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Going Mobile: Teaching First-Year Business Students Mobile Application Design

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Abstract:

Information systems (IS) enrollment has been declining in recent years. In an attempt to introduce key IS concepts to freshmen business students in a more engaging way, we introduced a semester-long mobile application-design project and a separate tutorial assignment involving real smartphones. Through this process, students learned basic tenets of IS while simultaneously recognizing the relevance and applicability of the field to their future lives as 21st century business professionals. In this paper, we outline the core course progression for a typical IS department, detail the process through which we engaged the students, and confirm our assertions through textual analysis of self-reported comments about their experience with this mobile application project.

Keywords: Mobile Application Design, Teaching Methods, IS Enrollment.

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I. INTRODUCTION

Low enrollment is one of the many challenges the information systems (IS) field currently faces. Reports of enrollment declines of 70 percent or more are not uncommon (Granger, Dick, McKinnel Jacobson, & van Slyke, 2007). Introductory IS classes designed as survey courses for all incoming business students are an essential tool for demonstrate the vast opportunities an IS degree can provide to these students' future careers. Studies show that having a genuine interest in a field is one of the most important, if not the most important, factor affecting students' choices in majors (Zhang, 2007). Central to this is the role of effective teaching at the introductory level of the IS field expressed through pedagogical style and methodology (Looney & Akbulut, 2007). Researchers note that students identified practical, real-world application of the coursework and the linking of business processes with technology as being among their main subject matter interest (SMI) factors when the students select IS as their major (Ferratt, Hall, Prasad, & Wynn, 2010). In the Department of Information Systems at Arizona State University (ASU), we experimented with a new method of teaching the introductory IS class to incoming business honors students: as a group project, we asked students to develop a proposal to design their own mobile applications. Mobile applications, or apps, refer to small-scale software applications developed to best use the interface found on thin client mobile computers, such as smartphones and tablets. Gartner (2014) lists mobile application development among the top 10 strategic technologies for 2014. Since "there's an app for that" has become ubiquitous in the vernacular of the millennial generation that represent current university students and the future business leaders of tomorrow, we wanted to seize this opportunity to generate curiosity and demonstrate the relevance of a degree in IS to freshmen business students. To enhance the experience and ground it further in reality, we developed a distinct follow-up tutorial assignment in which students used real smartphones to experience part of the design, testing, and deployment of a mobile application in a simple, limited manner befitting their level of experience. The relevance of the subjects taught related to the skills graduates need is identified as an important factor in addressing the credibility crisis in IS (Firth et al., 2011). Since use and development of mobile applications are multiplying annually (SAP, 2013), employing mobile app design as a curriculum enhancement tool in an introduction to information systems class is a powerful method to demonstrate how critical the skills learned in the IS field are for business students.

In this paper, we demonstrate how our approach introduced the scope and relevance of the IS field to freshmen business school students. We also summarize our methodology and the impact of using such a popular subject to teach the fundamentals of IS. More specifically, in Section 2, we introduce the prior research around IS teaching methods and the use of programming and game design methodology in business schools. In Section 3, we then outline the objectives of the introductory IS class for business students, and describe how we used the mobile app design project to meet existing learning objectives for the course. Next, in Sections 4 and 5, we explain our journey with our students, and how they dealt with knowledge limitations and the limitations imposed by available technology. Section 5 further explains students' app design project milestones as they relate to the IS field and presents their follow-up experiences with the AppMakr mobile app development tutorial. This project allowed us to see through the eyes of students as they compared what they "wanted" to do against what they currently "could" do and how they could bridge this gap through studying information systems. We conclude the paper in Section 6 with student feedback and next steps.

II. IS TEACHING METHODS – RELEVANT PRIOR RESEARCH

McBride and Hackney (2003) discuss the establishing principles of IS teaching: they emphasize IS's interdisciplinary nature involving a variety of reference topics and approaches. IS consistently draws on concepts and material from diverse subject areas while playing a role in many other fields (Baskerville & Myers, 2002). IS's broad subject base includes subjects as diverse as management, sociology, formal logic, and relational algebra (McBride & Hackney, 2003). A common denominator for all IS teaching is the need to encourage innovation and creative problem solving in IS theory and practice. IS's emergence as an authoritative field of study developed from the early recognition of the importance of combining its "soft" (behavioral) and "hard" (scientific) aspects (Davis, 2000; Mingers & Stowell, 1997). Given this diversity, designing and implementing strategic applications to improve business performance and deliver service enhancements requires innovation and creativity. Therefore, IS teaching must be approached with an emphasis on critical thinking, in theory and practice, to engage and challenge students (Robey, 1996). IS teachers need to be aware of the creative, more subjective elements of our field (Koch et al., 2002). Ferrat et al. (2010) found that applying coursework in practical settings outside the classroom and constantly learning about and investigating new topics made IS and other majors interesting to students. Identifying and designing opportunities for

organizational improvement using IT and finding ways organizations can develop their capabilities using information technology were also among the subject matter interest (SMI) factors that made the IS major interesting. IS programs can also attract majors by creating exceptional experiences. Maintaining a rigorous curriculum is recommended over dialing down the curriculum content (referred to as "IS lite") to attract more students. IS programs can maintain a flexible curriculum that emphasizes rigor by requiring courses that cut across different career paths. Many employers desire students with strong technical skills, and the "IS lite" approach offers relevant material that better addresses this need (Koch et al., 2010).

Gaskin and Berente (2011) used video game design in an MBA class to teach complex concepts to business students. The students enthusiastically received this technique, which provided them with a unique and memorable experience to draw on when encountering situations requiring design thinking. In their study, Wyner and Lubin (2011) introduced MBA students with nontechnical backgrounds to the concept of an application programming interface (API) to teach them not only what an API is, but also a sense of how one works and why APIs in general are important. Students also learnt why analogous concepts across computing and Web architectures are likewise important. In our paper, we demonstrated the IS field's relevance to first-year undergraduate students by providing a memorable experience to supplement and enhance the course's educational goals. Students in the introduction to IS course traditionally completed a project that focused on business process improvement. We adjusted this existing semester project to give it a context more readily available and relevant to their experience. Using fundamental IS concepts that paralleled the learning objectives of the course, we created a group project for students to design a mobile app.

The project's focus was to demonstrate the relevance of the IS field to business majors. In order to achieve this aim, we aligned the project milestones with the introduction of major IS survey topics and concepts. This app-design project allowed the students to relate to IS concepts and foundations in a way not previously experienced with this class, offering positive outcomes in the form of increased interest and enrollment in the IS degree program. During the semester, we also included a separate example of relevance in the form of a mobile app tutorial, which enabled students to develop and upload a simple but useful app on real smartphones. Although both the group app-design project and the tutorial were components of the same course, our major emphasis was on the semester-long app-design project. The weeklong tutorial employed commercial software made available through a Microsoft campus engagement program and was not a mandatory part of the semester-long app design project. In this paper, we explain how we combined these two separate initiatives to emphasize the relevance of the IS major to incoming freshmen students.

III. INTRODUCTORY IS COURSE LEARNING OBJECTIVES

ASU business honors students take the introduction to information systems class as freshmen. This is a point in their academic careers when they have either not officially declared a major or are able to change or take on a second major or minor without significant difficulty. The fact that students could change or add IS as a major was an important consideration when we designed the curriculum for the introduction to information systems class. The class overviewed the IS field and combined two previously separate classes: 1) the computer applications and information technology class and 2) a core IS course. The first class evaluated information systems from a business intelligence perspective for efficient and effective problem solving via database and spreadsheet application packages. The second class introduced the competitive and strategic uses of information systems, how information systems are transforming organizations and their management, and the issues, difficulties, and opportunities facing the technology professional and business manager today. Future business professionals need to be able to assess, evaluate, and apply emerging information technology to business (Kroenke, 2011). Thus, students learn not only basic applications (e.g., Excel, Access), but also how to transform businesses through information technology, and they become familiar with fundamental IS concepts. As seen with other fields, this introductory course is also intended to increase enrollment in IS.

Table 1 presents a sample course outline for the introduction to information systems class. As the table shows, the class started with an introduction to information systems that followed Kroenke's (2011) five-component framework of IS: hardware, software, data, procedures, and people (Kroenke). In week 2, business processes and their support through IS were introduced. The topics continued in week 3 with the introduction of organizational strategy, competitive advantage, and the importance of IS for business. Students needed to analyze several industries and firms to understand the forces determining industry structure and competitive forces (Porter, 1980). Next, in weeks 4 through 12 hardware and software, database processing, and simple data reporting concepts were covered and the class explored enterprise systems, e-commerce and business intelligence, and the basics of data analytics. Weeks 13 through 15 of the semester were dedicated to information systems development. Students learned about defining goals and scope, assessing feasibility, determining requirements, and the phases of the systems development life cycle (SDLC). The lecture material also included design of system components and a section on implementation and maintenance in order to illustrate what awaits IS majors in the capstone course and beyond. The homework

assignments and hands-on exercises introduced students to essential tools such as Excel, Access, E-R diagrams, “as-is” vs. “to-be” flowcharts, and cost-benefit analysis.

Table 1. Introduction to IS: Weekly Course Outline	
Week	**Activity**
1	Ethics in IS and IS in the Life of Business Professionals
2	Business Processes, Information and IS Project Introduction
3	Organizational Strategy, IS and Competitive Advantage and Harrah's Case
4	Hardware and Software Purchase Decision-Making with Excel
5	Cost-Benefit Analysis with Excel
6	Database Processing/ Database Design/ ERD Modeling
7	Process Flowcharts: “as-is" vs. "'to-be" process diagrams
8	Introduction to Access: Creating a Relational Data Base
9	Introduction to Structural Query Language (SQL)
10	Midterm Exam
11	Business Intelligence and IS for Decision-Making
12	“Competing on Analytics” Case and Database Marketing
13	Group Project Presentations
14	Information Systems Development: SDLC
15	Information Systems Management: IS Jobs

A group project focusing on systems development ran concurrently with the lecture and weekly homework assignments. By week four of the semester, students formed groups of three to five people to work on a project to understand systems analysis concepts and steps. Students selected their own group members. Several team activities were included during the first weeks of the class to engage students in discussions, which helped with group formation. The term project consisted of selecting a process that is manual or semi-manual, writing a business case to identify the “as-is” process, explaining, in detail, the steps of automation via the “to-be” process, and finally identifying and analyzing the automation requirements based on the five-component framework of IS. We aligned the project’s timeline to follow and enhance the concepts we introduced during class. The course culminated in the students presenting their app designs to the class. This final presentation served as a capstone to the course and demonstrated how students applied all of the relevant IS course concepts in this one mobile app design project.

IV. USING MOBILE APP DESIGN TO TEACH IS CONCEPTS

Given the recent developments in the smartphone industry and the proliferation of mobile applications, we decided to shift the focus of our course’s regular group project to a mobile application-design project. We asked students to form groups and design a mobile app to create greater efficiencies in their identified business processes. With this project, we introduced freshmen honors students to the IS concepts of automation, business processes, hardware, software, and networks, and to the steps of the system development life cycle (SDLC) in a form that was more accessible and relevant to their limited experience base. We designed the project to unfold as follows: first, student groups were to develop their app ideas, sort and scope the ideas, research whether or not a similar app existed on the market and, if necessary (because a similar app did exist), explain how their app would increase utility in a different way to the pre-existing app. They were then to verify that their business process improvement idea could be executed in app form. The students were then to propose their simple, small-scale mobile application and proceed through the steps of system analysis and design. This project introduced the students to concepts such as cost-benefit analysis using NPV, database design using E-R diagrams, the client-server relationship, “as-is” vs. “to-be” process analysis using activity diagrams, and professional business proposal writing and presentation. Since the majority of the students who have entered this course in the past possessed limited or no IS knowledge, the key focus of the project was to ensure that students saw the IS field as relevant and applicable to their lives and careers.

The group project’s description and requirements, as explained to the students, were as follows:

> *As part of this course, you will work in a team of 4 to develop a proposal for a mobile app that will automate (or partially automate) a process that is currently entirely (or almost entirely) manual. The process can be in a business or organization with which you are familiar, or it may be one that you encounter in your daily activities. Your team will write a report (10 pages minimum, but not to exceed 12 pages; 12-point font; double-spaced with 1" margin) and present the key findings from your project to the class. Each group must describe a different process. Therefore, you should sign up as soon as your team has decided on a process and presentation date. There are two presentation dates available. As part of the project, your team will address the following prompts:*

1. *Provide an overview of the process studied.*
2. *What is your rationale or justification for automating this process?*
3. *Compare and contrast the old process versus the new automated process. Use "as-is" vs. "to-be" flowcharts to explain how the process would change with automation.*
4. *Describe the specifics of your app design:*
    - *Which hardware will be used?*
    - *What does the software do?*
    - *Which types of data will be captured? How will it be captured?*
    - *Who will be interacting with the process?*
    - *Are there procedures in place to assist these individuals?*
5. *Include an Excel Workbook that shows the cost of the application and a cost-benefit calculation.*
6. *Are there similar apps in the marketplace that are doing what you envisioned in a similar way? What are the differences and similarities?*

Figure 1 depicts the flow of the course material presented in Table 1 and the project milestones mentioned above in parallel.

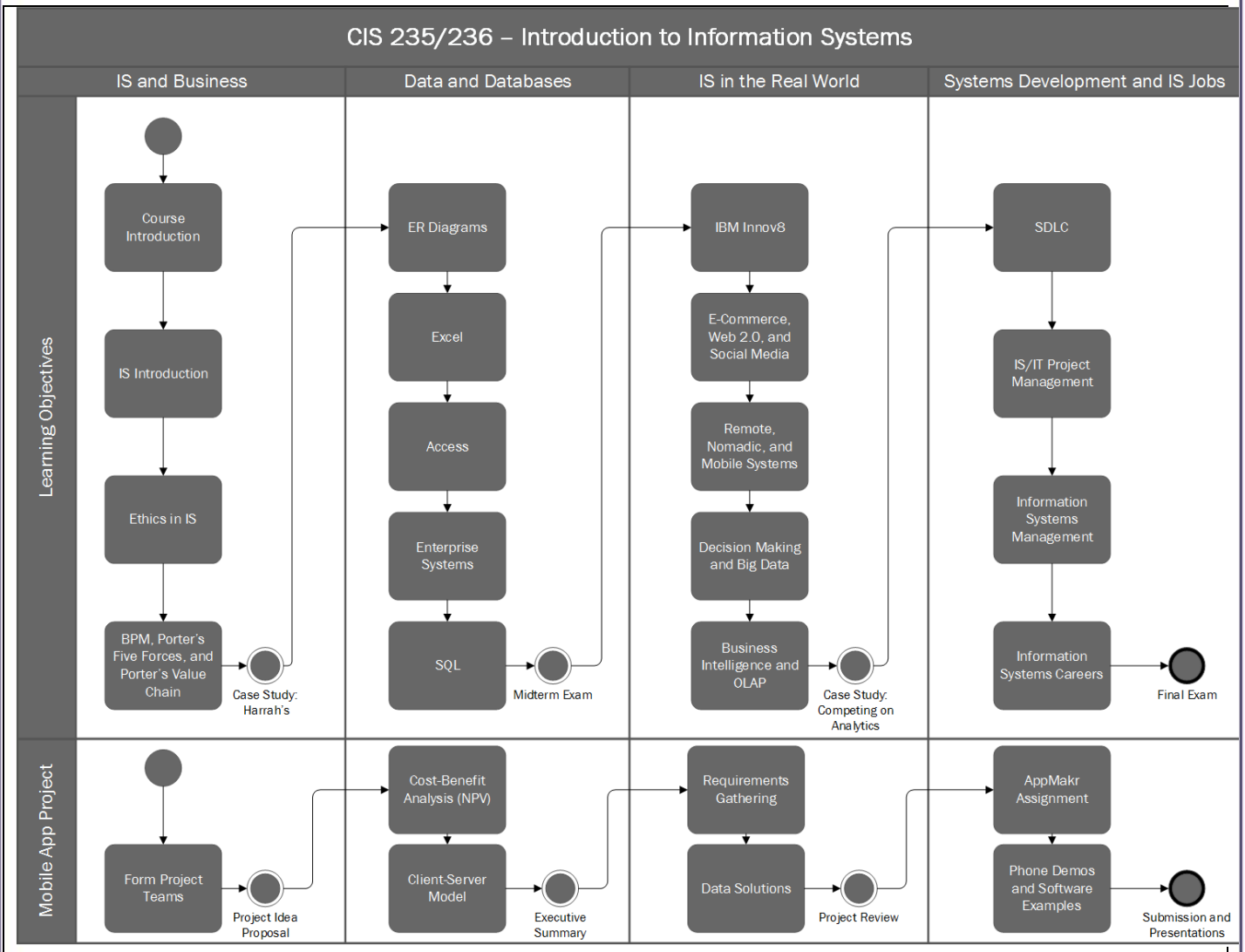

Figure 1. Course Curriculum and Mobile App Project Flow, in Parallel

We encouraged the students to develop new ideas for apps that were currently not available, or not implemented well, in the mobile app marketplaces (Google Play, Apple App Store, etc.). They were tasked with evaluating their routines to determine which recurring processes could be made more efficient through the use of a mobile app. Students came up with ideas such as a "check in/out system for dormitory recreation lounge items" and "an interactive map of the accessible restrooms on campus" and even "an app to determine campus traffic congestion hot spots and times". As we can see from the above project description, the projects stopped short of the

implementation portion of the SDLC. The focus remained on major IS concepts as demonstrated in the requirements analysis and design phases of the SDLC.

Since we did not expect the students to have any digital literacy, this term project focused only on designing an app and identifying its IS components. We first asked the students to identify which process they would target with their app and then to analyze this process using an "as-is" process flow diagram, They then had to show how their app created efficiencies or other improvements using a "to-be" process analysis. No coding was required, but students did have to identify the cost of IS components such as hardware and software and the cost of app development. They were expected to identify which programming language would be best suited for the type of app they chose. Students also had to identify the monetary benefits of the app for the purposes of learning to conduct a detailed cost-benefit analysis. We asked them to estimate how many downloads would be necessary to cover the cost of building the app, to decide whether the app would be free or "ad-free", and to calculate the ad click rates. We also expected students to use a PowerPoint-style presentation format to provide a visual prototype of their app and the process by which it would function. We expected the PowerPoint visual prototypes to show how to go through the app screen by screen, and to match the "to-be" process flow diagram.

The project's objective was to introduce systems thinking and to ensure that students were not omitting any of the critical details required for designing a fully functional app. The major critical components of the term project included writing "as-is" vs. "to-be" diagrams, identifying the hardware, software, database, server, and other IT requirements, and generating an Excel sheet itemizing all the cost and benefit components. We expected the cost-benefit analyses to show the benefits or value generated by the app versus the costs of app development. We expected all the projects to break even or generate positive revenue. At the end of the term, students' completion of the design phase of their app project coincided with introductory coursework on the system development life cycle (SDLC). Note that, though the students went through a process that follows the basic guidelines and objectives of the SDLC's phases, they did not do formal technical nor organizational feasibility studies. They only did basic economic feasibility studies in the form of research and simple cost-benefit analyses. To go beyond this would have been out of scope for their level of experience and the learning and university objectives for the course. We introduced some technical limitations to students as they went through the process of formally proposing their ideas in the early stages of the course project, but we wanted to offer some degree of freedom of expression to encourage them to have fun with the project while learning more formal IS concepts.

An introductory survey course in IS will not be able to teach freshmen all the skills required to build and fully implement a mobile app. However, students who complete degrees in information systems should be able to design and manage such a project. We wanted students to scope app project ideas while considering the possibility of realistically implementing these projects. This had the benefit of serving as a tacit technical feasibility analysis. This focus on designing realistic apps created a pronounced awareness of the scale and scope of the project. This new project approach gave us the opportunity to see first-hand how freshmen would deal with identifying the technical solutions for the ideas they proposed. For example, one group pitched an idea for an app that would require buy-in by university dining, requiring access to external systems and processes. Consequently, we asked them questions similar to those in Table 2. Table 2 relates the app-design questions to the topics in IS and then relates these topics to the courses in the IS curriculum. Students discovered that, to carry out a project that would be relevant in the real world, they needed to possess certain knowledge and skills (Table 2) and the IS curriculum would provide them with those skills.

Table 2. Sample App Project Questions and Their Relevance to the IS Field

Question	Related topics	Course(s) in IS curriculum (see Table 3)
Is there a "back end" that is managed by someone in campus administration?	Databases, UML, OOP, strategy, business administration	IS-201, IS-301, IS-302, IS-303, IS-402, IS-403
How would you incentivize this for the University so they would invest in your app rather than developing their own?	Strategy, business administration	IS-201, IS-403
How would you use the GPS functionality of the phone? Also, where would you obtain maps of locations on campus?	OOP, systems design	IS-301, IS-302, IS-401
How would the algorithm for matching dietary concerns with food choices work?	Databases, UML, OOP	IS-301, IS-302, IS-303, IS-401
How will this make money or at least be revenue neutral?	Strategy, business administration	IS-201, IS-403

Databases, unified modeling language (UML), object oriented programming (OOP), business strategy, and e-commerce (as seen in Table 2) are topics that students would learn if they continued as IS majors. As such, these topics were only briefly discussed in relation to the project. Presenting major topics with relevance to their projects' implementation cast the IS major as a relevant field to students. As the core curriculum list in Table 3 shows, this approach was in line with the same key principles that top-rated IS programs seek to emphasize (Topi et al., 2010).

Table 3. IS Curriculum Example

Course number	Course title	Course description
	Year one	
IS-101	Computer applications and information technology	Introduction to computing technologies and their business applications.
	Year two	
IS-201	Introduction to information systems	Overview of the important concepts related to IS.
	Year three	
IS-301	Business information system development I	Applying the SDLC with UML to small-scale application development.
IS-302	Business information system development II	Solving business problems with basic OOP.
IS-303	Business database concepts	Theory, design, and application of relational database systems.
	Year four	
IS-401	Electronic commerce strategy	E-commerce theory and client-server Web design.
IS-402	Networks and distributed systems	Communications protocols, distributed systems, network security, and client-server systems.
IS-403	Systems design and electronic commerce	Capstone course: enterprise systems design with a focus on project management.

Despite the project stopping short of any actual implementation, it did require students to think about potential implementation issues and to reduce the scope and scale of their app ideas. A significant majority of the app ideas proposed simply did too many things. We asked most groups to explain the core functionality of their apps in one sentence; once they accomplished this, they discovered their app ideas were more manageable and they could see a path to finishing a leaner, more useful design. Because the students had to consider more complex issues up-front, they had a better understanding of their own ideas and the teachers' high level of expectation for this project, and a stronger awareness of what system design entails. While a small number of students had some idea of what to expect writing code, which they would be introduced to in an OOP course later in their studies, a majority of the students had no real sense what programming mobile applications entailed. In order to complete their projects, students contacted software or service companies, conducted interviews with business owners, brainstormed with their engineering and computer science friends, and did extensive research to identify all the components required to make their ideal apps work with a positive NPV. Some groups shopped for servers, others decided to explore cloud-based and SaaS platforms; even database solutions varied. Most importantly, students learned about their classmates' projects during the week of presentations, and witnessed several new business ideas that were made possible with information technology.

V. THE APPMAKR TUTORIAL

The course also included a second completely distinct short tutorial that was designed to introduce students to the implementation phase of app development without requiring actual programming. As such, we allowed students to experiment developing simple software for actual mobile devices. This short tutorial was not part of nor directly linked to the semester-long app design project, and these two separate assignments did not need to be bundled together. Students spent the whole semester working on their app design projects while this assignment was covered in one class session. This short tutorial demonstrated the availability of different app development tools and their benefits and shortcomings to the students in less intimidating way than fully immersing them in application development.

Microsoft's Campus Engagement Program, part of the Microsoft Student Partners program (http://www.microsoftstudentpartners.com/), provided an opportunity for us to implement a simple mobile app on actual smartphones. Microsoft loaned the department Windows smartphones so that students could experiment with the AppMakr development tool. According to Microsoft's website, AppMakr is a do-it-yourself platform for creating

content-based apps for iPhone, Android, and Windows phones. The process requires no coding knowledge and builds apps with a "what you see is what you get" (WYSIWYG) editor. The Microsoft developer program, unlike the iTunes App Store, did not at the time require the students to sign up, pay, or publish their apps to the Microsoft App Store. This enabled students to create their apps locally with the tutorial and then push them to physical devices or emulators. In this way, we were able to limit the scope of the tutorial while still giving the students the rewarding experience of creating a "real" app.

After the students reached the project review phase (depicted in Figure 1) for their own app ideas, we introduced the AppMakr tutorial assignment. We gave students a detailed walk-through of the process needed to create an app with AppMakr on their loaned phones. AppMakr's platform employs RSS to power the content in a creator's app. This content may include text, images, podcasts, audio, and video. Creators can also add location-aware GeoRSS and media RSS feeds. Additionally, the platform allows in-app HTML, which serves locally from the mobile device and can access its camera, accelerometer, and other built-in features. Other platform features include push notifications, native photo galleries, and mobile ad network integration. Given the widespread popularity of RSS feed readers/aggregators and other multimedia formats, such as podcasts, students had a degree of familiarity with these different content options. While they may not have achieved mastery of these formats, their level of experience was commensurate with that needed to successfully complete and understand the AppMakr tutorial.

The AppMakr platform partners with a few advertising networks to enable creators to monetize their apps. In the editor, creators can customize the look of their apps by designing their icons, splash screens, headers, and tab icons. If creators do not want to design graphics themselves, the platform presents a database of icons to choose from and culls images from related Internet searches (Wikipedia, Google Images, etc.). While AppMakr has since been acquired by Infinite Monkeys, the tool still provides the same functionalities that were available during this experiment.

Unlike apps developed with full functionality and user experience engagement, the AppMakr tool is limited to creating "mashups", applications that aggregate existing information from sources such as text-based feeds, Flickr photos, or Twitter/Facebook activity. Since we wanted the students to experience the creation, testing, and deployment of a mobile application on actual smartphones, we presented the AppMakr and smartphone activities in the form of a tutorial, in-class assignment, and an instructor-led session to demonstrate the complexities inherent in even a simple mashup app.

The Barrett Honors College App

After introducing the AppMaker tool and its respective capabilities and limitations, we wanted students to experience designing, implementing, and building a useful app by employing this kind of tool. We wanted to demonstrate to students in a short-assignment format how to create an app that would generate utility in the limits of the technology available. Their mashup app would be implemented using the basic AppMakr tool for the Barrett Honor's College at Arizona State University, in which the entire population of students was enrolled. This mashup would bring together all the available information for the honors college from different available sources (websites, Facebook, Flickr, Twitter, etc.). In our walk-through of the assignment, we detailed steps for 1) creating a developer account through Microsoft, 2) installing the SDK for the mobile environment, 3) generating a mashup app via AppMakr, 4) generating a feed if one did not previously exist, 5) deploying the app in an emulator on the local machine, and 6) deploying the app to an actual mobile device for testing.

The process for generating an app of this type is not terribly complex, but it allowed the students to see some of the steps necessary for using actual tools and processes that they would encounter if they were to develop an app in a "real world" environment because many organizations employ similar tools as part of their organizational strategy. As they wrapped up the tutorial, we showed the students examples of what fully decompiled code generated by AppMakr looked like in Visual Studio 2010. Given that they felt the SDLC was already a complex but engaging process, many of the students were amazed by some of the elaborate examples of code. The key realization here had to do with the gap in their existing skillset compared with what they needed to realize their ideal apps. Having created a simple mashup and seen some of the inherent complexities, students took a step back and reevaluated their own apps from the design project. Their SDLC project required them to go through essential planning steps that resulted in relational database diagrams, user interface wireframe mockups, basic technology requirements, and activity diagrams. However, the majority of these students had no tangible experience with actually creating any of the items in their designs.

After the students realized their knowledge limitations through the AppMakr assignment, we decided to reintroduce the IS program in parallel with discussions about IS careers. As Table 3 shows, the IS degree program gives students hands-on experience working with SDLC, UML, basic OOP, database creation, and IT project management, and also provides opportunities to apply these concepts in various contexts. These subjects address

the hard skills needed to be more directly involved in creating apps beyond the limitations of a tool such as AppMakr. AppMakr does not generate local data storage, provide access to custom data beyond what is offered in RSS/XML feeds, or allow for complex interfaces. AppMakr is useful for creating a simple aggregation of existing content, but, for more-robust development, including more advanced concepts involving coding, rights management, intellectual property concerns, and publishing to an actual app store, students would need skills like those introduced in the IS program. Additionally, while this project relied on digital and social media feeds, we designed these elements of the assignment at a level commensurate with the experience demonstrated by this media-savvy generation of students. These include simple media links and social media feeds. Anything more complex would involve implementation of API's from these service providers and was well beyond the course's scope.

The news that freshmen students were working on a real mobile app project spread quickly and the Vice Dean of Barrett Honors College wanted to see the project. A group of enterprising students, with their professor, presented a demonstration of the Barrett mashup app they created with AppMakr and their experience in the app design project to the Vice Dean of the Barrett Honors College at ASU (Balkan & Sopha, 2012).

The Barrett mashup app was designed to aggregate information relevant to Barrett. It pulled existing and user-generated RSS/XML feeds from the Barrett Flickr photo tour, the Barrett news feed, the Barrett Twitter page, the Barrett Facebook page, W.P. Carey School of Business news, and the IS Newsletter (KnowWPC—www.knowwpcarey.com). Figure 2 shows screens from the app. This app demonstrates what freshmen students can create given the tools and means to express their creativity and skills with technology. The students who volunteered to handle this presentation, most of whom were not IS majors at the time, have since registered as IS majors or minors. The enthusiasm the students expressed in their presentation and the demonstration of what they learned in their app design projects encouraged us to explore further the potential success of this project with the students in these classes.

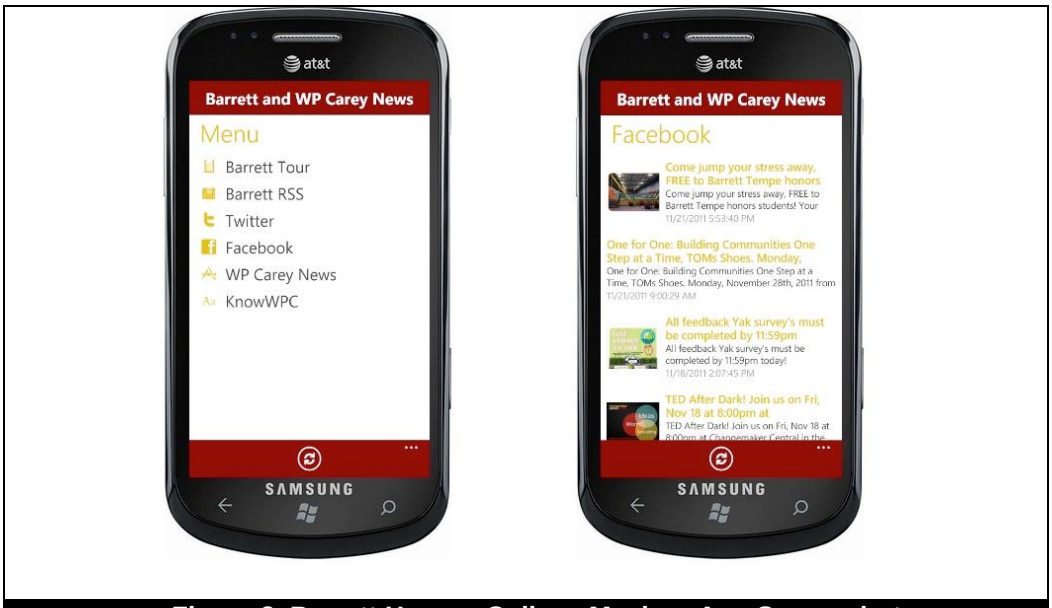

Figure 2. Barrett Honors College Mashup App Screenshots

We then asked students to compare the technical requirements of their apps from the design project to what they can actually do with something like the AppMakr tool. This contrast served as a bridge to what the students could potentially accomplish with a degree in IS, furthering the intended goals of an introductory IS course. As we note in Section 4, students researched in great detail what would be involved in implementing their apps, including database solutions, server solutions, coding requirements, and budgetary constraints, and addressed questions similar to the sample questions depicted in Table 2. However, when we introduced AppMakr's capabilities and limitations, students realized how technological restrictions may hinder an ongoing project. This portion of the project was strategically aligned with the classroom discussion and lecture on the SDLC project's scope and feasibility analysis, which included technological feasibility (Kroenke, 2011). We tasked students with finishing their group projects with a detailed explanation of the implementation requirements and how the implementation of their group's app would not be possible with AppMakr. Students concluded that almost all of the app ideas they introduced required more than what AppMakr could provide.

VI. STUDENT FEEDBACK ASSESSMENT

End-of-semester student evaluations showed that students were pleased with what they were able to accomplish in one semester. The overall academic rigor metric for the class, measured on end-of-semester student evaluations, increased by 0.5-0.7 points to 6.7 out of 7 from previous semesters that featured business process improvement projects. We observed a 10 percent increase in the number of students who wanted to major or double major in CIS. Out of 121 students who were taking the class, 12 of them changed their major to CIS at the end of the semester. Since this is a survey information systems class for incoming freshmen business majors, 10 percent of the non-IS majors in the class changed their majors to IS at the end of the semester. Of course, we cannot control the external factors that might influence enrollment, including the increased interest in learning to code, the recent spate of IPOs and big payouts to entrepreneurs whose companies are acquired, possible changes in the makeup of the student body, or other unidentified factors. Academic rigor and the year-over-year enrollment rates were the only metrics that we could use to perform a historical comparison to previous years. This is due largely to the fact that there was no significant change in the design of the course or the class project in the years leading up to our introduction of the mobile app portion of the course project. The specific questions we adapted from Gaskin and Berente (2011) regarding the project gauged the experience of the current group of students and were not asked of students in previous semesters, as there was no mobile app design project in those semesters.

The overall informal feedback from the students was very positive; students were excited to have identified and designed their own apps. In order to build further on what we learned from the general course evaluations and informal feedback, however, we decided to ask students two additional questions adapted from Gaskin and Berente's (2011) classroom experiment with MBA students:

1. Why do you think it is useful to learn how to build a mobile phone app in an introductory IS class for business students?
2. How did this hands-on experience change your perception about the capabilities of information technologies and the methods by which they can be developed in the service of an organization?

Analytical Methodology: Sentiment Analysis

A total of 121 students answered these questions in a free-text format. Anecdotal evidence by itself was always positive and we present some select student statements in Figures 4 and 6. As we can see from their feedback, students stated that the project forced them to think about the real-life importance of technology for business majors, and made them see topics such as business processes and databases in action. They mentioned how technology and applications are critical to business success. Instead of limiting our review of student feedback to an informal screening of the answers, however, we also employed a more standardized approach—sentiment analysis—to evaluate the results and remove any unintended bias. We did this to understand whether students' opinions about the app project were positive, negative, or neutral. Since there were a large number of student responses, reviewing answers manually was inefficient. Also, determining whether students' experiences were positive or negative by simply looking at their answers would likely lead to bias. We wanted to eliminate this reporter bias when analyzing student feedback. Our rationale behind finding out the true sentiment of the students was to see if we were able to create an engaging environment for them (Gaskin & Berente, 2011) while also showing that IS is a relevant field to the students. We conjectured that the more engaged the students were, the more positive their sentiments would be.

Sentiment analysis, also called opinion mining, is the field of study that analyzes people's opinions, sentiments, evaluations, appraisals, attitudes, and emotions towards entities such as products, services, organizations, individuals, issues, events, topics, and their attributes (Liu, 2012). With the growing availability and popularity of opinion-rich resources such as online review sites and personal blogs, new opportunities and challenges arise as people now can, and do, actively use information technologies to seek out and understand the opinions of others (Pang & Lee, 2008). A phrase has a positive semantic orientation when it has good associations and a negative semantic orientation when it has bad associations. Sentiment analysis classifies and determines whether a review is positive or negative, and it is typically used to extract subjective information from a set of documents to determine the polarity of the document set, an individual document, or even individual phrase(s) in a document, depending on the level of analysis. At the most granular level, sentiment classification software identifies the emotive phrases in a document, scores these phrases (-1 to +1), and combines them to discern the overall sentiment of the sentence where the phrases are located. Sentiment words are words in a language that are used to express positive or negative sentiments. For example "good", "wonderful", and "amazing" are positive sentiment words and "bad", "poor", and "terrible" are negative sentiment words. Most sentiment words are adjectives and adverbs, but nouns (e.g., rubbish and junk) and verbs (e.g., hate and love) can also be used to express sentiments (Liu, 2012).

Turney (2002) explains in detail how sentiment score is calculated. A U.S. patent on the topic explains how a sentiment is assigned a value of −1, −0.5, 0, 0.5, or 1. For example, the adjectives "awful", "so-so", "good", and

"great" are, respectively, −1, −0.5, 0.5, and 1. The verb expressions "I dislike" and "I like" are, respectively, −0.5 and 0.5 (Galitsky & McKenna, 2009). Turney (2002) used the so-called semantic orientation (SO), which is the point mutual information (PMI), a specific measure of association between two words, to calculate the distances between the terms "excellent" and "poor." The output is measured by the difference between those two distances ranging between -1 and 1 (negative and positive). Another approach that includes linguistics was introduced by Hu and Liu (2004). They used the WordNet database to find a broad range of positive and negative adjectives based on the distances through synonym and antonym graphs.

There are multiple examples of the use of sentiment analysis in both industry and academia. For example, Turney classifies a review as recommended if the average semantic orientation of its phrases is positive (Turney, 2002). BPang, Lee, and Vaithyanathan (2002) analyze movie reviews and extract an overall sentiment about the movies in the reviews. McGlohon et al. (2012) uses reviews to rank products and merchants. Mohammad (2011) tracks emotions in novels and fairy tales using sentiment analysis. Goul, Marjanovic, Bexley, and Vizecky (2012) use a similar approach to monitor app store review data to better understand and address current practice bottlenecks in requirements engineering.

Results

Students answered the first question ("Why do you think it is useful to learn building a mobile phone app in an introductory IS class for business students?") with 304 sentences in total. Manual inspection of the student feedback was positive. Recurring answers for the first question included: "being able to access the technology", "keeping up with the modern technology curve", "a great way to understand the information systems application and technology", and "to learn how new technologies are used in a business environment". Most students mentioned the importance and necessity of business majors knowing technology and the ways in which business and technology go hand-in-hand.

The sentiment analysis software we used (clarabridge.com) creates categories based on free-text comments (called "verbatim" by the software) by automatically categorizing themes. Categorization is the process of identifying the main themes of a document and then placing the document into a predefined set of categories based on those themes (Turban, Sharda, Delen, & King, 2011). The method includes rules that sentences must meet in order to fall into each category. These rules are imported from industry standard templates (clarabridge.com). The categorization is then given a sentiment score. For the first question, the sentiment score is depicted in the fourth column (the highlighted column) in Figure 3. As we can see from the sentiment score column, most of the sentiment categories are highly positive, indicating a positive sentiment for almost all the categories.

Category Volume Report, Total: 121

Category	Distinct Verbatim	% of Verbatim	Sentiment Score	Preview
Type: Category (10 Item)				
8 BUILD -> APP;USEFUL -> LEARN	78	64.46	0.76	
7 DEVELOP -> APP;MAKE -> APP	55	45.45	0.70	
1 PROJECT -> APP;GIVE -> PROJECT	53	43.80	0.55	
9 LEARN -> LOT;WORLD -> REAL	43	35.54	0.71	
5 WORLD -> BUSINESS;PLAN -> BUSINESS	40	33.06	0.71	
4 PROCESS -> BUSINESS;INVOLVE -> PROCESS	39	32.23	0.78	
6 SYSTEM -> INFORMATION;PHASE -> DEVELOPMENT	25	20.66	0.02	
3 TEACH -> APPLICATION;MAKE -> APPLICATION	20	16.53	0.48	
2 GIVE -> EXPERIENCE;OPPORTUNITY -> GREAT	18	14.88	0.99	
0 COLLEGE -> THROUGHOUT;FORM -> LAST	15	12.40	0.27	
Type: Others (1 Item)				
Global Other	13	10.74	0.96	

Figure 3. Sentiment Analysis Report for Question 1

There are 10 different categories, each inductively derived by Clarabridge when analyzing the student responses to our questions. Sentiment analysis showed that there were 78 distinct free-text comments that included the words

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"BUILD -> APP;USEFUL -> LEARN" for the first category (the arrow sign indicates the order in which these words appeared). The language processing tool also parsed the sentences and eliminated the "stop" or "noise" words, including "a", "am", "the", "of", and so on. By automatically summarizing the words in each category, the software program created a shortened version of the document that contained the most important points of the original text (Turban et al., 2011). For example, the first category had a score of 0.76, indicating a positive sentiment. Studying the remainder of the categories in a similar fashion, we see that the project provided a real-world experience for students about business processes and development phases, and overall created a favorable opinion. It was encouraging to see that nine out of ten categories had strong positive sentiment scores indicating mostly positive responses. For example, in category 4, 39 distinct free-text comments used the terms "business" and "process" with a high sentiment score of 0.78. category 2 had the highest sentiment score of 0.99 (indicating the category included sentences with the most positive sentiments) with 18 distinct text comments. Figure 4 shows a subset of sample sentences from category 4 . The sentiment analysis software categorized these sentences into the same theme. As we can see from the sample, students' perception of IS was positive following their experience with the app-design project and this course. Students had positive sentiments about learning processes, databases, and creating a competitive edge. Thus, the analysis showed that their favorable feedback covered not only the app-building experience but also fundamental topics in IS.

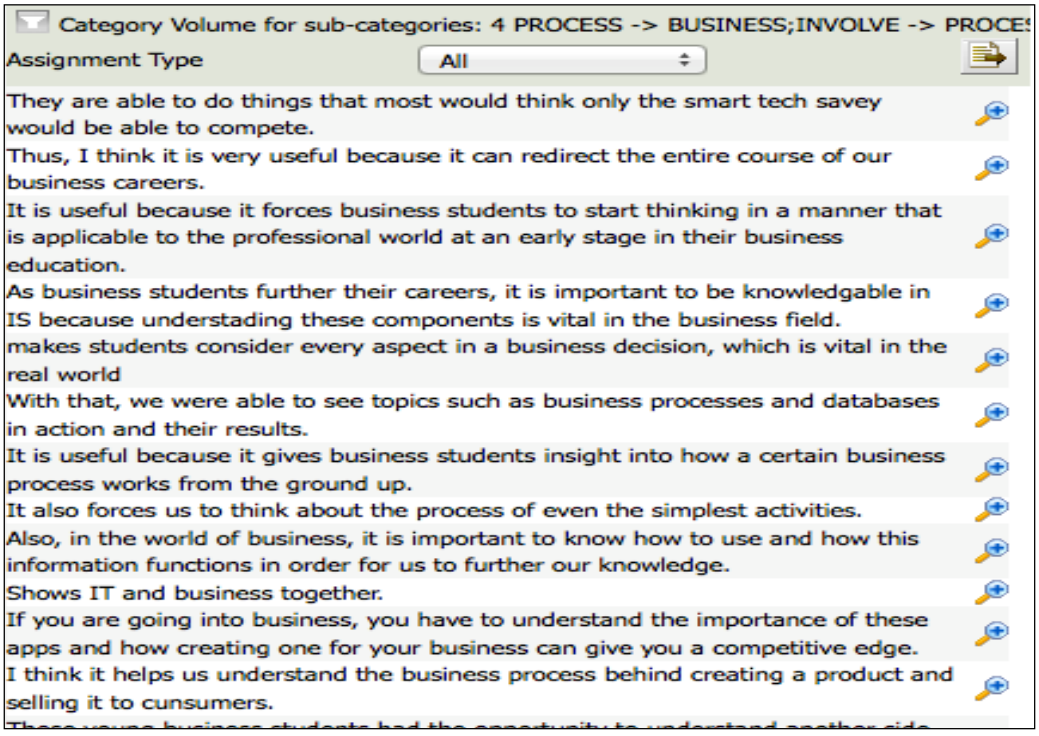

Figure 4. Sample Sentences from Category 4

Question two was more open ended; it asked: "How did this hands-on experience change your perception about the capabilities of information technologies and the methods by which they can be developed in the service of an organization?". Analysis showed that students learned about using information technologies and the value and capabilities brought to business by IS. Figure 5 shows the sentiment analysis of student responses. These responses used the terms "understanding business processes", "capabilities of IT/IS", "changing perceptions", and "eye-opening experience", The highest sentiment score was for the category (HELP->TECHNOLOGY; HELP->MARKETING), which shows that students' understanding of the technology was a helpful tool.

Category	Distinct Verbatim	% of Verbatim	Sentiment Score	Pre
Type: Category (10 Item)				
8 ENTER -> CLASS;DEFINITION -> SYSTEM	52	42.98	0.39	
7 PROCESS -> BUSINESS;BECOME -> BUSINESS	46	38.02	0.00	
5 TECHNOLOGY -> INFORMATION;CAPABILITY -> TECHNC	43	35.54	0.04	
9 MAKE -> APP;HELP -> BUSINESS	43	35.54	0.28	
0 CHART -> TO-BE;BRIDGE -> USER	33	27.27	-0.02	
1 SERVICE -> ORGANIZATION;METHOD -> DEPLOY	33	27.27	0.48	
3 CREATE -> APP;APP -> MOBILE	32	26.45	0.40	
4 CHANGE -> PERCEPTION;CHANGE -> EXPERIENCE	26	21.49	0.08	
2 OPEN -> EYE;OPEN -> EXPERIENCE	25	20.66	0.02	
6 HELP -> TECHNOLOGY;HELP -> MARKETING	16	13.22	0.53	
Type: Others (1 Item)				
Global Other	15	12.40	0.99	

Figure 5. Sentiment Analysis Report for Question 2

Figure 6 is a short list of samples from category 7 that demonstrates students' realization of how much technology is involved in every step of the business process and how imperative and relevant it is to learn IT/IS. These results suggest that our project helped students understand the value of IS for business through a real-life, relatable experience.

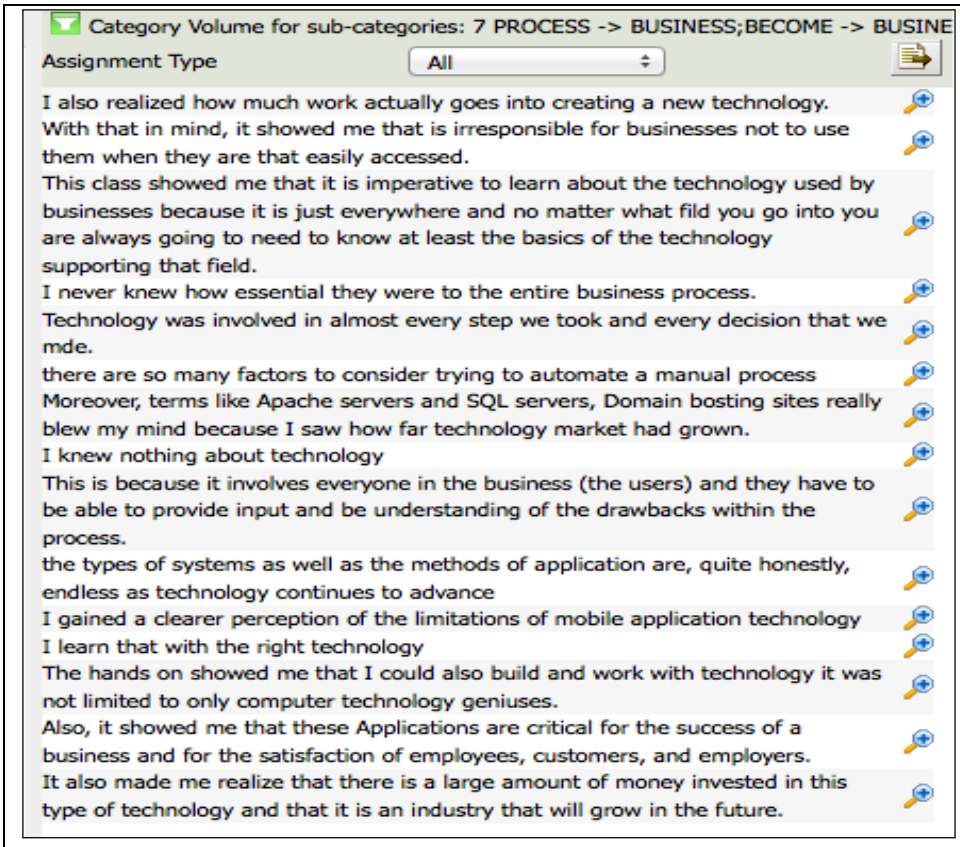

Figure 6. Sample Sentences from Category 7

Even though we asked students almost exactly the same questions as Gaskin and Berente (2011) asked their study's participants, one could argue that the overall positive sentiment could be the result of the way we posed our questions. However, in-depth analysis of all the categories showed that there are more and various different ways students showed their sentiments about the project besides the positive statements used in the questions, including

"useful" and "learn". This provides some evidence that students were not simply reflecting back the wording of the questions.

Another potential limitation of our analysis is the lack of a baseline control group. Without any historical data from which we can evaluate a change in the sentiment of student responses to the app-design project, we cannot proclaim that there was any positive change in student evaluations between the original business process refinement project and this new mobile app focus to the project. However, given the positive responses to the app project as revealed by sentiment analysis—and the increase in these students' enrollment in IS majors/minors following the introduction of the app design element of the course—we feel confident in our evaluation of the student sentiment in the first-year introduction to IS course. We are currently exploring future research in which we intend to further examine this change in student perceptions of the information systems curriculum when there they include mobile application projects.

VIII. CONCLUSION AND NEXT STEPS

This paper examines our journey with 121 freshmen honors students who began their business school education by completing the step-by-step design of a mobile application in an introduction to IS class. The results from the student survey show that the project was a welcome addition to the course and had a positive influence on student perceptions of IS. Although most IS programs do not currently (at the time of writing) offer actual application-development course that would allow students to create their own applications, we show that using the design and implementation phases of a mobile app demonstrated the process of "technology-enabled business development" to students (Topi et al., 2010). This project showed students that the IS major is about exploiting opportunities created by technology innovations. It created awareness of planning, managing, and monetizing technology projects and the SDLC, and helped students to develop an understanding of the details of IS and related business processes. The experiences outlined here, from the perspectives of both the students and the faculty involved, clearly demonstrate that the community of IS educators have no shortage of new and creative ways that we can employ to engage students' interest in IS through means that speak to their experience and interest. This is in line with the creative means explored in the extant body of pedagogical IS research showing again that, as the technology evolves, so must we as IS educators.

In this paper, we discuss our success in introducing core IS concepts to millennial students by employing topics and assignments that were relevant to their lives and commensurate with their experience base. The discussion does not end here. We hope to extend our work further by exploring the ways in which IS programs can more formally teach mobile application development by expanding on the principles laid out in our app-design project for first-year IS students. We are currently in the process of developing multiple approaches to introducing this advanced area of learning to IS students: we are allowing them to not only apply the concepts learned in IS programs in an engaging and relevant way but also to learn technically advanced skills, narrowing the IT knowledge gap that employers identify in the popular press. This future research will develop formal approaches that IS programs can adapt to their current curriculum and will also evaluate current IS programming and related application development courses.

This research presents an empirical analysis of the incorporation of a new mobile app design project into an Introduction to IS course. Future research could develop and test a set of more formal hypotheses for the mobile app design project, or an analogue of this project, which is largely beyond the scope of this article. We are in the process of laying out these hypotheses and establishing an environment in which to test the results. In this future paper, we intended to present our post-hoc analysis of the effects of significantly changing the existing curriculum in the first-year introduction to IS course.

To survive in an increasingly competitive information-centered economy, today's organizations must constantly assess and update their strategies, techniques, and tools for effective information management. Driven by this need and unprecedented advancements in technology, academic programs in information systems must continually rethink their standard concepts and principles, and incorporate contemporary concepts and specialized technology into their curriculum (Bell, Mills, & Fadel, 2013). Universities must become involved early and educate the future technology-driven business leaders in how best to harness the new technology and develop more efficient processes. The potential for IS degree programs to be at the forefront of this change is quite apparent if they address the need for future managers to have more robust skills to effectively lead teams of technologists into the 21st century.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
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