vygotskian notion that children learn in their zone of proximal development (ZPD) with the assistance of knowledgeable others, we explore problems teachers confront in choosing and using computers with young children. Teacher's assistance with the computer is in part related to their perception of what the job of teaching is and how software works to help achieve the teacher's learning goals. The purpose of this paper is to explore questions concerning the difference between what a software program claims to teach and what is actually learned.

Computers Don't Teach, Teachers Do

Teacher's perceptions of the supportive roles of technology for instruction influence the teacher's use of software. Since the time when technologies such as chalk and chalkboards supplemented the teacher as aides to instruction, every new form of technology has made teaching and learning potentially easier and more effective in schools. Books, films, and television allowed the students access to knowledge that previously had only been available from teacher talk. Because educators' dominant concepts of schooling focuses on the telling and accrual of knowledge (Cohen, 1988; McDiarmid, Ball, & Anderson, 1989), teachers are seduced into thinking that if the book/television/computer presents the information, their work as teachers is finished. Rarely do teachers focus classrooms on either metacognitive strategies or the application, analysis, evaluation and synthesis of knowledge.

One of the most confusing half-truths about technology, is the belief that computers are necessarily educational. Often children are just entertained with the sensory motor exploration of programs which flash colorful images, respond to their mouse clicking, beep, boom, and talk to them. Children often thrive on the fast-paced action they can get the computer to perform, but little else is learned. In the following vignette we see Josef, a three-year-old, who for three weeks finds Reading Blaster (Davidson, 1992) his favorite program, but learns very little. He seems to roam from one section to another randomly satisfying his need to be entertained but not apparently learning much more than the rudimentary mechanics of how a computer works. A typical session on Reading Blaster is as follows:

Josef launches Reading Blaster, where the evil space witch Illiteri threatens to take all the words in the world. He finds himself looking out of a space ship into space where letters come flying out at him. Using the mouse Josef clicks on the letters, exploding them. On the screen there is a word written with a missing letter which the user is asked to shoot, but Josef is content to just shoot at letters regardless of whether they fit in the designated word or not. A monster attaches itself to the spaceship, sucking out the fuel. Josef clicks on the monster, clicks on some space ship buttons, but nothing changes.

The spaceship runs out of fuel and the program returns to a main menu. Josef finds his way into a multilevel maze where he is supposed to read clues and move characters, allowing him to win. He spends five minutes clicking on various pictures and characters which beep and move. Finally, he finds himself in a different maze where he moves and characters chase him. Though the program is designed to test his ability to put words in alphabetical order, he simply moves the character until time runs out and the program moves him to a different section.

Sequences like the one above occur over and over. Josef continues to choose the program, although he has many others to choose from. What seems significant is the apparent willingness of Josef to stay in the program sensing the entertaining noises, movement, and mouse interaction as he clicks constantly. After a period of time in a section of the program, time for that section runs out and he is moved to another section. At one point, he clicks on the monster which attaches itself to the screen, but neither that action nor his clicking on the spaceship control buttons seems to result in any purposeful consequence. He doesn't know the rules or code (reading), but is nevertheless entertained. To contrast to edutainment where a child's main goal is to have fun and learn in the process, this is empty entertainment. Since this program is not in Josef's ZPD and his hand-eye coordination is already good, he learns nothing.

Although this example is extreme, the child's engaged interaction with the program that purports to be educational often satisfies educators who are hoping that prolonged engagement with educational material will result in learning. This 'logic of confidence' in the educability of technology is of course a long-standing one in American education (Cuban, 1986). Teachers have confidence that students doing workbook pages are learning and that simply watching informational videos is educational.

While it is true that people can learn from computers if they already know how to manage and organize information, it is the learner who must use the computer strategically during the process of learning (Reilly, 1992). Computers can present information and even suggest ways of using or organizing information, but it is the learner who must engage the strategies for the learning to have long-lasting effects. In contrast to mature learners, young children employ inefficient learning strategies (Seifert, 1993), and therefore often benefit from the assistance of knowledgeable others to develop strategies for using software as a learning tool (Mehan, 1985).

Past literature in teacher education and technology emphasizes the importance teacher guidance for student success using computers (Brennan, 1991; Charney, Reder & Kusbit, 1990). Teachers can provide a context conducive to using and learning from the computer (Michaels, 1990), strategic models (DeVoogd, 1995), and general metacognitive guidance (Salomon, Globerson, & Guterman, 1989). How technology is used, the functions it serves, and the extent to which it advances educational practice is critical to improving learning (Kulik & Kulik, 1989).

There is a need to be more specific in the teacher education literature concerning the software, contexts, roles, routines, and procedures that help teachers provide a context where students learn strategically. Teacher assistance that is directed toward the child's zone of proximal development is a promising place to begin.

Teacher's Assistance in the Zone of Proximal Development

All good educators know that children cannot learn something that is far beyond their ability to comprehend. This insight has even become sloganized as "developmentally appropriate practice." But what a child can do with assistance is not beyond him. According to Vygotsky (1978), the ZPD, or the distance between the child's current functioning and the child's potential functioning, that is, what the child can do with assistance, is the area in which development occurs.

The ZPD has profound implications for education. Currently accepted good practice dictates that teachers match the material they are trying to teach to the child's mental level. But the Vygotskian perspective would argue that this is not the best educational practice. Vygotsky argued that, "This procedure oriented learning toward yesterday's development" (1978, p. 89). Vygotsky was not alone in his awareness of this problem. For example, a Piagetian perspective would suggest posing problems that are just beyond what the child can do, so the child has to construct a new solution. But Vygotsky is more specific in his prescription of how teachers should proceed; specifically, teachers should determine what a child does on his/her own, and the limits of what the child can do with adult assistance, and then concentrate on what lies in between. By concluding that the child has the potential for those abilities, even if they need help now, it provides a powerful way of working toward a child's potential.

Toward these ends, Vygotsky suggests several types of assistance adults may offer children, in addition to simple teacher demonstration. For example, the teacher might initiate a solution which the child must complete, provide cues, or ask questions that focus the child on a particular path to solution. These are tutorial functions that can also be assumed by a computer program (and which are much superior to the drill and practice frequently offered as tutorial assistance).

Alternately, children may work together to solve a problem (Damon, 1984; Slavin, 1987). This might be thought of in terms of the ZPD, or it might be thought of in terms of the cognitive benefits of reconciling competing perspectives or attempts at problem solution (Mugny & Doise, 1978, Tudge & Rogoff, 1989). Collaborative work on computers is, of course, an especially rich educational context (Newman, Griffin, & Cole, 1989).

Opportunities and Limitations of Software

Like any curricular media (books, paper, manipulatives) each piece of software has its particular limitations and opportunities for instruction. Even though one can teach science from a book, it is generally recognized that books limit the possible conceptual growth of children compared to actually doing experiments with science materials. And yet few have examined the limitations of software and the teacher's contribution to children's learning during computer instruction (Samaras, 1996). Different software provides varying opportunities and limitations for strategic learning.

Interaction of material and user. Though a minimal requirement for software is that materials be developmentally appropriate for the child, this criteria is at best a limited prescription and useful primarily only to begin to cue the teacher to what materials the student *might* be able to understand and work with. Regardless of how teachers or software manufacturers assess the appropriateness of the software, that assessment can only be an approximation unless the evaluator can observe the interaction between the child and the software.

The fact that material is at an appropriate difficulty level for a child of a particular developmental level begs the question of what a child's possible interest and possible engagement with the software might be. Actually, thinking of the material as a separate entity is somewhat misleading. Although we can analyze the design features of a program, it is more important to examine the interaction between the individual and the program. So, the focus becomes not the features of the program juxtaposed to the features of the learner's mind, but rather, the interaction between the two. In other words, what does the student make of the material, how is it used and how is it interpreted, and, conversely, how does the material constrain or enable particular thought and action? These are not features of either the material or the individual in isolation, but emerges in the interaction between them.

Josef Plays with Pooh. To briefly illustrate the interaction of child and software, we return to Josef, the three year old, using the animated storybook, Winnie the Pooh (Disney Interactive, 1996). During Josef's interaction with the software, notice both the potential for learning for and possible misconceptions about educational benefits. In the next paragraph, although the text in the storybook is read to Josef, he does not respond to the text, but instead responds to pictures of things.

Josef initially clicked to an illustrated page of text with Pooh, Christopher, and Eyore. Words in the text were highlighted as they were being read by an off-screen narrator. Though Josef clicked around while the text was being read, the program did not allow any of the other features of the page to work until the text was recited and Christopher's extra-textual comment was expressed. Finally, when Josef clicked on the door in the tree, Piglet popped out of the door and said, "If you want to play a game with me click on the toys (in the corner of the screen)."

Instead, he clicked on the door again and Tigger popped out, jumping up and down like a pogo stick. He says, "Look, Jack in the box. Jack in the box." Next, Josef clicked on the balloon, which changed into the shape of Pooh. He smiled, then clicked on the balloon several more times as the balloon changed into the shapes of various characters in the story, smiling all the while.

Note that Josef does not appear interested in the text on the page although it is read and words are highlighted as they are spoken. If the teacher used this program for Josef reasoning that he would learn about the flow of text and the association of written text to spoken text, the teacher might be disappointed. Josef's action does not imply any such interest or ability. In fact one might conclude that his clicking while the text was being read was an indication of disinterest and lack of engagement in the text.

Instead, Josef appeared to prefer more animated and less abstract symbols by clicking on the balloon and the door in the tree. He is interested and able to understand pictorial representations but not textual ones. He responded to the character coming out of the door by clicking on it again and then saying, "Look, Jack in the box. Jack in the box." When Josef clicks on the balloon, he responds to the text by smiling and clicking on the balloon repeatedly.

Part of the intended lesson was surely to help the child recognize the relation between written and spoken language. Presumably the software is instructive in this way for some children. But Josef did not spontaneously use the software in a way that would promote this recognition. Perhaps it was simply beyond him, but we do not know this. A responsive teacher could have intervened, using the software with Josef, focusing him on educationally relevant aspects of the software by means of comments and pointing.

Further observation of Josef's interaction with the software provides additional insights:

Josef clicked on the pile of toys in the lower left corner, which launched the computer into a section where Piglet asks the child to help him find toys he thinks Christopher might like to play with (Figure 1).

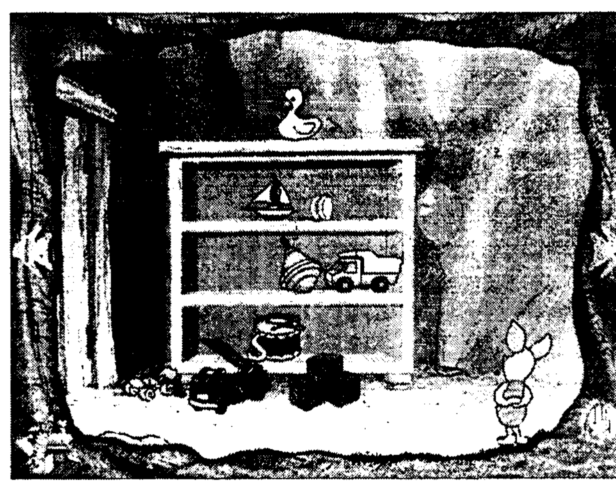

Figure 1. Piglet tries to find some good toys to bring to Christopher.

Then he gives the viewer clues about what he is looking for. "I'm looking for something that has wheels that is yellow." Josef clicks on the blocks. Piglet responds with very pleasant intonation, "I'm afraid that's not it, but keep trying."

Josef looks at his father and in the same pleasant voice says, "Dad, you say but keep trying, Joe. Dad, you say, but keep trying Joe." Josef then clicks on the skate.

Piglet replies, "That has wheels, but it's not yellow." Finally, Josef clicks on the correct answer (the yellow truck). Piglet says, "You found it. That's right."

In kind, Josef exclaims, "I found it. I found it."

In the brief interaction above, Josef responds to Piglet's comments by repeating, "Dad, you say, 'but keep trying Joe'." One would hope that the child might be learning a very powerful message, but it is not clear that the strategy of "trying it again" will be used in other contexts. It does, however, prompt the teacher or parent to work to broaden the child's understanding of both the words and, especially, the suggested strategies. Indeed, by encouraging his father to tell him to try it again, Josef appears to be indicating his understanding of Piglet's and his father's parallel roles as facilitators of his learning.

It is interesting to note that Josef responded to Piglet's voice but in the earlier section, he did not respond to the highlighted print read by the narrator. Perhaps seeing the character Piglet led him to recognize the communicative nature of the language spoken by Piglet , in contrast to the disembodied narrator. One may even ask if Josef has very little concept of print as language, or if he is just impatient with the narrator. In such an analysis, the careful observer comes to understand and explore something about what makes some—but not all—recorded language meaningful and engaging for Josef.

So, it appears from the sections and discussions above that Josef is learning some language and perhaps some strategies. What is less clear is whether he is learning about reading, the relationship between text and spoken language, or the concepts 'yellow' and 'wheels'. These are ideas the software claim to teach and yet Josef's unique interaction with the software indicates otherwise. We see that Josef does not use the software as expected or perhaps as the designers intended. He does not click on the words to find their definitions, nor does he make connections between spoken and written language, or the connection between word and pictorial referent. All of these are no doubt selling points of the software to parents. Yet Josef did find unanticipated opportunities for exploration and learning. It might be argued that the interaction of the child with the computer can create new possibilities. What is clear is that teachers have an important role to play, examining children's interaction with software, as they should with any media. At the very least, adults must observe to make a more accurate assessment of what children are learning, and not simply trust promises on the side of the box.

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A Creativity Triad: Teacher, Technology, and Collaborative Learning

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Teaching philosophy, computer programs, and collaborative learning are interwoven in scaffolding the development of creativity in young children. Adding technology into the learning environment requires a re-examination of philosophical foundations and restructuring of interactions which are supportive of the desired learning. Early childhood educators generally hold constructivist views and support methodology that facilitates the young learner's creation of meaning. The type of software and hardware available in the eighties led many early childhood educators to avoid significant use of the technology with young children. The nineties provide an expansion of the pool of open-ended software designed to be controlled by the child. This improved technology provides the opportunity for constructivist teachers to utilize computers in ways which are congruent with their own philosophy and to open windows for young children to become involved in the process of creating meaning through this technology.

Creative thinking is critical to higher level thinking and problem solving (Gardner, 1993; Guilford, 1956; MacKinnon, 1964; Torrance, 1962). These skills are demanded for the next century by the SCANS Report (USDL, 1992), are specified in the national goals (Committee on Education and Labor, 1994), and are emphasized in the mandated curriculum in most states. The rapid expansion of open-ended software supporting higher level thinking and problem solving is occurring concurrently with the increased emphasis on these cognitive skills. Studies of cognitive development suggest positive effects of developmentally appropriate computer experiences including increase in: problem solving skills, higher order thinking skills, mathematical reasoning, scientific concept formation, and language development.

In contrast, the computer software most frequently used with young children in school settings is structured in format. Research suggests that structured drill-and-practice software programs do not advance skill and are associated with significant losses of creativity (Char, 1990; Clements, 1991; Clements, Nastasi, & Swaminathan, 1993). Additionally the use of computers with children identified as at-risk for school failure shows promise for intervention. Yet, many schools continue to purchase expensive computer laboratory software and utilize the precious 30 to 45 minutes per week per child in a drill-and-practice modality valuing product as opposed to process. These research insights and field observations led to this current research addressing development of higher level thinking skills of kindergarten boys and girls through utilization of a cooperative learning computer experience utilizing either open-ended or structured software.

Historical Foundations

Early in this century the developing computer was seen as a producer of information and persons concerned with computers were ultimately concerned with the products produced. As the technological revolution unfolded, and with spiraling advancements of development and use of this equipment, the computer began the transition between product and process. The growing shift between a behaviorist, product driven orientation to a constructivist philosophy focusing on the process of human interaction exemplifies the product-process paradigm within the technological realm (Clements, Nastasi, & Swaminathan, 1993; Papert, 1992).

In perhaps no other field is the difficulty of this product-process shift as evident as in the field of education. While educational programs are typically designed to provide instructional methods and to assess student ability to assimilate and evaluate information as well as to communicate their knowledge, these programs seldom utilize the information technologies in the same manner as other professions. Technology is now at the center of most business operations, research endeavors, and the arts. Until educators begin to construct programs and curriculum which provide for the use of technology as the basic building block for student-centered construction of knowledge, the use of technology as a product rather than a process will dominate educational practices and philosophy.

In contrast to other professions, education continues focus on the computer as a support for product oriented education rather than as a tool to explore the process of higher level thinking (Mehlinger, 1996). The evolution of this process orientation requires not only the appropriate equipment and software but also the preparation of those who structure the computer experience and integrate these tools into the established curriculum (Withrow, 1990).

Early Childhood Perspectives

Early childhood researchers of the 1980s (Brady & Hill, 1984) argued against use of computers with young children citing the danger of the abstract nature of the computer environment being used by children who had not yet reached concrete operations. More recent research suggests that young children can benefit from developmentally appropriate use of computers within a meaningful context (Char, 1990; Clements & Nastasi, 1992; Clements, Nastasi, & Swaminathan, 1993) prior to concrete operations. Open-ended, unstructured software supportive of higher level thinking provides technical tools to support this philosophy and gives birth to a technology creativity triad in which teachers, technology, and collaborative learning are work together to provide the best possible computer learning environment for young learners.

Teacher Roles. Teachers must be prepared to select software that: matches the developmental age of the child; offers child control and choice; and provides the opportunity for use of higher level thinking skills, reflective thought processing, and the development of creativity. Various studies contribute to identifying the criteria from which to define developmentally appropriate software, establish methods for selection, and design the computer experience. Since children generally respond positively to use of the computer, it is vital that the teacher provide the discrimination in selecting the most appropriate software.

Concurrently, research has examined the roles of cooperative learning activities and of mediated instruction in enhancing higher order thinking and problem solving. Use of mediated instruction during the cooperative, open-ended computer experiences has been supported by Pogrow (1990). Since computers offer visual, tactile, and listening modalities, students can learn through whichever modality they prefer. They can test their own ideas privately and at their own speed. They receive immediate feedback and teachers can engage them in thinking about whether the results were their expectation or not. Socratic questioning techniques during a cooperative learning experience offers a firm foundation for structuring technology use with young children.

Technology Choices. Identification and selection of appropriate software is a critical issue to be addressed in teacher education. According to Haughland and Shade (1990), the type of software chosen by adults for the children to use is the key to developmentally appropriate experiences. It is important to keep the question in perspective since only twenty percent of all software available for young children provides this type of learning environment. On the other hand, the software used most frequently in school settings is structured despite research evidence that this type of software does not advance higher level thinking skills and is not supportive of early childhood philosophy (Char, 1990; Clements & Nastasi, 1992; Clements, Nastasi, & Swaminathan, 1993).

The choices made by teachers must be congruent with their philosophies and support the complexities of cognitive development of young children. The design of computer environments, must be governed by structuring technological experiences for young children which allow them to use their own questions to guide their building of knowledge through the transformation capability of the computer (Scardamalia & Bereiter, 1991). Studies suggest that it is this capability of technology that aids learners to elaborate their mental models and correct previous misconceptions. "Computers also have the capability of creating dynamic, symbolic representations of nonconcrete, formal constructs that are frequently missing in the mental models for novices" (Kozma, 1991, p. 197).

Cooperative Learning. Extensive research has linked higher-order thinking behaviors to interactions with appropriate computer programs as well as to use of cooperative learning principles and adult scaffolding of technology experiences. This link between higher-order thinking and use of computers provides a significant intervention for at-risk children and offers support of individual learning differences. Providing for individual differences through cooperative learning and the development of creativity involves the structuring of the computer learning environment design so that students work together toward a common goal (Nastasi & Clements, 1991). Students should be provided with the opportunity to experiences another individual's perspective which in turn may scaffold their experience so that they might reach a new level of development (Bowman, 1990). Teachers need to play with their own ideas regarding the use of computers to promote deep, meaningful, cooperative, and creative learning (Clements, 1995a).

Research

Design

This experimental study in the 1995-1996 school year examined the development of creativity in kindergarten boys and girls through utilization of either open-ended or structured computer software within a cooperative learning setting. A total of 86 kindergarten children formed the three study groups for this research: Group I, cooperative education with open-ended software; Group II, cooperative education with structured software, and Group III, the control group. Additionally, this experimental study explored the possible differences in performance between students designated at-risk by the school district and classmates not so designated.

Procedures

The four dimensions of the Torrance Test of Creative Thinking (TTCT), fluency, flexibility, originality, and elaboration, plus the criteria of abstractedness and thirteen criterion-referenced indicators were the dependent variables upon which the effects of different types of computer experience were measured. The sample was pretested and posttested for this 15-week study utilizing the verbal and figural tests of this creativity measure in Form A and in Form B. A two-way analysis of co-variance (ANOVA) was used to compare the adjusted posttest mean scores between the groups and to examine the at-risk variable. Three hypotheses relating to figural creativity measures and three hypotheses pertaining to verbal creativity measures examined the gains by groups, the differences between at-risk students and those not at-risk, and the interaction between the groups by risk status.

Findings

Group I utilizing open-ended software made significant gains in both verbal and figural creativity (fluency, flexibility, and originality) over Group II utilizing the structured software and Group III, the control group. There were no significant differences in the adjusted posttest mean scores of figural creativity, and no significant interactions among the groups by risk status.

Group II evidenced statistically significant gains in both verbal and figural creativity (fluency, flexibility, and originality) compared to Group III, the control group. No significant differences were identified between at-risk and not at-risk groups, and no significant interactions were identified among the groups and risk status.

Conclusions

Conclusions drawn from this study provide insight concerning factors significantly influencing the education of young children through the use of technology. The technology explosion offers new approaches and support for teaching higher level thinking and provides a scaffold for the development of creativity. Additionally, the impact of open-ended software on creativity provides an important question for continued research exploration. These implications coupled with the advantages of using a variety of software within a cooperative education learning structure for young learners during a computer experience cannot be overlooked. Designing a technology program based on the theoretical tenets and philosophies of developmentally appropriate practice, cooperative learning, and the higher level thinking skills used in creative endeavors has been proven to be an important factor in early childhood education (Clements, 1986, 1987a, 1991). In spite of the supporting research, many educators have been hesitant in implementing such a program in the area of technology. While many school districts pay credence to developing creativity through developmentally appropriate programs, few districts are actually implementing a technology program which is truly integrated and attempts to educate the "whole child."

This lack of implementation is not linked to lack of concern for the young child, but relates directly to the societal and political pressure felt in many of today's classrooms. This type of pressure still dictates the manner of educational assessment, a standardized test. Teachers of young children are, in many cases, held accountable for the scores produced on these types of tests. Unfortunately, many teachers are afraid to switch from computer programs and methods of using technology designed to facilitate the test, to a more developmental approach using computer programs that do not provide daily practice on similar test items. The use of technology within the school setting falls prey to the fear of utilizing this expensive equipment in a manner which may not provide instant proof that mastery of specific skills has taken place.

However, switching from a traditional use of technology to a model which reflects the tenets of developmentally appropriate practice, cooperative education and development of creativity should not cause teachers to fear the impact on standardized testing. The critical findings in this study clearly indicate that students participating in a "newer model" of technology use which provides a foundation from developmentally appropriate practices and cooperative education make strong gains in development of creativity which impacts higher level thinking skills. The development of higher level thinking skills in turn has a direct impact on performance on standardized tests. The practice of implementing technology use with young children in a highly structured and controlled manner in order to build the foundation for increased test scores should be eliminated. While the standardized test may still exist as a reality for many teachers, this does not need to be the impetus for the manner in which time at the computer is structured for young children.

The "old model" of technology where one child works in isolation on highly controlled computer programs gives little opportunity for problem solving situations to arise or to be created by children working together within a computer environment. As this research suggests, a variety of software, both structured and open-ended, can influence development of creativity as long as students are allowed to engage in computer experiences which are reflective and supportive of problem-solving situations. As shown in the test results of verbal creativity, Group I, which engaged in open-ended software, was found to make statistically significant gains in all three verbal creativity measures when compared to either structured software Group II or the control Group III.

More surprisingly, is the result that the structured software Group II was found to make statistically significant gains in all three verbal creativity measures when compared to Control Group III. This finding attests to the power of the structure in which children work together at the computer. No longer is it relevant to think that each child needs their own computer. Rather, it is in the group discussion of various ways in which to manipulate the structured software in order to allow more user choice which can increase development of verbal creativity. While most students appeared to be more motivated and engaged for longer periods of time on the open-ended software, the structured software offered motivation to students to practice basic skill development in a group setting.

With continuing emphasis on developmentally appropriate practice from early childhood professional organizations and the emergence of technology as an acceptable medium for young children's explorations, more teachers are beginning to implement the "new model" of technology described in this study. Many teachers are beginning to refine their computer skills and knowledge of appropriate software for young children, incorporating additional factors such as cooperative education, and integrated curriculum within the manner in which computers are utilized in their classrooms. Hopefully, through the actions of professional early childhood teachers and organizations, many districts will begin to see the inappropriateness of utilizing technology as a tutor for standardized testing. Until then, early childhood educators can begin and continue to implement "new models" of technology that are appropriate for young children, and feel secure that allowing children to explore these intriguing environments will increase higher level thinking skills.

Recommendations

The results of this study provides several recommendations for educators in the field of early childhood education. Given the current research in the area of using technology with young children, it is clear that a recommendation be made to educators to begin implementing a "new model" of technology use such as the one described in this study. With contemporary society involved in a continually shifting paradigm, it becomes necessary for education to supply a working environment in which children become immersed as they seek to solve problems. Technology programs designed to help children build higher level thinking skills should be based on the current research and the philosophical tenets of developmentally appropriate practice which support the growth of the "whole" child, not merely constructed to increase achievement on standardized testing.

The classroom should reflect the changing world at large in which children come to learn how to become part of the larger society in a positive manner. Through involvement with all tools, including technological environments, children engage in learning and experience growth in the psychological, socioemotional, cultural, and scholastic components of their development. When the additional factor of recognizing and providing for cooperative experiences within the motivating realm of a computer experience, students begin to understand their own strengths and preferences and recognize the similar and differing strengths and preferences of others. Thus, through these provisions, teachers have begun to facilitate an empowerment process internal to the individual student who can then become responsible for their own learning. Such intrinsic motivation for a student to develop their optimal growth does not come from extrinsic motivation as exists in the "teach the skills, drill the skills, and test the skills theory." Educators are encouraged to look at the type of technology programs supplied in early childhood classrooms, and judge their effectiveness based on the knowledge gained through research of technology use and young children and the philosophy of developmentally appropriate practice.

An examination of the use of technology within its societal context should be addressed. The argument that children should be exposed to computers now in order to prepare them for their future is no longer adequate. The computers of the future will have little in common with the computers of today. Artificial intelligence and sophisticated computer interfaces will make keyboarding skills and "computer literacy" courses obsolete. Appropriate programs which provide for young children to become engaged with technology should be designed to empower students to develop the type of higher level thinking and problem solving skills which will be necessary to understand and work with the computer systems of tomorrow. When such programs are put into place, children are provided with the capabilities and motivation to successfully work with and invent the technological advances in the 21st century.

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Visualizing Basic Math Processes: Using Computers in Early Childhood Education

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Many young children have problems employing cognitive strategies correctly in math. Lindquist (1987) points out how discouraging it is to watch second graders struggle with elementary problems such as, *Mary has 6 apples. Burt has 3 apples. How many more apples does Mary have than Burt?* A second common problem occurs when nine-year-olds reverse in subtraction, for example 450 - 168 = 318. The children's strategy is to subtract the smaller number from the larger. Often children don't realize that 450 and 168 are only two numbers of three digits each one. In addition to poor cognitive strategy employment, young children experience problems learning basic math skills (e.g., counting, numbering, sorting, grouping). Although is common for those in education to attribute these problems to learning disability, we argue that most of these problems could be explained by a lack of appropriate math problem-solving models.

Children usually learn to count or to add by watching how the teacher solves a problem on the blackboard and then solving some exercises themselves in workbooks. Teachers explain the process of solution of any math task using words, symbols and gestures. Probably, they are the best facilitators of solving models but they can only offer them for a short period of time because, usually, there are too many children in the classroom and all of them ask for the teacher's attention.

The workbook, in contrast is more accessible for all children in the classroom. Children look at the numbers, symbols, graphics and signs to learn to solve, for example, an addition problem, but all these things are displayed on a static media: the pages of the book. Workbooks cannot include sound or animation. They can't reinforce the performance of the student to maintain his/her attention and they do not inform children on how well they are doing the exercises. Mainly and most importantly they do not model the procedure of solving math problems.

VISPRO.Càlcul

All these limitations can be overcome with the computers and multimedia technology. Computers can offer dynamic models of math problem resolution and can so repeatedly. They have the capability of politely and explicitly describing problem-solving strategies using sound, images which explicitly teaches problem-solving strategies more effectivly than instruction that relies only on memorization of isolated facts (Steimberg, 1985; Thornton, Jones and Toohey, 1983).

We have developed an interactive multimedia software with SuperCard® to teach basic math skills. This software shares a philosophical background with the VISPRO.Grafies (Bornas, Servera, & Llabrés, 1996a; 1996b). With our program, dynamic models are displayed on the screen and children learn how to solve math problems by visualizing the processes involved in the calculating operations. VISPRO.Càlcul is easy to use, flexible and open. Every teacher may adapt the program to his/her classroom. The program itself allows changing the displayed pictures, the displaying speed, the number of example-cards, and the complexity of the exercises.

The application includes six modules with a similar structure. First, some models are displayed showing a basic calculating process. The importance of imitation as a learning procedure has been long recognized since Albert Bandura (1977; 1986) developed a technology of imitation. For example, the computer could show the process of adding in this way: first, two apples are selected with a circle and moved into a basket; then three other apples are taken and moved into the basket. Finally the apples are counted and a number appears near each one: 1, 2, 3, 4 and 5, so five apples are into the basket.

Secondly, children practice with some exercises related with the examples. Each card-exercise has a help button that shows the dynamic model again if necessary. These modules are sorted by their complexity. They are:

a. series,
b. counting,
c. adding I,
d. tens,
e. adding II (including tens), and
f. subtracting.

The first module focuses on the concept of series. The computer will show how to make up a sequence of shapes (e.g. yellow rectangle, green triangle, blue circle) or figures (e.g. cat, dog, fish). When the child clicks on one of such sequences or series the program begins to construct it by placing the first figure at the top left corner of the screen, the second one beside, and the third one on the right side of it. The program draws a line under the three figures so that children realize that this sequence has the same figures as the model sequence and that the figures follow the same order (e.g. cat - dog - fish). After a few moments another cat-dog-fish sequence is coming up on the computer's screen, and the program repeats the process until the page is full. Some cards of this module allow children to choose which figures will appear in the sequence before it is constructed. The Series module helps children to learn concepts like *before* and *after* or *on the left* and *on the right side* of something.

The second module is about another essential skill, counting. In spite of its simplicity, to count things requires a process and this module shows this process to the young children who are learning this skill. The program show, for example, five turtles on the left side of the computer's screen and the numbers one to nine on the right side. The first thing the program will do is to group the five turtles by drawing a circle around them so that all of them are into the circle. Then the program assigns a number to each turtle which appears next to the figure: 1, 2, 3, 4, and 5. Finally the program draws a line from the circle to the number five on the right side of the screen and highlights it. In addition to the modelling cards where children can see these processes, the counting module includes counting exercises. In these cards the child has to click the button that holds the correct number of figures shown on the computer's screen (there are always nine buttons with numbers one to nine).

The Adding-1 module is the third section of the VISPRO.Càlcul program. This module shows the process of adding up to ten things. There are exercises and modeling cards. When doing exercises children have to click the number that represents the correct result of the adding. If the answer is correct, the program displays a new exercise card. If not, the program gives appropriate feedback and prompts the child to try again. There is a help button in all of the exercises cards. When the child clicks this button, the program takes the child to the modeling card where the adding process is shown slowly. The card shows some figures (e.g. three flowers), the plus sign (+), some more flowers, and the equals sign (=). The process is as follows: the program counts how many flowers are in the first group and writes the numbers one, two and three beside each flower. Then the three flowers are moved to the right side of the equal sign and the number three appears into a field below the figures. The program repeats this process with the second group of flowers, it places the plus sign and the new number after the same field. When all the flowers are in the right side of the equal sign the program counts the flowers (writing the numbers beside the flowers) and then puts the equal sign and the total number after the field.

The next module refers to the concept of*ten* showing that numbers from 11 to 19 can be divided into a group of ten and numbers one to nine such as $15 = 10 + 5$. This program shows how to add, for example, 12 and 5 birds making one group of ten birds and adding to this group the remaining 7 birds: $12 + 5 = 10 + 7 = 17$ birds. While in the Adding-1 module the additions where displayed horizontally, in this module numbers are displayed vertically.

Adding-2 is the fifth module of the program and it shows the type of adding exercises that children will find very often in their school workbooks. This module does not present moving figures. It emphasizes the adding strategy and it focuses the child's attention to the most important issues of this strategy:

1. Start with the right column;
2. Do not forget adding; and,
3. In the next column if the first result is greater than ten, write the numbers in the correct place (aligned with the corresponding column).

The last module, Subtracting, has a structure very similar to that of the Adding-1 module. The modeling cards display the process of subtracting as follows:

1. The program counts how many objects are in a group;
2. Then it puts a mark beside the objects to subtract and counts the numbers;
3. The marked objects are eliminated and the others are counted; and,
4. At the exercise cards children have to eliminate objects, count the remaining ones, and write the result of the subtracting calculation.

As in other modules, if the answer is correct, the program displays a new exercise card. If not, the program gives appropriate feedback and prompts the child to try again.

In our opinion, teachers might use this interactive program as a resource to facilitate the acquisition of basic math skills, as well as a means of preventing or correcting the problems they normally find in this area. Impulsive children, who usually do not pay attention to the teacher's explanations to the whole class, would benefit from this software because they just need to pay attention for a short period of time to the computer's screen. We know, however, that this empirical question requires experimental research to test the efficacy of the software. Presently, we are carrying out some studies with it and the preliminary results are very interesting which we hope to present at SITE '97.

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Using Teacher-Made Software to Teach Pattern Recognition and Construction

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The reconceptualization of the teaching of mathematics in the past decade has focused on mathematics as "the science of patterns" (Schoenfeld, 1992). If mathematics is indeed the science of patterns, then teaching young children to identify and construct patterns may be the first goal of early childhood mathematics education. To achieve this goal, teachers need to have effective and inexpensive tools to help students seeks and construct patterns and order out of chaos. Though software programs could be effective in achieving that goal, quality software is difficult to find (Shank & Edelson, 1989/90) and prohibitively expensive. Some teachers have started to construct their own software out of a desire to use the computer effectively. The purpose of this study was to assess the efficacy of teacher-made software designed to teach first grade students to recognize and construct patterns.

Since Piaget's (1954) seminal work, researchers have recognized that mathematical thinking in young children starts with concrete physical manipulatives. As children mature into adolescence, they may abandon the concrete objects and think mathematically in a purely abstract way. Using computers, one may move beyond the level of physical manipulatives without moving directly into the abstract realm. A computer can allow children to make symbolic visual representation (cybernetic manipulatives) of concrete objects and manipulate those objects as an intermediary step toward abstraction. In fact, for some children below the age of abstract thought, cybernetic manipulatives may supplant the need for concrete manipulatives entirely. Thompson and Thompson (1990) found that average and above-average performing fourth graders using cybernetic manipulatives developed a deeper understanding of the number system and its algorithms than did peers who employed concrete manipulatives; among the weakest students, the groups did not differ.

One advantage to employing cybernetic manipulatives is the computer's ability to capture and store learning actions. For young children, the ability to capture and store a learning action on disk and also on paper allows affords the opportunity to engage in mathematical discourse with the teacher at a later time. Teacher-student discourse is essential to learning mathematics and at the heart of learning heuristics and metacognition (Mead, 1943; Resnick, 1988; Rogoff & Lave, 1984; Schoenfeld, 1992; Vygotsky, 1978).

The potential for cybernetic manipulatives to assist young children in their thinking about patterns combined with the need for inexpensive software led us to ask our first research question: Will engaging in teacher-made cybernetic manipulative activities increase first-graders' ability to construct and recognize patterns? We hypothesized that it would. Our second question was whether the intervention would affect higher and lower scoring students to the same degree. We had no reason to suggest that our findings would differ from those of Thompson and Thompson (1990).

Method

Design

The design of our study was a two-group post-test only design.

Participants

Participants in the study were 29 first grade students in a new lab school associated with a mid-sized university in North Texas. The students were randomly assigned to two first grade classes. The control class consisted of 5 boys and 10 girls; the experimental class consisted of 8 boys and 6 girls. Although the school was located in a new subdivision, a number of students in each class were bussed in from a low-income area.

The teachers of the two classes were both veterans who had applied to teach at the new school and been accepted over many other applicants. Those selected to teach at the new school made a commitment to the use of cutting edge technology in their classrooms. The study took place during September and October of the first year of the school's existence. Each classroom had three computers available to children in addition to the teacher's computer.

In addition, the first grade and kindergarten classrooms were built around a pod which held four additional computers which were available to the children.

Treatment

The treatment was developed by the second investigator who was the teacher of the experimental group. The treatment consisted of having students manipulate teacher-made and student-made cybernetic manipulatives. The cybernetic manipulatives were constructed on a draw document; the medium was inert, and the computer imposed neither constraint nor support structures on the participant. (For a discussion of *interactive* as opposed to *inert media* and *constraint* and *support structures*, see Kaput, 1992.)

On some activities, the draw document had a pattern started on the bottom half. On the top half of the document was a pool of cybernetic manipulatives which could be used to complete the pattern on the bottom half. On these activities, participants were directed to recognize and complete the pattern by clicking on the desired manipulatives in the pool and dragging them to their appropriate places in the pattern.

On other activities, the pool of manipulatives was at the top of the document, but there was no pattern started on the bottom of the document. Participants were directed to click and drag the manipulatives to construct a pattern of their choice. In still other activities, participants were directed to construct their own cybernetic manipulatives with which to create their own patterns.

The first activity in the treatment consisted of having the children use five red circles and five blue circles as cybernetic manipulatives with which to make a design. In the next activity, red and blue rectangles were added to the circles. In activity three, triangles were added. The activities became increasingly complex and ended with patterns of numbers and number families, e.g. 4 + 2, 2+ 4. The last activity consisted of number patterns: 3—4, 4—5, 5—6. Both the experimental and control groups studied pattern recognition and construction in traditional ways.

Instrument

Our instrument was a worksheet consisting of numerals in patterns which the students were to continue. The patterns were ones to which the children had not been exposed previously.

We gave full credit of 5 points for each missing numeral that a participant supplied that indicated that the participant recognized a pattern within the provided information and continued that pattern. However, we discovered that some students simply started the pattern over rather than continuing it. That suggested to us that children did not recognize the pattern *within* the provided information, but knew that repeating the information given would constitute a pattern. Therefore, we gave credit of 1 point for each numeral supplied in such a manner. Incorrect responses were scored 0. A total score of 45 was possible.

Procedures

The assessment was conducted by the senior researcher. Before the instrument was distributed, participants placed a cardboard shield around their desk in order to ensure that each child's answers were her own. Participants was then given a copy of the instrument and directed to complete the worksheet doing their best. Students who raised their hands to ask for assistance were told that they could not receive any help and to try their best.

During each class's assessment, the participants' teacher was in the room. The senior investigator was known to the children because she is field coordinator and scholar-in-residence at the school. In that capacity, she had visited in the classrooms of the participating children.

Results

First, we subjected the groups' scores to a 1-tailed t-test of independent samples. The groups differed at p=.06. The mean of the experimental group was 17.5 (SD=12.6; SEM=3.4); the mean of the control group was 11.4 (SD=11.4; SEM=1.9).

In order to determine whether the difference between the groups in the number of boys and girls biased the outcome, we then subjected gender to a 2-tailed t-test of independent samples. The groups did not differ (p=.85). Males had a mean score of 14.8 (SD=11.5; SEM=3.2) and females had a mean score of 14 (SD=10.1; SEM=2.5).

Next, in order to determine whether there were an interaction between treatment and gender, we subjected the scores to a 2-factor analysis of variance (ANOVA). There was no difference across the groups (p=.64).

Next, we subjected the 7 lowest scores in each group to a 2-tailed t-test for independent samples. The groups did not differ (p=.54). The experimental group had a mean score of 7.3 (SD=5.8; SEM=2.2) and the control group had a mean score of 5.7 (SD=3.5; SEM=1.3).

We then subjected the 7 highest scores in the experimental group and the 8 highest scores in the control group to a 1-tailed t-test for independent samples. The groups differed at a statistically significant level (p=.005). The experimental group had a mean score of 27.7 (SD=8.3; SEM=8.3) and the control group had a mean score of 16.4 (SD=6.2; SEM=2.3).

Discussion

Our results suggest that inert cybernetic manipulative activities which are constraint and support-free can increase young children's ability to recognize and construct patterns. Furthermore, the activities appear to be a powerful tool when employed with students who scores on the assessment place them in the top half of the class.

However, students whose scores place them in the bottom half of the class do not appear to benefit from the intervention.

Although participants' scoring in the top half of the class on the assessment does not assure they are among the top half of the class in intelligence, it may be that the higher-scoring students tend to be the more intelligent children. Such an argument has a great deal of intuitive appeal. If indeed that is the case, then it may be that because cybernetic manipulatives represent an intermediary step between the use of concrete manipulatives and pure mental representation, one must function well within the concrete operational stage in order to benefit from them. Children who are six years of age but who are developmentally in the bottom half of their class may still be in the preoperational rather than the concrete operational stage and therefore developmentally unequipped to benefit from manipulating cybernetic representations of concrete objects. It may be that they are even developmentally unequipped to recognize and create patterns by manipulating concrete objects. If that is the case, then perhaps when the children in the bottom half of the class reach the developmental stage of concrete operational thought, they will then show gains when exposed to cybernetic manipulatives. Future research in this area may provide useful information.

Our study has a number of problems. First, although the students were assigned to the classes at random, it may be that the groups were not equivalent in their thinking about patterns before the treatment was implemented. Because we did not conduct a pretest, the issue remains unclear; we did not conduct a pretest because the treatment did not start out as a research project. The second investigator developed and implemented the treatment as a normal part of her classroom teaching. When the senior investigator observed in her class, the second investigator shared that she had invented the treatment and that she was delighted with the results that she was observing. The senior investigator suggested that they collaborate to assess the treatment, and the formal investigation began. In the coming academic year, we plan to replicate the study using a two-group pretest-post test design.

The second problem involves time spent on the study of patterns. Although the teachers have identical schedules, it may be that they differed on the number of times during the day that they talked about patterns in classes other than mathematics. For example, during language arts, science, or social studies, the teachers may have differed in the frequency with which they had the children note patterns embedded in their activities. In order to address this problem in future research, teachers would need to document the frequency with which they engaged in helping children recognize patterns in classes other than mathematics.

A third problem also concerns time. Because the cybernetic manipulatives were available to the children in the experimental group during free periods, it may be that the added amount of time in which they were engaged in thinking about patterns, rather than the cybernetic manipulatives themselves, caused the improvement in scores. It also may be that only the children in the top half of the class in the experimental group elected to use the cybernetic manipulatives during free time; children in the lower half of the class may have preferred other types of free-time activities. Therefore the length and frequency of exposure to the treatment may differ drastically between the high and low scoring students in the experimental group. Controlling access to the treatment for a limited time may yield useful information in future investigations.

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Author Index

1375

Journal of
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JOURNAL OF TEACHER AND TEACHER EDUCATION (JTATE) is an international quarterly that serves as a forum for the exchange of knowledge about the use of information technology in teacher education. Information technology is defined broadly and includes the theories, concepts and strategies involved in professional education as well as relevant hardware and software. The content of this peer-reviewed journal covers *preservice teacher education, inservice teacher education, graduate programs,* and *staff development* in areas such as curriculum and instruction, educational administration, instructional technology, and educational computing for *all* disciplines. *JTATE* is the official journal of the Society for Technology and Teacher Education.

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