Experiences and Direction in Teaching an Undergraduate Course in Mobile Computing

B. G. BURTON
School of IT & Computing, Abilene Christian University, Abilene TX, 79601
AND
F. S. MHLANGA
School of IT & Computing, Abilene Christian University, Abilene TX, 79601
[1]

The Apple iPhone and iPod touch have become an integral part of innovative learning experience at Abilene Christian University (ACU), with all in-coming freshmen being provided one of these mobile devices. Despite pervasive use of these devices on campus, no formal coursework instruction on mobile computing had been integrated at the institution prior to the compilation of this paper. This paper shares experiences of the authors from a three-week lab-intensive undergraduate introductory course on mobile computing at ACU. The course assumed an appreciable understanding of programming and database management. It was designed for computer science and information technology students who started to develop applications for the iPhone and iPod touch on the very first day of class. Student enthusiasm and participation were very encouraging. The last one-third of the course was devoted to implementing projects which had been proposed for use either by the students participating in the course, departments on campus, or by the larger student body. The paper concludes with a direction for future courses in mobile computing at ACU.

Categories and Subject Descriptors: K.3.2 [Learning], C.1.3 [**Mobile Computing]** – Mobile Applications.

General Terms: Personal Digital Assistants, pervasive and ubiquitous computing

Additional Key Words and Phrases: iPhone, iPod touch, objective-C, Xcode

1. INTRODUCTION

So many technological breakthroughs continue to be witnessed in the field of information and communication technology. Personal computing costs are dropping drastically. At the same time, personal computing is no longer limited to laptops and notebooks. With advances in wireless technology, a variety of wireless devices including Personal Digital Assistants (PDAs), iPhones, and iPod touches are now pervading the world of computing. These devices are so-called "smart" mobile devices in that they encapsulate advanced communication, storage, and processing capabilities. They are much more portable than laptops, and are more convenient to use. As a result, a new paradigm of computing, called mobile computing, which allows users to access information and collaborate with others while on the move (Imielinski, 1996), is emerging.

Mobile computing is also called wearable computing (http://en.wikipedia.org/wiki/Wearable_computer), or more popularly pervasive (Hansmann, 2003) or ubiquitous (Weiser, 1999, 1994) computing. Mark Weiser, who coined the term "ubiquitous computing", distinguishes this computing paradigm as follows:

> Ubiquitous computing is not virtual reality, it is not a Personal Digital Assistant (PDA) such as Apple's Newton, it is not a personal or intimate computer with agents doing your bidding. Unlike virtual reality, ubiquitous computing endeavors to integrate information displays into the everyday physical world. It considers the nuances of the real world to be wonderful, and aims only to augment them. Unlike PDA's, ubiquitous computing envisions a world of fully connected devices, with cheap wireless networks everywhere; unlike PDA's, it postulates that you need not carry anything with you, since information will be accessible everywhere.

Authors' addresses: B. G. Burton, School of Information Technology and Computing, Abilene Christian University, Abilene, Texas, USA. E-Mail: Brian.Burton@acu.edu. F. S. Mhlanga, School of Information Technology and Computing, Abilene Christian University, Abilene, Texas, USA. E-Mail: fsm07a@acu.edu.

> Unlike the intimate agent computer that responds to one's voice and is a personal friend and assistant, ubiquitous computing envisions computation primarily in the background where it may not even be noticed. Whereas the intimate computer does your bidding, the ubiquitous computer leaves you feeling as though you did it yourself. (http://www.ubiq.com/hypertext/weiser/UbiCompHotTopics.html)

In fall 2008, ACU became the first university to distribute Apple iPhones and iPod touches to all of its incoming freshman class. This is paving way for the university to explore a new vision for mobile learning, and giving rise to integration of technology and learning in and out of the classroom. The initiative started with the introduction of a portal, ACU Mobile (http://m.acu.edu), which would help connect students to the campus through news and calendars, course documents and media, in-class surveys and polls. ACU will perpetuate this initiative with subsequent in-coming freshmen. The initiative has prompted a hive of activity on campus, with university fellows conducting ongoing research on use of the devices, and teams from various departments and schools putting together proposals for department specific web applications. In spring 2009, ACU hosted an international summit, under the banner "ConnectEd", which brought together institutions that are deploying iPhone and iPod Touch mobile learning applications, portals, and initiatives in higher education.

While ACU is now immersed in the pervasive use of iPhones and iPod touches, not much has been done in terms of integrating formal coursework instruction in developing applications for mobile computing at the institution. This paper presents the first of such an experience at ACU. It shares experiences of the authors from a three-week lab-intensive undergraduate introductory course on mobile computing which was designed for information technology (IT) students.

The rest of the paper is organized as follows: Section 2 presents the objective and structure of the course. The section also discusses the disparate levels of student preparedness for the course, and the software platforms that were utilized during the conduct of the course. Section 3 discusses the lab assignments and projects that were done. Finally, Section 4 concludes the paper with a direction for future courses in mobile computing at ACU.

2. COURSE OBJECTIVE AND STRUCTURE

2.1 Objective

The objective of the course was straight forward by design: *To provide the students with a framework within which they could develop applications for the iPhone and iPod Touch*. It was important to the developers that the course be balanced in addressing theory and application. We did not want to produce students that were only capable of programming on this one type of mobile technology. We also did not want to make the course theory intensive with no connection to application of the theory.

The course was designed to be taught in a regular semester to Computer Science (CS) and IT majors at the junior or senior level. However, for this first iteration, it was taught IT majors in an intensive 3-week, 4 hours a day, 4 days a week summer class.

2.2 Student Preparedness

The course prerequisites were very minimal. For the first iteration of the course, we only required students to have had at least one high-level programming language. This was done in order to attract students from various disciplines. Just in the School of IT and computing, for example, we have the two degree programs of computer science and IT, as well as information systems in Business. The six students that enrolled in the course all exceeded the minimum requirement.

Ideally, however, prerequisites for the course should include basic knowledge or understanding of elementary data structures, database systems, operating systems, computer networks, and object oriented programming concepts. This basic knowledge enables students to really appreciate mobile computing and approach it from design and practical perspectives. For example, it enables them to determine whether to implement a problem solution using simple arrays or a database. All the students in the first offering of the course had taken an introductory course on database management. Only two, however, had taken an introductory course on data structures. A basic understanding of operating systems also helps the student to appreciate, for instance, the challenges posed by mobile devices with respect to memory management, as mobile applications are implemented with heavy reliance on dynamic and automatic memory management. Besides, there are so many operating systems available on mobile devices. None of the students were well equipped in operating systems. An introductory course in computer networks also helps students to appreciate application development in an environment with issues such as narrow bandwidth of wireless communications. All the students were equipped in this area. Though not all of the students were very familiar with object-oriented programming, they quickly assimilated to using Xcode to write Objective-C.

An added salient prerequisite to the above has to do with student motivation and drive. The students needed to put time and dedication to the course. This prerequisite left the instructors spellbound and impressed. In our combination of over 30 years of teaching, this was our first time to witness such student motivation and dedication of wanting to see their applications done and working to satisfaction. We at least learned one lesson from the conduct of the course, that there are some courses where students prefer for the instructor to teach less and be available to guide and enhance what they already know how to do! The student dedication also made preparation for lectures and labs exciting and enjoyable for the instructors.

2.3 Software Platform

The course was taught on iMac computer systems utilizing version 2.1.1 of the Apple iPhone SDK that was included as part of the University Developer's license at the time of the course. Sample code for students' review was also included as part of the installation on each system. As the SDK includes a simulator, and the majority of these upperclassmen did not have mobile devices, the iPhone simulator was almost exclusively for testing purposes during the course.

3. COURSE CONDUCT

As the students in the course were primarily experienced in programming in the C++ or Java languages, some time at the beginning of the course was dedicated to familiarizing them with the syntax of the Objective-C programming language. The faculty also spent sufficient time discussing the limitations of mobile computing devices as compared to those of the typical desktop computer that they used for programming.

In one discussion with the students, prior computing and mobile devices of their youth were discussed. It was pointed out that the iPhone and iPod Touch are comparable to desktop computers of the early 1990's in processing and graphics capabilities. Students then further researched early mobile game systems such as the Nintendo Gameboy, learning about the graphics, memory, and processing capabilities of these devices.

3.1 Course Assignments

At the beginning of the course, the faculty had planned for four assignments, a mid-term exam, and a final project that was to be presented before an invited group. During the short time frame of the course, some of the original planned projects were modified to accommodate student interest. The four projects were designed to be increasingly difficult and to motivate the students to a deeper understanding of the concepts being covered without becoming too frustrating. On the first day of class, students completed a simple "Hello World" project to help them become more familiar with developing in the Xcode IDE environment.

Many of the students were interested in animation and game development for the mobile devices. While we had initially planned another programming project for the students, we instead gave the students a tutorial on developing a tennis game (Ruffenach, 2009). The students were instructed to successfully re-create the game and then to modify or augment the game. This became one of the most popular assignments for the students. Many of them have continued to augment their games well beyond the end of the course.

The third project was intended to be a project that involved the students accessing a database and building a table. Following the local Library Consortium visit with our students, the students asked to take on the Library Consortium's project as a group project in place of the table assignment. This involved connecting to an external database and creating the table information that could then be displayed to the user of the application. While the initial open source project provided by the Washington D.C. Public Library (http://dclibrarylabs.org/projects/iphone/) provided a framework for the students to work from, the students found the project challenging and rewarding. They were excited to be able to create a project that would be of use by the entire local community. We found that the project engendered a great deal of good will for our course, the College, and the University.

For the fourth project, we challenged the students in the class to create a simple drawing program on the iPhone and iPod Touch. The majority of the students were able to quickly finish this project, thanks to their earlier work on the tennis program.

3.2 Term Projects

As various departments around our campus became aware of the course, we had many requests for specialized applications to meet specific needs on the campus. Our original concept was that we would allow the students to develop their own final project for the course (with faculty approval). Due to the intense interest, we invited several of the departments to present their concept to the students. If the students liked the concept, they would work with the department to further develop the project to becoming an application. Two of these outside projects were

selected and further developed by students in the class. The first was the Library Consortium project which became the third project. The second project selected was designed to provide an easy way to submit or receive campus announcements of various types.

Students also completed projects in developing their own games, a voice board application that allowed the playing of famous quotes, a tool for students to learn more about their professors, as well as an application for farm management.

3.3 Evaluation

While the time for development of these applications was very limited due the length of the course, students still spent an additional four to eight hours outside of class for each class session, and they were all successful.

As of the time of this writing, a majority of the class has continued to develop iPhone/iPod Touch applications. This has continued to create a great deal of conversation amongst faculty, staff and administrators on the ACU campus.

Students were required as part of the course to present their final project. We had originally intended that this would have limited appeal and attendance. Our plan was to invite the departments with whom the students had partnered and the instructors. As the course continued to develop and excitement about the course continued to increase, key members of the university administration requested that a more formal presentation be made inviting members of the local media. While hesitant, we agreed to the request to include local media. This was well attended by the local news media, staff and administrators. Many of the students felt like celebrities for the day (a very uncommon occurrence for CS and IT students).

The presentations were a resounding success. The students did an excellent job showcasing their projects to the local television, newspaper, and campus news organizations. Since the completion of the course, the story has also been picked up on several websites and continues to generate discussion between all levels of the university administration, staff and students.

4. DIRECTION FOR FUTURE COURSES

ACU continues to make a commitment to mobile computing throughout the campus. Preparing to begin its third year of the Mobile Computing initiative, ACU continues to focus on how to improve learning using these marvelous devices. From an institutional standpoint, several issues had to be addressed during this course that had not previously arisen: ownership of student's work, publication of apps developed for the university, and appropriate availability of hardware and software. The instructors also took this as an opportunity to consider how other courses could be enriched by integrating mobile computing into them.

4.1 Ownership of Student Work

Students were understandably concerned about creating projects that they were vested in and hoped to market. After reviewing ACU's documents concerning ownership of student projects we found that unless specifically stated otherwise in the syllabus, students retain ownership of projects that they create. While this is not the case at many universities, our students (as well as faculty) were relieved to learn that they retained full rights to their projects. Before instituting similar classes at other universities, we recommend fully investigating this topic.

4.2 Publication of Applications Developed for the University

One major concern was the publication of software that would be used university wide. We felt it was inappropriate that the students who developed an application that would be used by the university community be expected to publish (and possibly maintain) the application. With graduation looming for many of the students, such a consideration was impractical. Beyond this consideration were also the concerns of copyright (if a student broke copyright creating an application that they created for the university) as well as presentation materials that would represent the university. Fortunately ACU has a central location in which such projects could be funneled, with a staff/administrative person being able to take final authority in whether an application would be published by the university.

4.3 Hardware and Software Availability

An initial problem that had to be resolved was lab availability. Like many traditional computer science degrees, our labs were (at least at the time of course offering) all windows based. With the expectation of using the Apple SDK, having a Macintosh computer with the current operating systems is a requirement. Fortunately the English department on campus had a lab of Macintosh computer systems available during the time of our course. One result

of this course was to build inter-collegiality between departments on the campus. With so many faculty and staff having great ideas for developing that 'killer' app, we found it a wonderful opportunity to develop relationships across the campus. It is highly likely now that we will have a Mac lab of our own in the iSchool by the beginning of fall 2009.

4.4 Integrating Mobile Computing into other Courses

Mobile computing is not only pervasive in use. It also permeates computing instruction in various other related CS and IT courses.

User interface design is an area in which mobile computing can be integrated. With so many users using a mobile application, the user interface better be user friendly and usable. Pervasive use of mobile applications is justification enough for them not only to be user-friendly but also effective, reliable, and meeting requirements specifications. This means they should not fail, and should accomplish their designed task easily and efficiently. Mobile computing thus integrates well with software engineering, which helps students to understand how mobile computer systems are developed to meet real business needs. Issues of how mobile computing systems are deployed at an enterprise level can also be covered in a software engineering course. Mobile computing also lands itself in the distributed computing paradigm. Despite the differences between mobile systems and traditional distributed systems, distributed languages have been developed that are suitable for mobile computing (Heinz, 1996). As the need for universal access and management of information increases, the area of database systems continues to evolve and advance to support current real-world situations, which include mobile computing. Topics such as wireless communication and data processing and mobility are now being integrated into database systems courses (Kumar, 2006 and Tewari, 1995). The design and implementation of data management applications for these systems is a task directly affected by the characteristics of the wireless medium and the resulting mobility of data resources and computation (Pitoura, 1998). There are many other areas in computing instruction to which mobile computing can be integrated.

ACKNOWLEDGMENTS

Many thanks to the students that took this first iteration of the course and to iSchool administration who initiated its offering as a special topics course.

ACKNOWLEDGMENTS

HANSMANN, U., MERK, L., NICKLOUS, M., AND STOBER, T. 2003. Pervasive Computing. 2nd edition, *Springer Professional Computing*.

HEINZ, S., SAJEEV, S., AND EXTON, C. 1996. Towards an object-oriented distributed programming environment for mobile computing. In *First Australian Workshop on Mobile Computing & Databases & Applications*, Monash University, Melbourne, pp. 53-59.

IMIELINSKI, T., AND KORTH, H. F., (Eds) 1996. *Mobile Computing*. Kluwer Academic Press, January.

KUMAR, V., 2006. *Mobile Database Systems*. Wiley.

PITOURA, E., AND SAMARAS, G., 1998. Data Management for Mobile Computing. In *Advances in Database Systems*, Springer, vol. 10.

RUFFENACH, C., 2009. *iPhone Game Programming Tutorial*. http://icodeblog.com/category/iphone-game-programming/ Accessed May 5.

TEWARI, R., AND GRILLO, P., 1995. Data Management for Mobile Computing on the Internet. In *Proceedings of the 1995 ACM 23rd annual conference on Computer Science*, Nashville, Tennessee, pp. 246 – 252, 1995.

WEISER, M., 1999. The Computer for the 21st Century. In *ACM SIGMOBILE: Mobile Computing and Communications Review*, vol. 3, no. 3, pp. 3-11, July.

WEISER, M., 1994. The World is not a Desktop. In *Interactions*; January, pp. 7-8.