

**Wireless Instructional Initiatives Program:
From Wireless 1.0 to 2.0 (2001-2006)**

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Executive Summary

The OIT/ITC Wireless Instructional Initiatives (WII) program was initiated in 2001. Its purpose was to help faculty use the then-new UT wireless network to enhance student learning. Each year the project incorporated a new group of faculty participants from various departments in the colleges of Arts and Sciences, Engineering, Communication and Information, Agricultural Sciences and Natural Resources, and Nursing. The equipment used by the students evolved from laptops and other equipment used just in class, to laptops distributed for 24/7 student use, to newer technologies such as Tablet PCs and PDAs.

Faculty participants applied and participated primarily due to their interest in collaborative learning. In most instances, they attended a multi-day training institute conducted by ITC staff the summer before their WII courses to familiarize themselves with the equipment to be used, explore new teaching opportunities, and learn strategies to facilitate collaboration among their students. The amount of faculty training and planning was found to correlate strongly to the success of the projects. Post-project student survey results indicated tremendous enthusiasm for the projects, with almost all students indicating that they loved their overall project experience and desired to expand upon it and/or continue using the equipment in their other classes.

Lessons Learned

- Above all else, technology should enhance, not interfere with, the teaching and learning process. Faculty must be able to pedagogically leverage, not just use, the technologies in order to enhance student learning by integrating them into course syllabi and activities.
- Faculty training is likely the most crucial element affecting the success of projects; enthusiasm and talent cannot compensate for preparation and equipment familiarity.
- Instructor attitude and willingness to model a flexible approach significantly impact the attitudes of students and their willingness to adopt emerging technology.
- Extensive technical support for both faculty and students had a dramatic impact on the success of the WII projects. Real-time support is ideal as class time is a precious resource that cannot be recovered once lost.
- Just because a given technology is readily available and familiar doesn't mean it should necessarily be utilized in the classroom.
- Equipment compatibility and functioning cannot be taken for granted. Thus the need for "safe" environments where faculty can practice and perfect their skills, such as The Commons' Practice Presentation Room.
- Instructors cannot assume student familiarity with technology. Although most students appear to have become quite familiar with standard laptop technologies, making this assumption of all students can result in difficulties for some.
- Faculty, staff, and administrators aren't the only ones who desire to maintain successful integration of technology in a class or project—students who experience success consistently desire to extend the integration throughout their curriculum.
- Purposeful review of syllabi/curricula requires significant time and effort; faculty should receive recognition for learning, developing, and using/implementing new technologies to enhance their students' learning.

The Future

Wireless computing presents a unique opportunity for educational institutions to expand beyond the classroom walls, turning any place into a classroom. Ubiquitous campus wireless networks, such as UT's, offer the potential for students to work, individually or in groups, almost anywhere on campus. The inclusion of "mobility tools"—email, web browsers, discussion boards, and chat rooms—enable students who are not physically present on campus to participate in collaborative projects. The explosive growth and increasing sophistication of online information resources and collaboration tools present a host of opportunities for education. They can also serve as a tantalizing distraction to students, but networked, mobile computing devices offer faculty with sufficient awareness and preparedness the opportunity to increase student engagement and enhance learning.

Given the great variation in devices currently being used to access the Internet, it is difficult to predict the future of wireless computing. Recent data from the 2007 ECAR Study of Undergraduate Students and Information Technology indicate that only ~13% of UT students own either a PDA or smart phone (combination cell phone and PDA device). As more and more technologies—cell phone, MP3 player, PDA, digital camera, GPS, Internet browser, classroom response unit—are combined in a single device, its potential utilization for educational purposes will be undeniable. However, there is no guarantee that a majority of students will have devices, much less the same device, absent a university requirement ensuring some base level of uniformity.

The UT Knoxville wireless network is a great resource; the Educause Center for Applied Research even wrote and distributed a case study about it in August 2002. Whatever the specific technology utilized in conjunction with it in the future, it is essential that collaboration and student-centered learning continue to be promoted, and that the university provide the support and infrastructure necessary to facilitate and develop best practices for faculty adoption of collaborative technologies for educational purposes. In contemporary practice in higher education, accrediting agencies are looking for opportunities that incorporate active learning, collaboration, real-world experience, and technological competence, all of which can be promoted via wireless networking and will also make the institution competitive in attracting prospective students and potential employers. Therefore, it would behoove UT's future and graduates to incorporate such practices into the learning experience to the fullest extent possible.

Introduction

History of UT's wireless network

In October 2000, The University of Tennessee, Knoxville launched an extremely ambitious initiative to create a seamless, integrated wireless network to encompass all academic, administrative, and residential buildings by August 2001. The scale of the UT wireless project was apparent when compared with other colleges' and universities' wireless initiatives at the time. Carnegie Mellon's Wireless Andrew project billed itself as the largest installation of its type when it reported in August 2000 that its wireless network covered all 34 campus academic and administrative buildings and key outdoor areas on the main campus. The October 2001 Campus Computing Project (Green, 2002) reported that just 6.2 percent of the 2001 survey respondents indicated that they had full-campus wireless networks up and running at their institutions as of fall 2001 (pg. 3).

The Office of Information Technology's (OIT) network services and customer support service units worked with the University's facilities planning and physical plant operations groups, as well as outsourced contractors, to achieve the infrastructure objectives more or less on time. Economic and logistical factors resulted in a revised two-phase implementation plan being adopted, with full implementation scheduled for April 2002. Phase I, which included administering site surveys in February 2001 and installing over 1,000 access points in 60 buildings on the main and agriculture campuses, was accomplished in August 2001. Phase II, completed in March 2002, expanded coverage to 130 buildings covering over 15 million square feet indoors and approximately 4 acres outdoors, making it the largest academic wireless network implementation in the United States.

The University of Tennessee was in a very favorable position in 2000 to leverage wireless networking to support and extend the teaching and learning environment. There was already a very strong, robust, adaptable wired campus network with excellent technical and administrative support. There was a highly regarded instructional technology support unit in place with an experienced, dedicated staff committed to faculty development, student success, and interdepartmental collaboration. Finally, there was a strong, dedicated teaching faculty committed to delivering high quality instruction and facilitating student success. Almost without exception faculty members expressed the sentiment that they would do whatever it took to provide meaningful, relevant learning activities and experiences for their students if someone would just provide the training and the resources they needed to do so. The Innovative Technology Center (ITC) did just that.

Rationale for the Wireless Instructional Initiatives Program

Prior to the creation of the campus wireless network, unless an instructor had access to one of the limited number of computer labs or had students who owned laptops, their teaching strategies were limited to using computer resources through classroom presentation systems and networked resources available in some, but not all, classrooms. This often fostered directed teaching (teacher-centered) strategies and restricted both student access to networked resources and instructor ability to model, guide, and direct student use of online resources.

There is abundant evidence that learner engagement is directly related to time on task, student-to-student-to-faculty communication, rich and rapid feedback, diverse ways of exploring

information, high expectations, and active (student-centered) learning (Chickering & Gamson, 1987). Essentially, then, for active, engaged learning to take place, students need to ask the questions, explore the information, communicate with each other, and formulate the answers. While it is true that fixed-base (space) learning environments and fixed-in-time learning opportunities can address these principles, they cannot accomplish it as well as a wireless environment can. When teachers are tethered to a specific learning place and point in time, they miss abundant teachable moments and opportunities for students to apply learning in context. Wireless untethers teachers and students by providing ubiquitous access to information and communications—the tools of collaborative (student-centered) learning.

While the creation of a ubiquitous wireless computing infrastructure at the University presented the opportunity to facilitate collaborative learning, its mere existence was not going to be sufficient to ensure effective use. Faculty would also need to be taught how to use this pervasive resource effectively. Indeed, a study by Butler & Sellbom (2002) identified the top four factors affecting faculty adoption of technology as:

- reliability of the technology;
- knowledge of how to use the technology;
- belief that the technology improves or enhances learning; and
- difficulty in using the technology.

Therefore, while OIT staff addressed the logistical and technical challenges of this initiative, the staff of the ITC began addressing the pedagogical implications, training requirements, and technical support issues posed by this dynamic new environment.

The result was the creation of the Wireless Instructional Initiatives (WII) program in spring 2001 to develop and explore instructional strategies for wireless computing environments that would empower faculty to enhance their students' educational experiences. The ITC WII team assumed the responsibility of designing, implementing, and evaluating collaborative, learner-centered environments in a diverse range of disciplines as a demonstration of the capabilities and potential of ubiquitous wireless environments to transform teaching and learning. A major part of this initiative entailed designing relevant faculty training and logistical and technical support strategies. In addition, ITC WII team members shared the belief that instructional objectives should drive the entire process. The technologies were to be used in creative, effective ways to facilitate the teaching and learning methods, goals and objectives.

NOTE: While the focus of the Wireless Instructional Initiatives program was to create collaborative learning environments for students, it has initiated other collaborative efforts as well. Each phase of the project was a truly collaborative effort, involving individual faculty members, academic departments, the ITC, OIT Network Services and Customer Technology Support, and the Office of the Chancellor. Since the projects relied heavily on a stable network infrastructure, responsive technical support, and a strong commitment to faculty development, these collaborative working relationships established for the program were vitally important to its success and have persisted beyond the original projects as well.

WII 2001-02: Wireless Instructional Strategies for the Humanities (WISH)

Overview

The WISH project consisted of in-class use of cart-based wireless laptops and involved an eclectic group of faculty from various departments within the College of Arts and Sciences and the College of Education, Health, and Human Services, all of whom were teaching in the Humanities building. This project was targeted as the initial project for a number of reasons, among them the opportunity to involve a large number of faculty from very diverse disciplines, the potential to impact large numbers of primarily undergraduate students, and the likelihood of working with faculty and students from every segment of the technology adoption curve. A call for proposals was issued and, from a pool of 20+ applications, 13 faculty members representing 8 departments and serving over 350 students were selected. The Office of the Chancellor provided modest stipends for the selected faculty, and OIT supplied funding for the project hardware and software.

Technology

Each of the faculty participants received a laptop with a wireless card. Two carts holding 16 PC laptops each were outfitted with projectors, external speakers, and extra batteries and made available for faculty to use in their classes. All laptops contained a variety of productivity, brainstorming, and collaboration software. In addition, a file server was purchased to store and host student and faculty files.

Carts were purchased for their mobility and security—they required keys to be opened and were relatively easy for a lone individual to roll through the halls. Since all WISH classes were being taught in the Humanities building, the carts were stored in the Language Resource Center on the second floor and transported to the first floor via the elevator. A student worker was also hired to support the project by overseeing the checkout of the equipment and performing basic laptop maintenance as required.

Participants

College of Arts and Sciences

- African & African American Studies: Amadou Sall
- English: Russel Hirst, Michael Lofaro
- History: Palmira Brummett
- Modern Foreign Languages & Literatures: Margaret Beauvois, Jeff Mellor, Stefanie Ohnesorg, Euridice Silva-Filho, & Dolly Young
- Religious Studies: David Dungan
- Philosophy: Phil Hamlin
- Political Science: Janet Kelly

College of Education, Health, and Human Sciences

- Counseling, Deafness, & Human Services: Marianne Woodside

Total number of students impacted: 350+

The participating faculty members were organized into two teams that continued to hold biweekly progress and planning sessions throughout the project. Faculty committed to integrating the student wireless laptops into a minimum of one-third of the class sessions for the semester, participating in the biweekly meetings, conducting periodic student assessment of the project using assessment instruments provided by the ITC, participating in pre- and post-project faculty assessments, and submitting a final report. Two WISH training institutes were conducted in the summer of 2001, and the project was implemented in the 13 courses in fall 2001.

Project descriptions and final reports available online at
<http://itc.utk.edu/about/archives/wii/2001/wiirec2001.shtml>

Training/Support

Upon receipt of the WISH project grant, each faculty participant completed a survey regarding their level of experience, comfort, and skill using a variety of technologies and submitted a detailed project description in which they defined their goals and objectives for the project. Then, in consultation with the selected faculty, the WII team designed a faculty development plan which included a summer institute consisting of six hours of core workshops in technical strategies, instructional strategies, and collaborative models for the wireless classroom, plus 10 hours of individualized training focused on reshaping the curriculum and content in order to make maximum use of networked resources. Their final assignment before fall semester classes began was to examine and revise their original project description based on what they had learned in the institute.

Once classes began, faculty participants attended biweekly “team” meetings, which consisted of the ITC WISH project team and about one-half of the WISH project participant faculty, during which they discussed their specific successes and challenges from the previous two weeks. Participants could also request immediate technical support in their classrooms via phone calls to, and subsequent visits from, the WII team members.

Sample WISH In-Class Activities

African American Studies	Groups created concept maps re: term ‘Africa’ Submitted in class & saved/distributed copies Presented research reports
French: Intermediate Composition & Conversation	Reviewed/discussed URLs in groups, then presented Also used foreign language discussion board / chat
German: Advanced Composition & Conversation	Viewed & discussed German apartment web cam/site Provided real-time cultural perspective on events
German: Composition & Conversation	Computer-based Q&A every day in class Students transcribed notes from interviews Also searched for relevant German job listings
Images of Jesus	Displayed images to students Students drafted 3 symbolic & 3 literal interpretations Submitted to instructor, who grouped & presented
Intro to Human Services	Worked in groups on Blackboard site assignments Evaluated websites of service organizations, then presented findings at end of class

Intro to Literary Research	Explored Library databases, search strategies, tactics Evaluated online resources in class
Philosophy of Art	Teams visited museum websites Questions, URLs provided to guide experience Submitted written response(s) by end of period
Portuguese	Visited Portuguese news & tourism websites Utilized Blackboard quizzes re: content
Teaching a Foreign Language	Placed in discussion forums re: assigned reading Students gave mini-teaching examples utilizing tech.
Technical Editing	Used online exercises as self-paced, in-class activity FTP'd to save in-class work (with edits from others)
Urban Policy	Had detailed rubric for student research roles Used class time to work in groups on presentations
World History	Utilized customized image database

Assessment/Results

Faculty

Faculty participants completed a pre-project survey in August 2001 regarding their computer skills & teaching activities and were interviewed in December regarding their course experience upon the conclusion of their WISH course. They also completed a follow-up survey approximately one year after their initial course (in Dec 02). Here is a sampling of their responses:

The best thing about using the wireless laptops in class was:

- “The enthusiasm students bring to technology-enhanced collaborative projects and the depth, scope and creativity of their results. They learn twice as much as in a traditional lecture.”
- “Access to resources.”
- “Students working collaboratively in groups.”
- “Forced me to learn how to use Blackboard, a very useful experience/tool.”
- “The ease of access to applications and the Net—eliminating the necessity to reserve lab space. Technology can be more smoothly woven into each lesson.”
- “Students attached to powerful, versatile learning tools during class.”
- “I’m just sorry I’m not 20 years younger and could be more flexible, persistent, and imaginative with this wonderful technology.”

The worst thing about using the wireless laptops in class was:

- “Not enough laptops for every student to have one; no guarantee that laptops will be available if you develop a course using them; no guarantee that a smart classroom will be available to support the use of the wireless laptops.”
- “Planning a and b and c – when things do not work.”
- “When activities are planned and then cannot be carried out due to technical difficulties.”
- “Logistical and technical problems.”
- “If something does not work for the 2nd or 3rd time: you lose valuable classroom time and the students gain the impression that trying to use the computers wastes valuable classroom time (This DID NOT happen in my classroom during the last 2 semesters!!)”

Students

Here is a sampling of responses submitted by students in WISH courses who completed a post-course survey in November 2001:

- “Get the system going and all the bugs gone and this will help take education to a new level.”
- “[The best thing about this class was] (l)earning new ways to present older material and spice up presentations so that they are fun and interesting. I learned and can remember more information because a new and fun way of presenting material was introduced.”
- “[The best thing about this class was] (v)iewing things that were interesting to other people in the group, which I would have never explored.”
- “It was fun to access another medium for us to learn the language. The manner in which I learn best is to see, hear, and write it in many formats, so it was great for me.”
- “It would be great to check-out a computer at the beginning of the semester to use during the span of the class... able to take it home, take notes in class, write the papers...etc.”
- “The instructor’s use of a computer in class improved my learning experience.”

Project Outcome (Successes and Challenges)

Obtained a clearer picture of support needs:

- Logistical issues. The student assistant in the LRC was essential to coordinate and oversee the scheduling of the cart and to ensure that all equipment was returned. This was particularly important given the distribution schedule for 50-minute, Mon/Wed/Fri classes; every minute required to transport the cart between rooms and distribute laptops was one less minute to spend teaching.
- Technical issues. The network was somewhat unreliable at the beginning of the semester when the network technicians were still working out the bugs. The configuration of the laptops also required occasional tweaking in order to accommodate last-minute software needs. Once both of these were stabilized, by late in the semester, the process of integrating the technology into the courses became much more seamless.
- Support issues. WII team members underestimated the need for and importance of ongoing consultation and hands-on training for the faculty participants. However, it was crucial that the participants had a safe environment in which they could experiment, knowing that technical assistance was available as needed and that they could focus almost exclusively on the pedagogical content.

Determined effective instructional strategies:

- Learning from others. The biweekly participant meetings were valuable in providing an opportunity for participants to share their successes and challenges with their colleagues and the WII team in order to benefit from the experiences of others and learn new approaches to shared problems. The process facilitated the serendipitous development of new instructional strategies among participants.
- Familiarity with technology. An awareness of the potential of the technology was a prerequisite for developing instructional strategies. As the participants learned more about the laptops and the software installed on them, often at the request of another colleague, opportunities arose for both planned and ad-lib classroom learning activities.

Identified hidden software issues:

- Vendor license negotiations. These proved particularly problematic due to the relatively short timeframe prior to the fall semester and the extensive amount of paperwork required to procure the necessary software. The assistance of the OIT software procurement team proved invaluable during this process, though.
- Lack of UDP broadcasting. A technical constraint of the wireless network prevented the functioning of a software application that would have permitted an instructor to monitor students' laptop use on her or his own screen. This was a need unforeseen by the wireless networking engineers, and one that could not be resolved prior to the conclusion of the semester.

Connected to a national network of other higher education resources:

- Conference workshops/presentations. Due to increasing national interest in the nascent field of educational applications for wireless networks, the ITC WII team made several presentations at various conferences upon the conclusion of the WISH project. Contacts and conversations from these conferences were valuable in determining how best to expand the project in subsequent years.
- ECAR Case Study. Largely as a result of the increased publicity garnered from multiple conference presentations, UT was selected by the EDUCAUSE Center for Applied Research (ECAR) for a case study entitled "Wireless Networking at The University of Tennessee." This paper was printed and distributed nationally in August 2002.

WII 2002-03: Wireless Instructional Strategies for Engineering (WISE) and Biology

Overview

Engineering

Initiated in January 2002, the WISE project entailed working with College of Engineering (CoE) faculty to develop and implement strategies to foster student-centered collaborative learning communities using wireless computing, while simultaneously exploring the logistical and technical challenges of supporting these learning communities/environments. Some CoE faculty were concerned about continuing to rely on static hardware and software resources in departmental and public labs that they saw as insufficiently flexible and dynamic to meet accelerating computational and instructional requirements. Concurrent with the WISH project, members of the ITC team conversed with CoE faculty and administrators who were examining the opportunities and challenges of initiating a student laptop requirement in fall 2003 to enhance the learning experience and provide students with computing and computational skills required in their profession.

The WISE project was explicitly designed to develop and demonstrate effective teaching strategies, activities, and practices prior to the laptop requirement. The WII team worked with individual faculty to develop an implementation plan that would maximize the use of scarce hardware, software, and personnel resources while adhering as closely as possible to the instructional objectives of the faculty participants. This resulted in three distinctly different implementation methodologies that included issuing laptop computers to graduate students taking a sequence of computation-intensive courses, issuing laptop computers to undergraduate students and developing instructional modules and interactive learning exercises to guide them through the learning objectives of the course sequence, and developing and evaluating a process for using cart-based wireless computers in the classroom to promote interactive cooperative learning. Aware that “(s)tudents who have grown up ‘digital’ expect to be involved in active, social learning situations in which they participate in the creation of knowledge rather than passively absorbing information” (Frاند, 2000), all three sub-projects explicitly sought to foster the development of learning communities inherent in the project-focused, problem-based learning environment of in the Engineering curriculum.

Biology

Concurrent with the implementation of the WISE project, the WII team received an unsolicited proposal from the Division of Biology in the College of Arts and Sciences for the design and delivery of an inquiry-based alternative to the traditional biology lab sections in the non-majors biology sequence. Since the available resources would only support integration of the wireless laptops into approximately one-half of the lab sections of this course, this presented a unique opportunity to compare outcomes between the inquiry-based and traditional approaches to conducting lab sessions in the non-majors biology sequence. Working with the faculty member responsible for this large (400+ students) survey course and 7 of his 18 Graduate Teaching Assistants, the WII team facilitated the development of three WebQuests based on current issues in biology. Implementation was randomized due to temporal and logistical requirements, resulting in each of the GTAs having at least one inquiry-based lab section and one traditional lab section.

Technology

The ITC purchased and distributed 40 Dell Latitude C600 laptop computers with wireless cards to the three engineering faculty participants. The distribution included 16 machines (with a cart) for in-class use, 8 machines for distribution to graduate students, and 16 machines for distribution to undergraduate students. One of the faculty participants also used departmental funds to provide 9 additional laptops for his undergraduate students. Due to the fact that the laptops arrived late in the spring semester, full deployment was postponed until fall 02, with all three participants piloting deployment in spring 02 and summer 02 to test the functionality of the logistical and technical support systems. The project was extended into the 2003 academic year due to this revision of the implementation schedule. In the fall 02 semester, the program was fully implemented, with 8 graduate students and 27 undergraduate students receiving full-time loaner machines for the duration of the semester, and one cart-based set of 11 laptops remaining in the Perkins Hall computing facility for classroom use.

The Biology WebQuest project utilized 10 Apple iBook computers on a mobile cart, with a digital projector to facilitate student presentations. Students in the WebQuest sections worked in teams of two, with one iBook available for each team during the scheduled lab section meeting time.

Participants

College of Engineering

- Chemical Engineering: Fred Weber
- Engineering Science: A.J. Baker
- Mechanical and Aerospace Engineering: Jack Wasserman

College of Arts and Sciences

- Biology: Stan Guffey

Total number of students impacted: 460+

Project descriptions available online at

<http://itc.utk.edu/about/archives/wii/2002/wiirec2002.shtml>

Training/Support

Variation in instructional objectives, technical requirements, and logistical considerations resulted in engineering “mini-projects” that were very different in character and organization than the initial WISH project. Consequently, rather than using a cohort group/summer institute model of faculty development, the WII team worked individually and independently with the CoE faculty to develop and implement strategies to foster student-centered collaborative wireless learning communities. Only one of the three mini-projects resembled the in-class, cart-based environment of the initial WISH project such that the lessons learned in areas of logistics and technical support could be used to meet these challenges. The other two projects, which employed loaning laptops to students 24x7 (24 hours/day, 7 days/week), more closely simulated the challenges the College of Engineering would face in implementing its forthcoming student laptop requirement. For these two projects, new logistical and technical support mechanisms had to be developed. ITC staff also provided development assistance for online course components.

For the Biology WebQuest project, the ITC staff worked with the participating faculty member to develop the WebQuest site and content, and to develop student evaluation rubrics. The ITC staff and the faculty member met jointly with the participating GTAs to provide instruction on how to use the WebQuests and the evaluation rubrics. In addition, ITC staff attended the initial session of each lab section utilizing the laptops to provide instruction to the students on how to use the equipment.

In both the Engineering and Biology projects, a disk image was utilized to pre-load software onto and ensure uniformity among the laptops. The ITC staff also provided on-site support for cart-based laptops and walk-in support for the laptops that were checked out to the students. An effort was made to ensure that all hardware or software issues were resolved within 24 hours to minimize disruption for the students. In most cases this was achieved, due primarily to the use of disk imaging to restore systems to their original configuration.

Assessment/Results

An initial survey was administered to all of the students, whether they had full-time or classroom-only access, to assess self-reported computer comfort and skill levels, collaborative learning comfort and experience, and anticipated laptop usage patterns. At both the mid-point and the end of the semester, additional surveys were administered to assess changes in students' self-reported skill and comfort levels with computers and collaborative learning, to explore their actual laptop usage patterns and perceptions of successes and obstacles, and to determine their level of satisfaction with the project. The Biology faculty participant and his GTAs did not complete surveys, but were interviewed by the WII team to explore their perceptions of the challenges, successes, and obstacles they and their students had experienced during the project.

Faculty

- WISE: Faculty participants reported generally positive experiences and a perception that students collaborated more and produced higher quality work than in previous semesters.
- Biology: Faculty (and GTA) participants overwhelmingly reported that student attendance, participation, and learning were enhanced in the WebQuest sections, and expressed a unanimous desire to continue the project into the spring 03 semester.

Students

- WISE: Students reported very positive overall experiences and a desire to continue to utilize the wireless laptops in their future courses.
- Biology: A majority of students self-reported increased engagement, enhanced learning experience, and increased satisfaction with learning outcomes.

Project Outcome (Successes and Challenges)

- The WII team expanded and improved logistical and technical support for the multi-platform environment, and developed a wider range of instructional development tools and integrated additional effective collaborative strategies.
- The Biology project has been the only WII project to date to permit a direct comparison of traditional outcome measures (test scores) between a 'control' and a 'treatment' group. The findings, while failing to achieve statistical significance, showed a strong positive trend. This, coupled with exceptionally high self-reported student satisfaction, led to one of the

most important outcomes of any WII project—a departmentally funded and supported expansion of the project to all lab sections beyond the initially funded term.

WII 2003-04: Wireless Instructional Strategies for the College of Communication and Information

Overview

Spring of 2003 presented another compelling opportunity for the ITC wireless implementation team to work with faculty to support the migration of existing technology-rich courses into the wireless teaching/learning environment. The then-recent merger of the College of Communications and the School of Information Science resulted in a blended, but not bonded, College of Communication and Information. The faculty from both programs tended to have considerable knowledge and experience in using computing and telecommunications technologies, the curricula was generally technology intensive due to the nature of the fields represented, and the move of a substantial number of 'new' faculty and students into an existing physical facility put additional strains on already crowded classroom and lab space. The opportunity for building collaborative relationships among this newly merged faculty, relieving the pressure on overcrowded and somewhat outdated classrooms and labs, and migrating courses that were already technology intensive into a wireless teaching and learning environment was irresistible. A call for proposals was issued, and faculty from the departments of Public Relations, Advertising, Broadcasting, Journalism, and Speech Communication responded. Notably and regrettably, no proposals were submitted by faculty from the department of Information Science.

This project encompassed a variety of wireless learning environments including in-class use of wireless laptop carts; semester-long, 24/7 laptop checkout; short-term (1 day to 1 week) laptop checkout for blended in-class and field-based projects; and the use of web-based assessment forms with hand-held PDAs. The latter led, ultimately, to some of the design criteria for the WII 2004 next-generation wireless project.

Participants

College of Communication and Information

- Advertising: Mariea Grubbs Hoy (note: no final report available), Sally J. McMillan
- Broadcasting: Mark D. Harmon
- Journalism: Daniel J. Foley, Sam Swan, & Barbara Kaye
- Public Relations: Lisa Fall
- Speech Communication: John Haas, Linda Sennett

Total number of students impacted: 247

Project descriptions and final reports available online at
<http://itc.utk.edu/about/archives/wii/2003/wiirec2003.shtml>

Technology

The combination of field-based and in-class learning environments led to a mix of technologies. Two separate carts of wireless laptops—one with 16 PCs, the other with 10 Macs—were provided for students to use in class or via short-term checkout. Ten camcorders, microphones, and tripods were also provided for student use in the broadcasting courses. Another 8 wireless PC laptops were set aside for long-term check out by students, and several PDAs were provided to one instructor for in-class use by students to evaluate speeches.

Customized software was required for several of the courses, including advertising-specific, statistical analysis, and multimedia editing software. For the first time, the ITC also developed a customized programming script, to collect survey data from PDAs, for one of the instructors.

Training/Support

Similarities in the courses, collegiality among the faculty, and shared goals and objectives across the curriculum, combined with variation in instructional objectives in the individual courses, technical support requirements, and logistical considerations, resulted in the need for a 'blended' model for faculty development and support. The faculty participated as a cohort for group training sessions in the summer and follow-up support/feedback sessions during the semester, but also worked individually with members of the ITC wireless implementation team on instructional design, technical and logistical support, and assessment issues for individual courses.

Although students received a basic overview regarding the use of the equipment in class by WII team members, instructors were encouraged to refer students to The Studio and OIT web-based training modules for additional, application-specific training. The presence of two in-house college technical support personnel, who utilized ghost/build images to restore malfunctioning computers to working order, helped alleviate much of the burden from ITC staff. They also assisted with the rather complicated logistics resulting from having faculty on two floors share carts for numerous classes, while overseeing equipment security via locked rooms and a central location for key storage.

Assessment/Results

Collaborative Learning

The Speech Communication capstone course exemplified the continuing theme of collaborative learning among students involved in the WII projects. Students utilized cart-based laptops for in-class group presentations, to work on senior research projects, and facilitate group decision-making.

Leveraging of Technology

The WII 2003-04 project was the first in which the technology facilitated the extension of the learning environment from the classroom to the field. Sports Reporting (Journalism) students attended a variety of sporting events on the UT campus, wrote articles, captured audio and video, and uploaded their stories from these remote athletic venues via UT's wireless network, just as professional journalists would. This was also the case with a Broadcasting course in which students moved beyond the classroom in dyads to conduct on-the-street interviews on a variety of "hot" communication or campus topics. They were forced to operate under tight deadlines while shooting and editing live video for critique by their fellow classmates.

The technology also facilitated the real-time collection of data for both instructors and students, as evidenced by Speech Communications classes in which PDAs were used to gather evaluations as speeches were being given. The computer carts also functioned as mobile training labs and enabled several faculty to conduct in-class software training without having to compete for one of the few dedicated labs available.

Formation of Nomadic Communities

An unexpected by-product of the 24/7 checkout of laptops to students in a Public Relations

course was their use of the computers to work outside of class not only on their assigned campaign development project, but also on their development of a paper/presentation for their professional society. The instructor hadn't envisioned this use, either, but was pleasantly surprised by their resourcefulness in utilizing the tools available to them.

Project Outcome (Successes and Challenges)

There will always be complicating interpersonal factors that cannot be overcome by technology. Although the WII 2003-04 project was originally envisioned as an ideal means to encourage collaboration and resource sharing among faculty from newly combined colleges, inherent political and personal factors combined to thwart this goal. However, the participating faculty projects proved that good teaching trumps political boundaries.

- Faculty participants were uniformly positive about the experience and their perceptions of the quality of student work.
- Students were generally enthusiastic about their experiences and expressed a strong desire to continue to use state-of-the-art technologies in their studies.
- WII team members were able to observe the effects of providing undergraduate students with professional quality tools and experiences.
- The College was able to observe the effects of interdepartmental collaboration and curricular innovation.

WII 2004-05: Wireless Instructional Strategies for Agricultural Sciences and Natural Resources

Overview

The fourth year of the Wireless Instructional Initiatives program might best be characterized as “going mobile.” Previous projects focused on assisting faculty from targeted colleges to leverage collaborative learning principles in conjunction with wireless computing devices to exploit UT’s campus-wide, 802.11b (now b/g) wireless network. Wireless laptops were the primary equipment utilized in prior projects, but for the 2004-05 project the WII team opted to focus on the opportunities presented by emerging mobile devices, including wireless-enabled Personal Digital Assistants (PDAs), Tablet PCs, and Global Positioning Systems (GPS) devices. Cellular phone delivery models were considered, but UT contractual limitations made those plans untenable.

The College of Agricultural Sciences and Natural Resources was selected to participate in the project based upon their stated desire and commitment to incorporate collaborative learning and wireless devices into both in-class and field-based learning activities, and specific equipment was procured based upon their needs.

Participants

College of Agricultural Sciences and Natural Resources

- Animal Science: John Waller
- Biosystems Engineering and Environmental Science: Joanne Logan
- Entomology and Plant Pathology: Bonnie Ownley, Robert Trigiano, Mark Windham, Alan Windham, & Paris Lambdin
- Food Science & Technology: Dwight Loveday and John Mount
- Forestry, Wildlife & Fisheries: Mark Fly, Jennifer Franklin, Sam Jackson, Lisa Muller, & Richard Strange

Total number of students impacted: ~150

Project descriptions available online at

<http://itc.utk.edu/about/archives/wii/2004/wiirec2004.shtml>

Technology

The WII 2004-05 project actually consisted of three smaller projects, each of which utilized a different mixture of wireless technology. All of the participating faculty members were from the same college, but each sub-project differed based upon the participants’ departments and/or specific curricular needs.

The first group consisted of the junior-class students from the department of Forestry, Wildlife, and Fisheries. Although this program encompasses three distinct majors, many of the students overlap in common courses, and all three programs utilize a “block” structure during the spring semester of the junior year in which students take all of their classes together as a cohort and participate in experiential methods of instruction via extended field trips across the country. This group was selected to participate due to the collaborative and field-based learning opportunities inherent in their program. Each of these students was issued a wireless laptop to use 24/7 during the entire academic year, and several GPS units were supplied for specific activities.

The second group consisted of faculty from the department of Entomology and Plant Pathology. Several faculty members who taught their classes in the same building determined that they could augment their instruction via collaborative activities by sharing a mobile storage cart of wireless computing devices. A set of sixteen Tablet PCs and ten digital cameras was provided, although sometimes instructors opted to check out the equipment to their students for 24/7 use for a limited duration rather than restricting it to in-class use. This sharing of communal equipment required significant logistical and curricula coordination amongst this faculty cohort.

The third group consisted of four faculty members from three departments—Animal Science, Biosystems Engineering and Environmental Science, and Food Science and Technology—teaching three different courses. Each set of students was issued a wireless PDA for 24/7 use across the entire semester. Specifically, the PDAs were Toshiba Pocket PC devices with internal 802.11b WLAN adapters and both compact flash and secure digital slots. Depending on the specific course activities, some students were also issued wireless Tablet PCs and/or PDA add-on GPS receivers or digital cameras.

Training/Support

The summer before they taught their courses, all WII 2004-05 faculty participants attended a week-long faculty development institute that focused primarily on collaborative learning models. Participants were encouraged to revisit their curricula for the purpose of developing and incorporating such group-based activities as opposed to traditional instructor-led activities. About one-fourth of the institute was devoted to training regarding the specific equipment being used in each instructor's course. Participants were also encouraged to borrow and experiment with the equipment prior to the commencement of fall classes.

Once classes began, most participants opted to dedicate a class session to having WII team members provide in-class technology training for their students. Information on technical assistance and specific, applicable uses of the equipment was posted online in course sites for students to access, and they were also given contact information for the WII team in case they needed to report any hardware or software failures. Each of the PDAs included a secure digital card with a back-up file of the unit's project configuration that the students could reinstall in the event of device failure, and a ghost image was created for the laptops and Tablet PCs so they could readily be restored to their original project configuration if needed.

Assessment/Results

Project results were obtained from a variety of sources: pre- and post-course student survey responses, faculty participant exit interviews and summative project reports, and WII team observations and experiences. Surveys of students who participated in fall 2004 WII courses indicated that over 85% believed that having access to the equipment in their class improved their educational experience, and over 85% indicated that they would like the opportunity to use the equipment in other classes, too. Over 85% also agreed that working in groups in their WII class improved their educational experience, and over 67% indicated that they either liked or loved their overall experience using the technology (with less than 10% indicating dislike or hatred).

The survey results from spring 2005 courses were similarly positive for the most part. Over 95% of the students who had been issued laptops for yearlong use reported that the laptops generally worked and that having the laptops improved their educational experiences. Over 95% also said

that they would like the opportunity to use the equipment again next year and that they loved their overall experience. Approximately 75% indicated that most or all of their instructors had incorporated the laptops into their courses, and 85% believed that they benefited from this integration. Obstacles to laptop use identified by students included limited battery life and off-campus Internet access, but the value of increased communication capabilities (e.g., email) and the benefits of field use were cited as extremely positive aspects of their 24/7 laptop access.

A distinct trend emerged among the students who had utilized a combination of Tablet PCs and PDAs in the spring. Approximately 80% agreed that they had benefited from their instructor incorporating the equipment into their classes, and the same percentage stated that they would like the opportunity to use the equipment again for other courses. However, whereas 80% said that they liked or loved their overall experience using the Tablet PCs, 53% indicated that they disliked or hated their experience with the PDAs. This may be due to the observed instability of the PDA platform. Over 80% of students stated that they had to use their PDA's reset switch at least once, and 53% reported having to restore its project configuration from a back-up file. Students also cited the PDAs' limited battery life as a significant obstacle to their use of the devices.

Project Outcome (Successes and Challenges)

Faculty participants and WII team members noted/observed:

- The relevance of the technology and application of course content to professional realms. Several students and faculty members noted that WII activities and equipment closely mimicked actual workplace experiences in their fields and offered the opportunity to teach skills valued by employers.
- A desire to maintain and increase the integration of technology experienced in the project throughout the curriculum. Many faculty participants formulated plans to sustain and expand upon their projects and activities from the current year. Based upon the success of its WII course, one department is considering expanding PDA use across their entire curriculum.
- The engagement of students to educate/help each other. Despite language barriers and differences in content knowledge, collaborative projects apparently helped foster a sense of shared responsibility and investment by students in both the process and product.
- An increase in efficiency as the semester progressed. Students became more proficient in their technology use and group work during the course of the semester, and their survey responses echoed this observation.
- The emergence of non-intuitive student leadership patterns. Several group experiences led to the development of separate and distinct roles of team leaders and motivators.

WII 2005-06: Wireless Instructional Strategies for Agricultural Sciences and Natural Resources, Year 2

Overview

The original plan for the WII 2004-05 project was to provide laptops to just junior-year students in Forestry, Wildlife and Fisheries (FWF) to facilitate collaboration among the targeted student cohort. However, this seemed inefficient given that the rising senior-level students were already familiar with and had incorporated the laptops into their learning. In fact, a group of juniors petitioned to allow their class to keep their laptops through their senior year. Therefore, the WII team opted to extend the project's technology-enhanced cohort to the FWF seniors as well. The ITC funded the purchase of a new set of laptops to distribute to the junior cohort, thus enabling the senior-level students to retain their same laptops from the year before.

Also, having issued PDAs to teams of freshmen students during the WII 2004-05 project, the two faculty participants in Food Science and Technology (FST), Dwight Loveday and John Mount, decided to expand the project for WII 2005-06 by distributing additional PDAs to a few other instructors and some upperclassmen as well for use in other FST classes.

The WII team also consulted with John Waller in Animal Sciences and Robert Simpson, Associate Superintendent of the Knoxville Station, regarding a project to track cattle movement in designated 3-acre lots on the UT Blount Farm. The Blount Farm had requested estimates from private consultants to set up a wireless network and asked to meet with the ITC WII team along with one of UT's wireless network engineers, Philippe Hanset, for advice. The researchers were hoping to collect real-time data in 15-minute intervals, with the data ideally sent to a central server and made available for access via the Internet.

Participants

College of Agricultural Sciences and Natural Resources

- Animal Science: John Waller
- Food Science and Technology: Dwight Loveday & John Mount
- Forestry, Wildlife & Fisheries: Matt Gray, Don Hodges, Billy Minser, Lisa Muller, David Ostermeier, & Larry Tankersley

Project descriptions available online at

<http://itc.utk.edu/about/archives/wii/2005/wiirec2005.shtml>

Technology

The FWF department received an additional 40 Dell Latitude D610 laptops and 6 combination GPS/PDA units (Trimble Geo XM) and software licenses for GIS data analysis (Terrasync Pro & GPS Pathfinder Office). The department of Food Science and Technology was given 32 additional Palm Tungsten C PDAs to be used by their students and faculty.

Training/Support

The ITC provided substantially less training and support to the FWF faculty participants for the WII 2005-06 project than for the WII 2004-05 one since many of them also taught junior cohort courses and hence had already received training the prior year. There was a general training session one afternoon for faculty teaching the senior cohort, and most participants opted also to

schedule one-on-one consultations with WII team members during the summer (as opposed to the previously utilized multi-day, mass training sessions). Participants also availed themselves of ITC assistance with the Blackboard course management system. Little support was provided for the GPS units and software as they were very specialized and the faculty participants were already familiar with them. No training was provided for the FWF students by the WII team.

Instead of providing live, in-class training regarding the PDAs for the Food Science and Technology participants, as had previously been done, the WII team developed a quick start reference manual with the assistance of members of the ITC START (Student Technology Assistants for Research and Teaching) team and distributed it to students along with the actual PDAs.

Assessment/Results

FWF senior cohort

Surveys of senior FWF cohort students after the fall 2005 semester indicated that:

- Although ~60% of the students indicated they were “very comfortable” using a laptop and another ~20% said they were “comfortable”, approximately 20% said they were “very uncomfortable” using one. This was somewhat surprising given that the students had had/used the laptops for the entire previous academic year.
- Approximately 75% of students reported that they “almost always” took their laptop to on-campus classes, with 85% saying they used them “often” or “almost always” during those classes.
- Approximately 50% of students said they “often” took their laptop to field-based classes, with ~52% reporting that they used their laptops “occasionally” in those classes.
- Over 70% of students said “all” or “most” of their instructors incorporated the laptops into their courses.
- Over 80% of the students “strongly agreed” that their learning experience that semester was improved by using the laptop on their own in the classroom, on their own outside of class, and in groups outside of class, with a similar percentage indicating they “agreed” or “strongly agreed” that using them in the field also improved their learning experience.
- Ninety-five percent said they “loved” their overall experience using the laptop.
- All the students “agreed” or “strongly agreed” that having a laptop that semester improved their educational experience and that they benefited from their instructors’ incorporation of laptops into class.

At the conclusion of their second year and final semester (spring 06) using the laptops, the senior students reported the following information via a survey:

- The laptops were used most frequently for email, presentations, and papers/projects.
- All the students said they “loved” their overall experience using the laptop over both years.
- Approximately 90% of the students “agreed” or “strongly agreed” that having a laptop improved their educational experience and that they benefited from their instructors’ incorporation of them into classes.

FWF junior cohort

Survey results from junior FWF cohort students after their fall 2005 courses were similar to responses from the previous year. Over 75% believed that having access to the equipment in their class improved their educational experience, and over 90% indicated that they would like

the opportunity to use the equipment again next year. All of them indicated that they either liked or loved their overall experience using the technology, and over 70% said “some” or “most” of their instructors incorporated the laptops into their courses. Somewhat surprisingly, ~40% said they never took or used their laptops on field-based classes. Also, although all the students agreed that their laptop generally worked, many said technical problems were the most significant obstacle to using the laptops during the semester.

The survey results from juniors after their spring 2006 courses were similarly positive. All of the students who had been issued laptops for year-long use reported that having the laptops improved their educational experiences, that they would like the opportunity to use the equipment again next year, and that they either “loved” or “liked” their overall experience. Approximately 50% indicated that some of their instructors (with over 35% indicating most or all) had incorporated the laptops into their courses, and 100% believed that they benefited from this integration. Interestingly, 75% of the students were neutral as to whether using the laptops in the field improved their learning experience.

FST survey results

Although over 80% of the FST students indicated on an initial student survey that they were comfortable or very comfortable using computers, one-half of them reported that they had no experience using a PDA, with another one-third indicating just “little” or “some” experience. Unfortunately, the analysis of this particular sub-project is incomplete since the two faculty participants never submitted a final report to the ITC or had their students complete a final survey, despite numerous requests from the WII team. This is particularly regrettable as all of their students had articulated classroom PDA activities that they thought would be most valuable, primarily focused on improving communication and organization.

Blount Farm project

The WII team investigated using GPS collars or other tracking technology for this project, but the expense was prohibitive. The most viable option appeared to be to use satellite dishes to “beam” an Internet connection to/from a nearby farmhouse and to set up multiple wireless access points to create an 802.11 wireless (WiFi) network covering ~18 acres, and then to equip six test cattle with some type of transmitters whose location could be determined within 1 meter by a wireless network. WiFi technology presented an opportunity for groundbreaking research, but various obstacles such as the need for long battery life, small transmitters, triangulation software, and site mapping led to the abandonment of the project. Given the importance of reliable, safe, and verifiable food chain monitoring, though, this project may warrant continued investigation.

Project Outcome (Successes and Challenges)

Given the similar nature of the WII 2004-05 & WII 2005-06 FWF laptop projects, many of the observations by WII team members and faculty & student participants were redundant. However, there were a few new ones to report:

- Due to other ongoing projects, WII team members had less time and fewer resources to devote to the WII 2005-06 project than in previous years.
- The most valuable laptop activity reported by the FWF students was conducting research.
- Students reported that the most significant obstacles to using the laptops were weight (when carrying), limited battery life, and the difficulty in finding compatible printers.
- Although ~90% of the students believed that having a laptop improved their educational experience and all of them said that the FWF department should continue to provide

laptops to students, ~90% said incoming juniors should not be required to purchase their own laptops. However, upon graduation students did want the option to purchase the specific laptop they had been using in the program.

WII 2006: Wireless Instructional Strategies for Nursing

Overview

The College of Nursing sought to explore the use of mobile learning (m-learning) tools in a cooperative learning model for both clinical and didactic learning. Although research had demonstrated the usefulness and satisfaction of students who use PDAs as a reference tool during clinical situations, the faculty participants believed that little was known about how the PDA and associated applications enhance collaborative learning in both the clinical setting and the classroom. Therefore, the goal of this pilot educational action research project was to explore ways m-learning could be used to enhance collaborative learning in clinical and classroom nursing education for nurse practitioner students located centrally and at a distance.

During the implementation of this project, student experiences were to be measured using educational action research methodology. While the specific plan of action for this proposal was initially undetermined due to the nature of action research, it was anticipated that PDAs and collaboration tools such as SharePoint® would be used to promote cooperative learning by synchronously connecting learners at a distance and as references and/or diagnostic tools during clinical learning opportunities. The results of this pilot were to guide a future study whereby UT students would collaborate with students at two other universities during clinical and classroom learning using similar tools, applications, and instructional strategies.

The purpose of this research project was to determine if m-learning technology and techniques using a cooperative learning model enhance the didactic and clinical learning of nurse practitioner students. Specifically:

- With the assistance of ITC staff, the investigators and research assistants identified and examined various handheld tools commonly used in healthcare and education, and strategies that promote collaborative/cooperative learning.
- Selected m-learning tools and teaching strategies were used in UT's Pediatric Nurse Practitioner (PNP) program. During focus groups, students described their experiences using these tools and teaching strategies and helped modify current assignments and strategies based on their experiences.
- Based on the results of the focus groups, an action plan for teaching and m-learning would be implemented to include family nurse practitioner students at University of Alabama, Birmingham and Shenandoah University. Additional focus groups would also be conducted with these students.

Participants

College of Nursing

- Pediatric Nurse Practitioner Program: Tami Wyatt and Nan Gaylord

Total number of students impacted: 15

Project description available online at

<http://itc.utk.edu/about/archives/wii/2006/wiirec2006.shtml>

Technology

A total of 20 PDAs that included memory cards and a variety of discipline-specific software

were distributed to the faculty participants, a graduate student assistant, and the graduate nursing students. Applications were installed on the PDAs to facilitate file sharing, text chat, and polling. Equipment was also procured to enable the instructors to project their PDA screens to the class and to establish a PDA station in one of the student labs.

Training/Support

ITC staff members conducted an extensive planning session with the faculty participants in November 2005, but since the primary faculty participant on this project has a graduate degree in instructional technology and previous experience with PDA-based instructional projects, very little training was necessary. Student training was handled by the faculty participants in conjunction with their designated graduate student.

Technical support for the PDAs was centralized via a PDA station that was established in one of the nursing student labs. At the station, students could download applications, synchronize files, and recharge the PDAs without having to load the necessary handheld applications on their home computers.

Assessment/Results

A pre-test survey was administered to the pediatric nurse practitioner students to determine their previous PDA experiences and their preferred learning methods regarding a PDA. In the spring of 2006, students completed a post-test survey and participated in a 90-minute focus group to examine their learning experiences by answering such questions as: 1) how did using a handheld and resources influence learning in this course, 2) how did cooperating with other learners using a handheld influence your learning, and 3) what recommendations do you have to improve learning.

Pre-test and post-test surveys were compared using only descriptive statistics due to the small sample size. Focus group data were analyzed using multi-step heuristic method of evaluation. First, initial content analyses were performed at the focus group level to determine differences in subject responses in three phases: coding, categorizing, and creating a descriptive summary. Next, field notes were examined for themes with the goal of revealing and refining categories or themes. Finally, subjects proposed ways to enhance learning with the PDAs and associated applications during the focus group.

All of the students used their handheld either daily or three times a week. Students preferred resources were 5 Minute Clinical Consult® and ePocrates®. There were no changes between pre-test and post-test perceptions in the usefulness of the PDA for classroom learning. All participating students valued the ability to share resources, emails, documents, etc with students using their handheld.

The focus group revealed that one participant was not given permission by her preceptor to use her PDA as a reference during her clinical experience. This impeded her ability to fully use her PDA as a reference and, therefore, she limited her use of the PDA altogether, including classroom case study discussions. All students wanted to continue using the PDAs as a resource during clinical experiences and to discuss case studies, share images from clinical experiences, and build case studies for one another. Students suggested integrating more treatment discussion in the case studies while using the various PDA resources.

Project Outcome (Successes and Challenges)

Due to unforeseen legal matters related to purchasing equipment and disputed End User Licensing Agreement terms, the PDAs and the associated applications were not available to students until the last month of the semester. For this reason, the PDAs were not fully integrated into the class as planned. This likely influenced the students' experience and perceptions of the usefulness of the PDA for classroom learning. To address this shortcoming, the pilot study was extended to include another group of students during summer 2006. The PDA was fully integrated into the classroom experience from the beginning of the semester, and students had more opportunity to collaborate with one another during learning exercises.

Overall, students from spring and summer 2006 were most satisfied with the health care applications and resources that were available to support their clinical learning experiences. Students also liked using the PDAs to organize their coursework, manage their time, and to share resources and files with one another. Those students who were most enthusiastic about the PDA applications investigated PDA freeware on the Internet and shared their findings with classmates. The participants in the project found Skype®, the application used to connect with one another in cooperative learning experiences, cumbersome and difficult to use. The students also reported less value in the ClassInHand™ application that was used as a classroom response system because the class sizes were no larger than 10 students allowing students to respond verbally.

Establishing the networked PDA support station also proved more challenging than anticipated and required extensive assistance from the college's IT support personnel, including the writing of installer programs.

As with all technology-based projects, students experienced technical difficulties. Despite the students having a help desk telephone number, technical assistance available via email, and the faculty meeting with them on a regular basis, none of the students reported their technical difficulties with the wireless access. Educators that use PDAs for learning must provide online resources, tutorials, and training because students will not necessarily seek the technical assistance that is available. Further, more practice and guided instruction in the classroom will identify some technical issues that might occur outside the classroom.

During the fall 2006 and spring 2007 semester, more refined m-learning strategies were developed based on the findings of this pilot study. Students from UT connected with students from another southeastern university to learn in a cooperative learning model. The students used various healthcare applications to support their cooperative case study work and used Skype® to connect with one another. More experienced learners were paired with novice learners. Students also used SharePoint®, the collaborative management system, to host their shared documents and case studies. Participants in the study had various suggestions about how to effectively use m-learning. For example, students reported they would not use Skype® for voice connections when they could use their cell phones but they would use it for international collaborative work with students. Participants also suggested that the voice recording capabilities of the PDA could help students learn how to dictate patient assessments.

Nurse practitioner students and undergraduate students are currently using PDAs as a reference tool and as an organizer. Students are not required to purchase PDAs but those that were purchased for the above study are available to students during clinical learning experiences. Nurse practitioner students are also using the voice recording features to practice dictation and

continue to use the references while discussing case studies in class. For future studies, faculty are exploring future collaborations with international colleagues in Thailand.

Conclusion

Wireless networks present a unique opportunity for educational institutions to untether from the physical infrastructure and expand beyond the walls of the classroom into less formal learning spaces. Students have, of course, been utilizing informal learning spaces all along, but they were previously constrained by the necessity of having to take any information resources or supplemental materials they might need with them. That often restricted group study or teamwork sessions to the library, the university center, or common areas in the residence halls that might (or might not) have Internet access. Ubiquitous campus wireless networks, such as UT's, offer the potential for students to work, individually or in groups, almost anywhere on campus, and the inclusion of "mobility tools"—email, web browsers, discussion boards, and chat rooms—enable students who are not physically present on campus to participate in collaborative work with their peers as well. Wireless networks translate into mobility, which translates into opportunities to learn from anywhere, at any time.

There are some issues that can prevent the realization of the wireless network's full educational potential. Although a variety of devices can access the network, faculty cannot presume their students can make use of it absent a department, college, or university requirement for such devices or laptops. It would require substantial effort to provide uniformly configured laptops and support to all students in any given program, but UT could consider specifying a set of recommended standards to help ensure that all student machines exceed a minimum computing power and have particularly useful software applications. This would allow faculty to model their teaching activities accordingly. There is also potential for Internet-connected laptops to pose a distraction to students in class. However, it has always been an option for students to disengage from lecture classes and let their minds wander; it remains the responsibility of faculty to make classes sufficiently interesting and keep students cognitively engaged. Networked computing devices offer faculty with adequate awareness and preparedness the opportunity to increase student engagement by harnessing online resources.

The explosive growth, ready availability, and increasing sophistication of online information resources and collaboration tools present a host of challenges, some technological, some pedagogical, some logistical, and some administrative. Among those immediate challenges are:

- Developing, disseminating, and supporting strategies teachers can use to create, nurture, and maintain active, engaged online collaborative learning communities.
- Ensuring equitable, reliable, sustainable access to online information and resources.
- Creating, fostering, and sustaining a high degree of high quality interaction and collaboration among students, faculty, and external resources.
- Overcoming the strong bias of faculty for creating and producing paper-based academic work, teaching materials, and assessment instruments.
- Promoting quality and quantity of feedback. One of the "Seven Principles for Good Practice in Undergraduate Education" (Chickering & Gamson, 1986) is providing rich and rapid feedback. If an instructor only meets with students in a face-to-face environment for two to four hours a week, they have a limited amount of time to provide feedback, and the quality of that feedback is limited by time and location pressures.
- Developing models of accountability that primarily define units of learning using something other than contact hours or seat time, which don't transition well to extended learning environments, as the basis of certifying competence.

- Accommodating the greater pressure on network bandwidth and resources, and increased network latency, that inevitably results from achieving the goal of more faculty generated digital content and increased student access to that content.

On the other hand, the presence of a reliable ubiquitous wireless network affords many attractive opportunities:

- It provides a reason for individual faculty members to increase their repertoire of innovative strategies and to transition from teacher-directed to learner-centered activities.
- The network, and associated communication applications, facilitates collaboration.
- Having 24/7 access to information and networked resources from virtually anywhere has the effect of minimizing temporal as well as geographic barriers to access and increasing flexibility & choice by several orders of magnitude.
- The always-on nature of networks gives faculty (and peers) the ability to give and receive rich and rapid feedback, thereby reducing the amount of time and effort invested in pursuing inaccurate, incomplete, or irrelevant lines of inquiry. It also reduces the amount of time and energy “wasted” on redundancy or duplication of effort in collaborative activities.
- The anytime/anywhere nature of ubiquitous wireless access requires rethinking existing models of what constitutes a “learning environment” and beginning to reconceptualize learning as something that occurs continually, along a continuum, rather than at specified times, in discreet units.
- Faculty, students, and content material experts can easily create, produce, and distribute, on a more personal level, all manner of text, visual, audio, video, and animated content.
- Each person now has the ability to contribute to the available resources on the network when it is most convenient. They can document and record activities, experiences, and insights anywhere, anytime, then add to the knowledge base on the network from wherever they happen to be.
- Finally, with access to the learning process via archived discussions, multiple iterations of work products, and multi-modal representations of ideas, teachers can capture their students’ patterns of thinking rather than having to rely on the “snapshot” of student understanding most often captured by in-class assessment tools.

Lessons Learned

Following are some specific lessons learned from the WII projects and considerations for future projects:

- Above all else, technology should not interfere with the teaching and learning process. Extensive technical support for both faculty and students had a dramatic impact on the success of the WII projects. Real-time support is ideal as class time is a precious resource that cannot be recovered once lost. There is great potential to leverage existing resources such as Technology Enhanced Classroom support and the Student Technology Assistants for Research and Teaching (START) program to assist in these efforts.
- The importance of faculty training cannot be overemphasized. It is likely the most crucial element affecting the success of such projects; even unbridled enthusiasm and natural talent cannot compensate for preparation and equipment familiarity. Faculty must be able to not only use but also pedagogically leverage the technologies in order to enhance student learning (e.g., the College of Engineering’s laptop requirement—if faculty aren’t

aware of how to incorporate laptops into their curricula, what good is it to require students to purchase them and bring them to class?).

- Instructor attitude and willingness to model a flexible and experimental approach is of crucial importance and significantly impacts the attitudes of students and their willingness to adopt emerging technology. The level of student adoption of the various technologies associated with such a project appears to be a direct function of their integration into course syllabi and activities as well as of faculty expectations.
- Just because a given technology is readily available and familiar, that doesn't mean it is the right technology to use. In the case of the Blount Farm project, it would have required far more effort than it was worth to establish a wireless network and customize wireless transmitters for the cows.
- Equipment compatibility and functioning cannot be taken for granted. Several peripherals were discovered not to be compatible across all Wii devices. This led to the need for last-minute workarounds for preplanned activities. It is always best to test an identical configuration beforehand, whether it's a laptop & projector, computer & video file, or an audio file & a set of speakers. Therein lies the value of "safe" environments where faculty can practice and perfect their skills without an audience, such as the Practice Presentation Room in The Commons.
- Instructors cannot assume student familiarity with technology. The results of the Wii 2004 student surveys indicated that more than 25% had no previous experience with PDAs and over 50% had no experience with Tablet PCs. Although most students appear to have become quite familiar with standard laptop technologies, this assumption of all students can result in difficulties for some.
- Faculty, staff, and administrators aren't the only ones who desire to maintain successful integration of technology in a class or project—the students who experienced success consistently expressed a desire to extend the integration throughout their curriculum. The Wii team had experienced faculty wanting to sustain and expand upon projects from current years, but Wii 2005-06 was the first time there was a strong push from students to extend the project another year (into their senior year). Never underestimate the addictive nature of success!
- Faculty enthusiasm often wanes prior to implementation of transformation. Although it can result in meaningful change, purposeful review of syllabi/curricula requires significant time and effort on the part of faculty participants. Ideally, incentives could be provided to encourage the growth and evolution of faculty goals. Faculty should receive recognition for taking the time to learn, develop, and use/implement new technologies to enhance their students' learning. At the same time, there is a need to ensure adequate accountability for participants before committing limited resources.

Future Opportunities

In the short time between 2000, when they were new, unstable, and relatively unknown, and 2007, wireless networks have proven to be so transformative that they are not only an accepted utility but an expected one. But today's wireless networks are not the end of the story. Twenty-first century education will not happen in isolation; it will be an ongoing conversation between the teachers and learners, who have specific educational objectives to achieve, and the technologists and system integrators, who have the responsibility to create, deploy, and manage the infrastructure and applications required to meet those expectations. Emerging technologies to support even more flexible learning environments include proximity-aware and location-enabled

devices and applications, converged devices that support both Wi-Fi and cellular connections, and platform-independent applications that ease the restrictions of proprietary hardware and software systems.

There has been interest in higher education in the possibility of utilizing student cell phones, an almost pervasive technology, for educational purposes, but many students view this as an intrusion upon their privacy, especially when they incur out-of-pocket charges for text messaging or Internet connectivity. OIT has investigated smart phone (combination cell phone and PDA) programs such as MobileU (<http://mobileu.wfu.edu/>) at Wake Forest University, but these normally entail the university specifying a particular model of cell phone for students; an option that might not be well received. Similarly, location-based information has lots of potential, and UT's wireless network could possibly be utilized for such purposes (e.g., receiving botanical or historical information when in the immediate vicinity on campus), but there are privacy concerns and technical limitations. Classroom response unit "clickers", which have proved quite valuable for immediate feedback, are also appealing to faculty and have the potential to be utilized via a wireless Internet connection, regardless of device.

As more and more technologies—cell phone, MP3 player, PDA, digital camera, GPS, Internet browser, and classroom response unit—converge into a single device, the appeal of using such a device for educational purposes will be undeniable. However, there is no guarantee of students having devices, nor the likelihood that an overwhelming majority of them will be using the same one, absent a university requirement. Such a decision could be made on a unit-by-unit basis, but the university could benefit from economies of scale by making a centralized decision regarding a specific device to be supported.

Whatever the specific technology utilized in conjunction with UT's wireless network in the future, it is essential that collaboration and student-centered learning continue to be promoted, and that the university provide the support and infrastructure necessary to facilitate faculty adoption of collaborative technologies for educational purposes in order to keep the institution competitive in attracting prospective students. Collaborative learning also has immense value as real-world preparation for UT students; the nature of work in the information age is such that few people work in isolation. Therefore, UT would behoove its graduates as well by incorporating this design into their learning experience.

UT was ahead of the curve in 2000 by installing and deploying a wireless network that, at one time, was the largest of its kind in the United States. That network now serves as a great resource that should not just be maintained but also leveraged in new and innovative ways to maximize return on the initial investment. Whatever the device used to access the network—be it a Personal Digital Assistant, Tablet PC, Internet-enabled cell phone, or laptop computer—it is likely to be utilized in an unforeseeable variety of methods by a diverse set of users. UT should seek to capitalize upon, and expand, existing online resources and collaborative applications, such as the Online@UT/Blackboard course management system or synchronous collaboration tool, that can be leveraged in conjunction with the network to enhance the learning experience for and academic environment of students.