A Framework for E-Learning in Agricultural Education

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Abstract. Further education and training are very important factors for the agriculture sector. Unfortunately, the lack of time and space has lead to their limited appliance to farmers. Limited financial support and low background knowledge in Information and Communications Technology are two more suspending factors. At the same time rapid technological progress has lead to the implementation of Internet applications which offer e-learning. This paper proposes a framework for applying e-learning to agriculture. It may be applied to three different stages of educational process: (i) platform development, (ii) courses development and delivery, (iii) platform and courses evaluation. The Nielsen Heuristics for system usability, the Technology Acceptance Model for evaluation, and indexes and metrics for system log file analysis are used. The expected benefits of the framework application are the qualitative presentation of educational material, the overcoming of spatial and time restrictions and the continuous evaluation of courses.

Keywords: e-learning, agriculture, Technology Acceptance Model (TAM), indexes and metrics.

1 Introduction

Times change. New technologies cause new capabilities and provide new occasions for everyone. People try to increase their knowledge with lifelong education but at the same time they have less time to allocate because of the intensive requirements in their jobs. On the other hand, the advances in Information and Communication Technologies (ICT), assisted an alternative mode of learning, e-learning, to come on to the scene. It changes the way people meet and communicate. ICT affects the way people teach and learn (Delacey and Leonard, 2002; Radcliffe, 2002; Starr, 1997).

E-learning is technology-based learning such as computer-based learning, web-based learning, virtual classroom and digital collaboration (Tsai and Machado, 2002). The e-learning education gives the learners the opportunity for education without the restrictions of time or location. A significant benefit of e-learning is that it allows

In: M. Salampasis, A. Matopoulos (eds.): Proceedings of the International Conference on Information and Communication Technologies
for Sustainable Agri-production and Environment (HAICTA 2011), Skiathos, 8-11 September, 2011.

learners access to learning material at their convenience (DeLima, 1999). The advantage lies in the fact that training can be offered without the necessity for a physical classroom, as learners can learn anywhere where there is access to the Internet. Arnone (2002) reports that some learners find that e-learning suits their learning styles better than the conventional, face-to-face options - which could be attributed to the fact that some learners are more visual than auditory. Furthermore, some learners prefer working at their own pace and prefer not to restrict their learning to a specific location.

Many organizations, institutes, universities, schools and corporations are investing substantial amounts of time and money in developing online alternatives like e-learning to traditional types of education and training systems. Many authors have discussed the way in which e-learning can be used for the delivery of training, assessment and support (Fichter, 2002).

E-learning in agriculture related fields is still in the early phases of adoption, but is being implemented more now than ever. A study by Elbert and Alston, (2005), indicated that Cooperative Extension could serve as a change agent in the Digital Divide.

Extension professionals and agricultural educators express an increasing desire to inform farmers about improved management practices and other issues via the Internet (Hall et al. 2003; O'Neill, 1999). In the 1990s and 2000s, studies indicate limited perception of and experience in the use of the Internet for educational communication purposes. According to Gloy et al. (2002) and Tavernier et al. (1996), modern communication strategies, such as computers, e-mail, and the Internet, were less preferred by the farmers.

Agricultural extension, both at the central and local levels, has been and remains one of the most notable and successful agents for assisting farmers with knowledge and technology adoption (Burt, 2006; Fliegel, 2001; Eveland, 1986; Roling, 1988). Farmers who utilize precision agriculture and other technology-driven production strategies may not view the Internet as a hurdle, but may view it as the best way to obtain cutting-edge information (Ferguson, 2002). Therefore, evidence suggests that extension needs to continue to embrace the use of the Internet (Hall et al. 2003; O'Neill, 1999; Tennessen et al. 1997).

Traditionally, extension has provided agricultural producers with timely information covering a wide variety of farm management and business technologies to assist them in maintaining profitable and sustainable production. The primary goal of agricultural extension is the decimation of research information developed by universities and research institutions to potential users, particularly farmers (Park et. al, 2007).

Additional education and training methods are needed for agricultural producers to remain competitive, since the field of agriculture is affected immensely by global market changes (Drew 2008). Despite an overall lack of support for the Internet, it is important to know whether preference for innovative communication strategies is related to farmers' demographic characteristics. Previous study (Hall et al. 2003) indicated that younger and more educated farmers demonstrated a greater appreciation for modern sources of information.

If farmers perceive technology as difficult to learn, time consuming, or a threat, in some way, they probably will not use it (Carr, 1999). Therefore, in addition to

providing training sessions to introduce farmers to the benefits of using the Internet as a communication strategy, educators must specifically address reasons why farmers are hesitant to utilize the Internet as a communication strategy on an individual needs basis (Hall et al. 2003).

Farmers have generally been constrained by time and finances, commitment to family and jobs, and responsibilities in the operation of the family farm or business. According to Nudell et al. (2005), by utilizing video-conferencing, educators are successfully facilitating connections between their clients and educational resources located anywhere in the world.

Some metrics, which are firstly introduced by the authors (Valsamidis et al. 2010a; Valsamidis et al. 2010b), are used for the evaluation of the e-learning usage by the learners.

The paper is organized as follows. Section 2 describes the background theory. Section 3 describes the proposed framework. Section 4 presents discussion about the framework together with directions in the future.

2 Background Theory

This paper proposes a framework for applying e-learning in agricultural. However before we proceed to the proposed framework some background theory would be presented. More specifically this section presents the Nielsen Heuristics for system usability, the Technology Acceptance Model (TAM) used in evaluation as well as specific indexes and metrics for system log file analysis.

2.1 Nielsen Heuristics

Nielsen (1994) proposed ten general principles for the interface design which are called heuristics. Every e-learning system should try to follow these heuristics in order to be easy in its use. The Nielsen's heuristics are the following:

1. System status visibility. The system should inform users through appropriate feedback about what is going on.
2. Match between system and the real world. The system should present information to users' language with familiar phrases and concepts
3. User control and freedom. System should provide a clearly marked "emergency exit" in case of user mistake.
4. Consistency and standards. System should be consistent and follow specific standards and conventions in order not to confuse its users.
5. Error prevention. Even better than a good error message is the adequate design of the system which eliminates error conditions. For this reason the platform shall ask for confirmation from users before the commit to an action such as course or user removal.
6. Recognition rather than recall. System should reduce user's memory load by making options and actions visible. In addition it should provide simple instructions, easily retrievable whenever appropriate.

7. Flexibility and efficiency of use. The system should provide alternative ways of navigation to experienced users, not seen by the novice users, which accelerate learning process.
8. Aesthetic and minimalist design. Minimalism should characterize system design. Users should not see information which is irrelevant or rarely needed.
9. Help users recognize, diagnose, and recover from errors. Error messages should be simple and help user recover from errors. Therefore attention should be paid at the language used in error messages.
10. Help and documentation. Adequate documentation should be available whenever needed by the user. For this reason the proposed LMS should provide links to help and documentation in all of its pages.

2.2 TAM

Technology Acceptance Model (TAM) (Davis, 1989) was developed in order to explain the acceptance of information systems as well as to predict the value of related factors to the spread of these systems (Davis, 1989). TAM is studying the factors that affect the intention of the user to use an information system, an environment or just information, and proposes the connection between two main factors: the perceived ease of use and the perceived usefulness.

Davis (1989) defines perceived usefulness as the degree a person believes that a specific system will be raising his/her performance in his/her job. Respectively the perceived ease of use is defined as the grade that a person believes that the use of a specific system does not need effort.

According to this model the main factors that affect the actual use of a system are the perceived ease of use and the perceived usefulness. Research has proved the validness of TAM model, which is widely accepted (Legris et al. 2003).

2.3 Indexes and metrics

Data analysis techniques have been used to discover the sequences patterns of learners from log files (Romero et al. 2007). Server log files store information containing the page requests of each individual user. After the pre-processing this information can be seen as a per-user ordered set of web page requests from which it is possible to infer user navigation sessions. The extraction of sequential patterns has been proven to be particularly useful and has been applied to many different educational tasks (Romero et al. 2008).

The platform usage may be analyzed with specific indexes and metrics. In brief the metrics used are presented in Table 1. The number of the sessions and the number of the pages viewed by all users are counted for the calculation of course activity. The index unique pages measure the total number of unique pages per course viewed by all users.

Table 1. Proposed indexes and metrics.

Index/Metric name	Description of the index/metric
Sessions	The total number of sessions per course viewed by users
Pages	The total number of pages per course viewed by users
Unique pages	The total number of unique pages per course viewed by users
Enrichment	The enrichment of courses (*1- Unique Pages/Total Pages*)
Disappointment	The disappointment of users (*Sessions/Total Pages*)
Interest	It is the complement to the disappointment (*1-Disappointment*)

3 Proposed Framework

This paper proposes a framework for applying e-learning in agricultural. The goals of the proposed framework may be summarized on the following three:

- Development of an innovative e-learning platform that shall be adequate for farmers' characteristics while at the same time provides all the necessary features and tools for educators.
- Development and delivery of life-long learning courses in agricultural domain.
- Continuous evaluation and revision of delivered courses through specific evaluation process, in order to further improve educational content.

Therefore the proposed framework is applied in three different stages of educational process: i) platform development, ii) courses development and delivery, iii) platform and courses evaluation.

The rest of subsections are investigating the requirements that system and courses should fulfill in order to achieve the above goals and provide a path to a continuing courses' evaluation.

3.1 Platform Development

The first stage of the proposed framework is the development of an innovative e-learning platform. This platform shall be a Learning Management System (LMS) which intends to be an asynchronous learning system for delivering and managing learning content. The platform that will be used could be one of the widely used for e-learning like Moodle, eClass, Claroline with the appropriate modifications in order to be adequate for use by farmers, or an entirely new platform design exclusively for this reason. Whatever LMS used according to TAM is should be easy and useful both for educators and learners. These two major factors will define the use and success of the adopted LMS. Therefore the proposed LMS should be useful containing qualitative courses and also conform to Nielsen Heuristics, presented above, in order to be easily used by learners and educators. This factor is even more crucial since most of the farmers are not familiar with Information and Communication Technologies (ICTs).

In addition to the above, the proposed system should provide adequate tools and features both for learners and educators. Educators need to easily manage their online classes and deliver educational content while learners shall be able to easily use the platform and exploit its features and capabilities.

More specifically LMS should fulfill the following requirements in regards with educators needs:

- Provide integrated authoring tools that let educators to easily develop online courses,
- let educators upload specific educational documents and publish announcements to their learners,
- Record user actions and provide useful feedback to educators for both students and their courses.

The adopted LMS should also satisfy learners' needs. Since learners will be farmers system should:

- use simple and familiar language for them,
- have minimalistic design without extra options that reduce learners memory load,
- provide appropriate documentation and help whenever needed,
- motivate learners to their study,
- let learners keep notes on their courses,
- provide tools for communication between learners and educators such as forums, chat rooms etc.

As long as these requirements are fulfilled learners' and educators' perceived ease of use and usefulness will be raised and subsequently LMS usage will be also be increased.

3.2 Courses Development

The second stage of the proposed framework is the development of adequate to the agricultural domain courses. This section aims to guide authors in creating quality such distant education courses. The delivered courses in the e-learning platform should cover a wide range of domains related to agriculture techniques. Since in agricultural domain many times techniques and supplies are improved, the courses should be accordingly updated with all the evolutions in agricultural science.

We propose a process consisting of two main layers: the *Pedagogical Design Layer* and the *Technical Layer*.

The **Pedagogical Design Layer** includes three basic activities and is similar to that proposed by Barrera–Sanabria (2004) and Kazanidis and Satratzemi (2009). First, the *educational goals* of instruction have to be defined. These goals should be clearly indicated and appropriate to the farmers' characteristics. Second, the instructors have to decide on the *contents* to be presented to the learner, which must cover all the predefined educational goals. Contents of a course should cover all the basic knowledge of a specific domain while at the same time provide advanced information and techniques for those that want to go one step further. The next step of this layer is to effect the *definition of the applied instructional strategies*. Here, the instructor studies all the parameters, such as the generated student groups and the teaching strategies for each group. For example content may start with a simple example and proceed to instruction domain theory or start with a small question, in order to motivate learners, and continue with a theory and an example module.

The Technical Layer can be divided into two main steps: the development of educational material and the course construction design.

Educational material development. First of all authors have to find or create the necessary educational material for the course. The material should be related to the predefined course content and adopt the following specifications – characteristics:

- Clear, simple, friendly and explanatory text. You should use simple and understandable language learners.
- Reports on the experience of student. The content should be enriched by references and examples of learners' previous experience.
- Use different types of media (text, graphs, videos etc), or other types of educational material (theory, activities, examples etc) in order to motivate learners in their study
- Many examples and case studies. Examples are a key element of the traditional teaching. They help learners to better understand the subject. Each time after the presentation of a case study content should be analyzing the situation presented and make reference to alternative actions that could be followed.
- Clearly formulated aware of any difficulties they may learners face. Where possible, also should be given all necessary explanations - comments to clarify possible misunderstandings or questions from learners.
- Explanatory titles and subtitles. The titles and subtitles of the text should enable learners to understand what will be the content of each unit. Particularly in the online hypermedia systems, where the transition from one section to another can be done not necessarily sequentially, the names of the links should state clearly the material presented by the respective course units.
- Summaries at the end of each chapter. As in traditional classroom education where the teacher spent the last few minutes in a summary of taught educational material each course unit should indicate a summary of main points which were addressed in it.

A qualitative educational material, appropriately designed for use by farmers will motivate learners continue with their study and learn more in less time.

Course construction design. At this step the instructor designs the course structure. The course is separated into learning units, modules, or chapters. Each unit shall contain learning objectives that are comprehensive enough to ensure that the course will likely be mastered by the learners. An appropriate structure of the course will help novice learner with their study while at the same time will help more experienced learners proceed faster.

3.3 Course evaluation and revision

It is crucial factor in e-learning to continuously evaluate and revise the delivered courses. We propose three distinct ways for evaluating platform, delivered courses and the results of e-learning.

Platform Evaluation

To test the extend of the e-learning platform acceptance by users, the TAM should be used. According to TAM the adoption of a technology is mainly depended on the perceived ease of use and the perceived usefulness of that technology by the user. Consequently, a system's usefulness and how easy it is to use should be carefully evaluated.

There upon the goals of the platform evaluation are to find out:

- any possible effect on the learning process and proposed knowledge of subjects
- the usefulness of either the overall or separate system features (adaptive or not)
- the usability of the system

Courses' Evaluation

The courses should be evaluated according their quality and usefulness by the learners. For this reason the metrics and indexes presented earlier are used. Course evaluation may be applied in three steps: i) Logging the data, ii) Data pre-processing, iii) course ranking in accordance with indexes and metrics

Logging the data. This step involves the logging of specific data from an LMS. A module may record attributes before and after web server request processing, was implemented. In detail, the installed module at the web server of the LMS platform, monitors fields such as: request_time_event, remote_host, request_uri, remote_logname, remote_user, request_method, request_time, request_protocol, status, bytes_sent, referer, agent and user requests. These fields may be recorded with the use of an Apache module. The development of such a module has the following two advantages: rapid storage of user information, since it is executed straight from the server API and not by the LMS application, and the produced data are independent of specific formulation used by the LMS platform.

Data pre-processing. The data of the log file contain noise such as missing values, outliers etc. These values have to be pre-processed in order to prepare them for data analysis. The produced log file is filtered, so it includes only the following three fields: (i) courseID, which is the identification string of each course; (ii) sessionID, which is the identification string of each session; (iii) page Uniform Resource Locator (URL), which contains the requests of each page of the platform that the user visited.

Indexes and metric. The aforementioned fields of the previous section are not adequate in order to evaluate the course usage. So, some indexes and metrics are used for the facilitation of the course usage evaluation as presented in section 3.3. First, the indexes Sessions, Pages, Unique pages, Unique Pages per CourseID per Session are computed and then, the metrics Enrichment, Disappointment, Interest and Homogeneity are calculated.

Platform courses may be ranked according to these metrics and feedback should be send to the educators with actions required in order to improve their courses.

Evaluate the results of e-learning

An important goal of e-learning is that it should be equivalent to or better than the learning provided through other delivery modes, such as the traditional face-to-face

and classroom-based methods of instruction. According to Kirkpatrick (1979), the results of learning can be evaluated at four levels:

Level 1: reaction is a measure of the learners' reactions to a course.

Level 2: learning is a measure of what the learners have learned.

Level 3: transfer is a measure of the changes in the learners' behavior when they return to their jobs after their training programs.

Level 4: result is a measure of the production outcomes that occur because the learners are doing their jobs differently.

Therefore e-learning results may be also be evaluated in the above four levels.

4. Discussion and Conclusion

E-learning in agriculture is still very new but the study by Elbert and Alston (2005) indicated that Cooperative Extension could serve as a change agent in the Digital Divide.

This paper proposes a framework for applying e-learning in agricultural. Initially a review on the e-learning in agricultural took place in order to show the paper motivation. Following the essential framework background theory was presented. In particular we discuss the Nielsen Heuristics for system usability, the Technology Acceptance Model (TAM) which is used in evaluation procedure and we propose specific indexes and metrics for system log file analysis. The proposed framework presented in detail as well as how it can be applied in agricultural domain. The expected benefits of applying such a framework for distant and continuous training of farmers are the following:

- qualitative presentation of educational material via ICT,
- overcome of spatial and temporal restrictions that farmers usually have,
- evaluation of courses using current metrics and indicators that will lead to further improvement of the course.

The proposed evaluation method through specific indexes and metrics uses existing techniques in a different way and it has the the following advantages: (i) It is independent of a specific LMS, since it is based on the Apache log files and not the LMS platform itself. Thus, it can be easily implemented for every LMS. (ii) It uses new metrics in order to facilitate the evaluation of each course in the LMS and the instructors to make proper adjustments to their course educational material. From a pedagogical point of view this method contributes to the improvement of course content and course usability and the adaptation of the courses in accordance to learner capabilities. Improvement of course quality gives to learners the opportunity of asynchronous study of courses with actualized and optimal educational material.

However there are some limitations in this framework. First of all ICTs are not widely spread in the target group of this study. More specifically many farmers still do not have access to a personal computer and are not familiar with Internet. In addition since this framework is proposed by use in life-long learning the learners are not students in a specific class or education level and therefore each learners has different pre-knowledge of the instructional domain. Subsequently there is a possibility to either novice students find difficult the educational content while on the

same time some experienced users find useless and boring. For this reason the use of adaptive hypermedia should also be examined.

As future work we also suggest to include in the target group:

- Economically and socially disadvantaged youth and adults.
- Special needs groups.
- Geographically-challenged individuals.

By eliminating travel miles and hours of faculty and staff instruction through distance education, considerable savings are predicted throughout the extension system. Additionally, these savings can be passed on to e-learning participants, easing the economic burden of learning.

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