DO MOBILE AND WIRELESS TECHNOLOGIES ADD VALUE TO HIGHER EDUCATION?

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Abstract *— Will handheld, wireless devices replace traditional teaching and enhance student learning? In the College of Engineering at the University of Texas at Austin, we set out to find answers to these questions. In the fall of 2001, the College was awarded a grant by Hewlett-Packard (HP) to focus on two key arenas: the instructional redesign of the traditional higher-education classroom and the expansion of the engineering community environment for anytime, anywhere learning and access. This grant, known as the Mobility Initiative, built a college-wide wireless network using HP Access Point technology as well as pioneered mobile technologies in two courses. This paper will describe the wireless environment, changes to the teaching approaches, preparation of materials, student issues (both technical and instructional), and lessons learned.*

Index Terms — mobility, online learning, wireless technologies

INTRODUCTION

There is no doubt that there has been an explosion of technology in the world of work. Technology is changing the workplace by changing the way work is done. Industry is taking the lead and today's workplace now has workers using mobile technology for just-in-time training and performance support. However, technology has not yet profoundly changed education. Technology really has not moved into the classroom and into the learner's hands. Predictions are "the handheld computer may just become the technology that revolutionizes the face of learning." [1]

Why are compact, portable computers and hand-held devices (PDAs) becoming more prevalent on college campuses? These handheld personal technology tools can fit in a backpack, are affordable and can be accessible via a wireless network. Of course due to their small size and low cost there are some tradeoffs in computing power and functionality.

Whether or not these devices will make an instructional impact is a question that remains to be answered. However, case studies on their educational use and potential, are being published [2][3]. Educational institutions and industry are both exploring how handhelds and wireless environments will change what we do at work and at school. This paper provides a view of the College of Engineering at the Univeristy of Texas at Austin (UT) and its partnership with industry that resulted in a mobility initiave which created a wireless infrastructure and allowed the integration of mobile devices into the undergraduate engineering curriculum.

HEWLETT-PACKARD MOBILITY INITIAVE

In the spring of 2001, Hewlett Packard (HP) send out a request for proposals to institutions of higher education to participate in a program to support the creation of teaching-and-learning test beds that incorporate HP mobile technology solutions. A group from the College, consisting of staff from the College's corporate relations, the Faculty Innovation Center (FIC), and the Informational Technology Group (ITG) met and decide to pursue the grant. This group brainstormed possibilities and selected a strategy to pursue the grant proposal. They discussed how UT's classrooms are increasing equipped with multimedia tools that allow faculty to enrich his/her lectures through the use of presentation software and simulations, access to websites, and displaying of streaming media. In addition, the use of Websites and other Internet tools allow for greater collaboration and communication outside of the classroom between students and their peers, as well as with the instructor. While these tools are helping to redesign education, the use of technology has not yet been fully integrated into all the aspects of the learning process.

It was decided that UT's HP Mobility Project would propose to take the academic experience one step further by integrating the use of wireless technology into the teaching and learning environment. By placing wireless technology in the hands of the students and faculty, a new dimension of mobility and connectivity is brought into the experience. As a result of this new added dimension, the College believed that there would be increased communication amongst the participants, allow for new types of team-based instruction and learning experiences, and even increase students' learning efficiency as they have better access to resources.

The College of Engineering proposed to conduct a pilot program in the Fall 2001 by deploying wireless technology to the participants into a selected course. A faculty member was selected to participate based on these criteria:

- Innovative instructor
- Faculty who did research work in areas relevant to HP

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- Course he/she teaches
- Size of group & classification of students
- Current use of tech in instruction of particular course
- Lab component with the course
- Recruiting alignment

Dr Archie Holmes, a professor in the ECE Department, was asked to lead this pilot project. He agreed to partner closely with the College of Engineering's FIC to redesign the way the course is presented. ITG agreeed to provide tools and network resources for the students.

The College of Engineering at UT Austin was awarded one of the ten grants to partner with HP to design new, innovative learning experiences for its students and faculty based on HP's mobile and wireless technology. The Mobility Initiative allowed the creation of a new learning environment for students by focusing within two key arenas: in the instructional classroom setting for enhanced student and faculty interaction, and in the engineering community environment for anytime, anywhere learning and access. The grants include HP hardware and software products, consulting expertise and increased direct contact with HP employees.

ENGINEERING'S WIRELESS ENVIRONMENT

UT's College of Engineering has been interested in mobile technologies for years. The College is entering its fifth year of the Laptops for Learning Initiative, with over 1,300 laptops having been sold through this voluntary program. This year the laptop offering included an integrated wireless option, and so the College applied for the HP RFP in order to create a wireless environment.

Bringing the College-wide wireless infrastructure into operation, required an integration with the extant campus computer network, UTnet. Careful planning resulted in the following deployment actions: 1) surveying all buildings for appropriate access point (AP) placement; 2) installing AP and power access; 3) installing AP cabling access to UTnet; 4) integrating APs with UTnet authentication system; and 5) integrating APs with UTnet management/performance monitoring system.

By January of 2002, the above deployment steps were completed and all buildings in the Engineering area are now in full wireless operation. We did find, however, that the scale of this project challenged campus resources to refine its wireless security strategies and to establish protocols to manage campus air-space. Our experiences will be leveraged across Campus and we are exploring extending our wireless capabilities into the surrounding community.

ELECTRICAL ENGINEERING 302

At the University of Texas at Austin, EE302 is an introductory class in Electrical Engineering, typically taken by students in their first semester. In this course, the main goals are (i) to help students develop a better understanding of the various fields within electrical and computer engineering; (ii)to better understand the different roles an electrical and computer engineering graduate may play in the work force; and (iii) to develop an appreciation and enthusiasm for future courses. In addition, the course helps student to develop the skills necessary for their future success as engineers: the ability to assimilate new information, apply that information to problems, and draw connections between the various bodies of knowledge.

This class began at UT in the early 1990's as a means of increasing the retention of electrical and computer engineering students during their first year. While this is still a goal of this course, the mastery of concepts required for future courses has been added in recent years. These topics are in the area of analog linear circuits. In this course, the students are expected to master the following:

- Physics Representation of Analog Circuit Quantities such as voltage, current, energy, and power
- Definitions of various analog circuit elements such as resistors, voltage and current sources
- Kirchoff's Current and Voltage Laws
- Advanced circuit analysis techniques such as node voltage and mesh current analysis
- Development of Thevenin and Norton equivalent circuits for analyzing circuits
- Advanced circuit analysis and equivalent circuits using dependent sources

A particular challenge for the instructors of this course is to help all students equally due to a wide range of previous experiences the students bring into the course. Some students have been exposed to resistors, capacitors, etc. via a calculus-based physics class in high school or have participate in hobbies, which utilized these circuit elements. Other students are currently taking calculus for the first time at the University.

Wireless Integration into EE 302

Due to the wide range of previous knowledge of the students, our goal was to help both the students and instructor access what it understood by students in real-time in the classroom. Many methods such as peer instruction [4] or cooperative learning have been used for this process. These systems are particularly adept at allowing an instructor to look at general understanding of the class. In addition, these systems allow students to learn from each other. One disadvantage of these systems is that they are not set-up to provide real-time feedback to the instructor about each individual student. We believe such information would be particularly important for first-year students in that it allows for the instructor to intervene, as needed, to help students master the concepts.

To achieve this in the classroom, we introduced wireless access into the classroom. In addition, HP donated 65

Jornada hand-held PCs for instructional use. To access students knowledge and understanding, course management was achieved via the UTwired System. The survey/test administration section of UTwired afforded the instructor an easy method to construct and administer an in-class exercise pertaining to recent material. Normally, grading quizzes is a time-consuming process which can only provide feedback to the instructor after he performs the tedious tasks of grading and statictically analyzing the results. Through the use of UTwired's real-time tabulation abilities, however, the instructor is able to gauge the students' collective and individual comprehension levels, while occupying a minute amount of lecture time. Based on the student feedback aggregated by the system, the instructor can instantly shift the focus of the lecture from the topics his student understand to which topics require further explanation. This style of dynamic, interactive instruction would not be possible without the assistance of technology. (I like this...)

USE OF WIRELESS IN THE CLASSROOM: RESULTS AND DISCUSSION

The initial test of the use of real-time assessment via wireless devices was done in the fall of 2001 in the honors section of EE 302. There were 60 students who participated where each student had their own Jornada. Throughout the semester, two types of assessments were used. The first was to present a knowledge assessment of topics to be covered PRIOR to their discussion in class. This type of assessment gives the instructor an idea of how students currently understand the material via reading assignments or prior knowledge. Thus, topics, which are understood by the class, can be covered quickly and concepts that were not can be emphasized. In addition, the students get an idea of where they stand in their current knowledge and they can use the assessment as a means of determining what they need to get out of the lectures to follow. The second type of assessment used was AFTER topics were discussed in class. This type of assessment gives the instructor a feel on how well topics were covered and it gives students an idea of how well they understand the material.

The procedure was the following. The instructor makes an assessment within UTwired prior to class. This assessment tool allows for multiple choice, true/false, and short answer questions. For real-time assessment in the classroom, only multiple choice and true/false were used since these could be graded automatically after the student submitted their answers. After creation of the assessment, the instructor has the option of hiding it from student view. In the classroom, the instructor would make the assessment visible to the students. To take the assessment, each student would log into UTwired and take the assessment. When done, they hit the submit button and are immediately given their results to review. While students are taking the assessment, the instructor can monitor each of the following: how many students have completed the assessment, which students have completed the assessment, how each student who has completed the assessment has done, and how the class overall has done. Thus, while students are completely the assessment, the instructor can be monitoring the results and determine how to use this information in the course.

Results

The initial results of real-time assessment were encouraging. From the instructor's perspective, it is extremely useful to have the means of tailoring course delivery to the needs of the students. Not only was this found to be useful in real-time, the results are available outside of the classroom to help the instructor prepare future lectures or in-class problems for the students to do which address their needs. In general, the assessments done AFTER the topics were covered in class were more successful than the ones, which measured prior knowledge. One reason discovered for this was that students would see these assessments as exams (which they were told they were not) and showed a lot less confidence in giving their thoughts. After the topics had been covered, students noted that their confidence level was much higher. Thus, work must be done to help make assessments PRIOR to topics being covered in class more effective.

Student comments were mixed. In the end of the semester evaluation, many students noted that they found it useful to them in determining what they understood and what they need to continue to work out. They liked the fact that the real-time assessment could be used to make their own study time more efficient. The main complaints from students were not related to the wireless assessment process, but the limitations of the Jornada. These included the small screen which made it hard from students to take the assessments, the fact that the number of programs which currently run on the Jornada is limited, and that numerical problems like they had to do one exams or on the HW were not included.

CONCLUSION

In this paper, we outline our initial use of a real-time assessments in the classroom using a wireless infrastructure. Our initial results show that such a system is useful for both students and instructors to make the time spent in the classroom teaching new concepts more useful and productive. In the future, we are looking to expand the type of problems that can be asked via UTwired to include numerical ones which can be graded when the student submits an answer.

We are continuing to look at mobility and instruction. During the spring of 2002, a professor with 20 seniors in his Network Engineering course, is using HP Onmibooks equipped with wireless interfaces. These students design and implement a wide-area network equivalent to a modern corporate intra-net, through group experiments conducted in the Network Engineering lab. Assignments and network

designs are currently limited to tasks that can be accomplished within weekly laboratory sessions. With these HP tools, the students will be able to wirelessly access the lab facilities outside of scheduled hours. This allows the depth and breadth of the projects assignments to increase and include new topics, such as VLANs, QoS techniques, firewalls, intrusion detection and socket level programming.

The College is planning to build upon this project's success by developing eservices that allow for users to access resources and services near his/her proximity and to be aware of the presence of others using the network. The College is interested in exploring the integrated use of Jornada tools (or future HP appliances) with modularized adaptive learning efforts. The study and development of new, collaborative applications for the HP wireless tools is also envisioned in a broad range of research and distributed learning activities. The College hopes to use these tools in outreach programs, where pre-college students are engaged in exciting engineering-oriented activities using HP technologies.

REFERENCES

[1] Shields, J. & Poftak, A. "A Report Card on Handheld Computing", *Technology and Learning*,22,#7,2002, pp. 24-36.

[2] Nybo, V., "Will Handheld Computers Work in the Classroom?" *Syllabus*, November 2001, pp 36-37

[3] Griffioen, J., Seales, W., & Lumpp, J., "Teaching in Real-time Wireless Classrooms", *Journal of Engineering Education*, October 1999, pp. 397-402.

[4] Ramaswamy, S., Harris, I., & Tschimer. U. "Student Peer Teaching: An Innovative Approach to Teaching in Science and Engineering Education", *Journal of Science Education and Technology*, 10, #2, 2001, pp. 165-171.