Utilizing Wireless Pocket-PCs to Promote Collaboration in Field-based Courses

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Abstract
The Innovative Technology Center at The University of Tennessee, USA, is currently facilitating the fourth year of the Wireless Instructional Initiatives (WII) project, an ongoing effort to encourage faculty to incorporate collaborative learning principles and wireless technology, via the existing campus-wide 802.11b/g wireless network, into their teaching. In previous years the project has equipped students with wireless laptops and digital cameras, but during the 2004-2005 academic year wireless Pocket-PC devices, with add-on cameras and GPS receivers, and Tablet PCs were distributed to students in three courses which will utilize the equipment for field-based activities and data collection: food science, animal science, and environmental science (GIS-focused).

Prior to the start of classes, faculty participants from the College of Agricultural Sciences and Natural Resources attended a faculty development institute designed to help them infuse collaborative learning activities and the mobile technology into their course curricula, with a particular emphasis on group projects. The WII team also provided initial equipment training for the students and supplied ongoing assistance and technical support for faculty participants. This year students have been using the devices for a variety of activities including diet analysis, exercise tracking, and GIS data collection, and faculty have begun incorporating student response system and synchronous communication applications as well.

This paper will share experiences and lessons learned from the project, which was completed in May 2005. Data gathered includes pre- and post-course student surveys, faculty interviews, and summative project reports submitted by faculty participants, coupled with ongoing WII team observations.

Keywords
wireless Pocket-PCs, field-based learning

1. A brief history of University of Tennessee wireless project

In October 2000, the University of Tennessee committed to an ambitious, $4.5 million initiative to create a ubiquitous wireless computing environment, by August 2001, encompassing 15 million net assignable square feet in 110 academic, research and administrative buildings and serving 26,000 students and 4,200 faculty and staff.

The staff of the Innovative Technology Center (ITC) viewed teaching faculty to use this pervasive computing resource effectively as an essential element of this campus-wide network and accepted the challenge of addressing the pedagogical implications, training requirements, and technical support issues posed by this dynamic new environment. The focus of the project was on using wireless technologies to support the primary objectives of encouraging and facilitating the use of collaborative learning activities and implementing the Seven Principles of Good Practice in Undergraduate Education (Chickering and Gamson, 1987).

2. The Wireless Instructional Initiatives Project
In March 2001 the Wireless Instructional Initiatives (WII) team began by designing and implementing faculty development, logistical, and technical support strategies. The 2001 Wireless Instructional Strategies in Humanities (WISH) project served over 350 students with 32 wireless PC laptops for use during scheduled class meetings. Project details may be found at http://itc.utk.edu/grants/wish2001/.

The 2002 Wireless Instructional Strategies in Engineering (WISE) project focused on creating collaborative learning communities in the engineering curriculum and extended support from cart-based classroom use to 24 hours a day, 7 days per week student checkout use. Project details may be found at http://itc.utk.edu/grants/wise2002/. A concurrent project involved the biology department 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. This involved the creation and use of three WebQuests based on contemporary issues. http://itc.utk.edu/grants/wise2002/wii_biology.shtml.

The 2003 WII project involved 7 faculty from 4 departments serving nearly 250 students in the College of Communication and Information, and support was provided for classroom based carts and 24/7 laptop loaners. http://itc.utk.edu/grants/wii2003/.

3. Overview of 2004-2005 project

The College of Agricultural Sciences and Natural Resources was selected to participate in the 2004 Wireless Instructional Initiatives project because their proposal included several unique opportunities to deploy wireless computers, PDAs, and peripheral equipment, plus a variety of standard productivity software and course specific software, in field-based educational activities. The project involved 14 faculty from 5 departments serving over 130 students in the college, and is the subject of this report. Support included a summer faculty development institute, monthly meetings and ongoing logistical and technical support.

3.1 Selection of participants

Participants were selected based upon evaluation of solicited proposals for evidence of technology integration in support of collaborative learning objectives. Proposals that included field-based use of wireless technologies as opposed to strictly in-class use received priority consideration. Limited resources did not permit the purchase of all of the requested hardware and software. Faculty participants were consulted, and appropriate compromises were reached on the kind and quantity of hardware and software provided. All faculty participants felt that they could meet most, if not all, of their objectives with the hardware and software available. The proposals that were awarded may be viewed at http://itc.utk.edu/grants/wii2004/wii04rec.shtml

3.2 Equipment utilized

50 Dell Latitude D600 laptops
22 Toshiba Portege M200 Tablet PCs
20 Toshiba e755 Pocket-PC PDAs
30 256MB SD memory cards
7 Veo PhotoTraveler CompactFlash PDA cameras
8 Pharos Pocket GPS Portable Navigator CompactFlash PDA units
10 Kodak EasyShare digital cameras
10 Garmin Rhino 120 GPS units
15 Fisher temperature probes
5 Kestrel 3000 mobile weather gauges

3.3 Software

Keyoe Diet & Exercise Assistant
Behave Plus (Fire Modeling System)
FOFEM 5.0 (First Order Fire Effects Model)
ArcPad (Mobile GIS and Field Mapping)
ArcView (GIS visualization and integration)
MS Office Pro
MS OneNote
DreamWeaver MX
Photoshop Elements
Endnote 7

3.4 Training

Faculty participants attended a summer development institute in which they received an overview of the hardware, software, and networking technologies they would be employing. They then worked collaboratively with each other and the ITC wireless implementation team to develop and refine the collaborative learning strategies and activities they would be using to facilitate student learning in their courses. Finally, the ITC wireless implementation team provided in-class training on the use and care of the wireless devices for students in all of the courses.

3.5 Technical support

The ITC wireless implementation team developed and disseminated documentation on the setup, configuration, and use of each of the wireless devices, including how-to guides for performing network synchronization and file sharing. The ITC team also created disk images of the laptops, Tablet PCs, and handheld devices in order to provide system recovery in the event of disk failures or malfunctions caused by malware. Since disk images cannot salvage user data, the ITC team provided SD cards and CDRW drives and instructed students in how to use them and network servers to save and back up user created files. The ITC team also worked with the university's network services staff to install a solar powered remote access point in the Trial Garden area on the Agriculture and Natural Resources campus. This outdoor wireless "hot spot" would serve as an on-campus training and testing area.

4. Courses & activities

4.1 Food Science & Technology, Fall 2004

Students in the Food Science and Technology course utilized PDAs, PDA cameras, and temperature probes to gather on-site data from grocery stores, restaurants, etc. They also utilized them to track nutritional and wellness data throughout the duration of the semester.

Diet tracking and nutrition analysis. As part of the food composition section, students recorded daily food intake and submitted data to an internet nutrition calculator. PDAs allowed students to easily collect food consumption data for an extended time period to reflect a more accurate dietary nutrient composition. The Keyoe Diet and Exercise tracking software on the PocketPC allowed students to record dietary and exercise data conveniently and accurately throughout the day.

Meat purchasing problem. Students compared purchasing a meat gift pack from a local grocery meat counter with internet mail order gift packs. Students used PDAs to collect meat prices and at local markets. MS Excel templates were provided to guide the decision-making process.

4.2 Biosystems Engineering and Environmental Science (BEES), Spring 2005

GPS data collection and GIS analysis. BEES students used PDA-based GPS units to collect data in the field for later GIS software analysis. They also used Tablet PCs in conjunction with ArcView software to annotate GIS maps while in the field, and their instructor experimented with incorporating a wireless student response system (ClassInHand) and instant messaging/VoIP application (Skype) into course activities.

4.3 Beef Cattle Production & Management, Spring 2005

Specimen photos for group presentations. Students utilized PDA cameras and Tablet PCs to capture specimen photos and other data while in the field for future use in group projects and presentations. This instructor also attempted to incorporate UT's existing course management system (Blackboard) into the process.

4.4 Forestry, Wildlife, and Fisheries, Fall 2004 and Spring 2005

Field data collection and analysis. During the fall semester, students in this program were attending residential classes, and utilized their wireless laptops for a variety of group projects in their courses. However during the spring semester, they undertook a variety of field trips around Tennessee and to other U.S. states (Colorado, Georgia, South Carolina, Kentucky, and Kansas) to gather weather and geographic data in the field for projects such as data analysis for developing fire modeling scenarios. They also used handheld GPS units to gather coordinates from state hiking trails and import the data into GIS software to topographically document them.

4.5 Entomology and Plant Pathology

Multiple activities and courses. Faculty participants from this department utilized the cart-based Tablet PCs and digital cameras for a variety of courses. A plant entomology course partnered PhD and MS students, each assuming a different role, to research and write actual grant proposals. Plant genetics students utilized a WebQuest to solve scientific problems related to genetically modified organisms, and then worked in

teams of four to collaborated on a 15-page paper and corresponding web-based presentation. Students in a plant pathology course gathered images of and data on diseased plants around campus, which they then uploaded to a central Agricultural Extension database for on-demand analysis and distance diagnosis by agents across the state in Nashville. Based upon the success of this project, the instructor opted to utilize GPS coordinates in locating future specimens.

5. Results/Outcomes

Project results are 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. Due to small sample sizes (Fall = 92, Spring = 37) and incomplete data sets from some courses we have determined that the data gathered cannot be analyzed in any statistically meaningful way. Instead, the student responses will be reported as "general impressions" gleaned from the usable survey data, and "anecdotal evidence" as expressed in student comments. For the purpose of this discussion, then, unless otherwise noted a "majority" will mean 50 to 75% and a "substantial majority" will mean anything above 76%.

5.1 Student responses

5.1.1 Pre-course survey results

5.1.1.1 Fall 04 sections.

Prior experience with the technologies.

A substantial majority said they were "comfortable" or "very comfortable" with computers and that they either "owned" or had "reliable access" to a computer beyond access to university computing labs. Software and application experience tended to be limited to using email and web browsing, to which a substantial majority responded that they had "high" or "extensive" experience. Less than half claimed similar experience with spreadsheets, and less than a quarter claimed similar experience with databases and statistical software. Nearly half of the respondents claimed "high" or "extensive" experience with a wireless laptop computer and digital cameras, but reported experience with PDAs, Tablet PCs, and GPS devices was less than 20% in nearly all courses surveyed.

Prior experience with collaborative (group) work.

A substantial majority agreed or strongly agreed that they had experience working in groups, were comfortable working in groups, and believed that working in groups would enhance their educational experience. A majority also expressed the belief that using the technologies on their own or in groups would enhance their educational experience. A substantial majority expressed the following beliefs: that the ability to collaborate with peers was necessary to be successful as a student; that the ability to collaborate was a valuable skill; that they had a positive attitude towards collaborating with fellow students; that collaborating with peers will help them in their career; that solving problems in a group is an effective way to learn; and that solving problems in a group is an effective way to practice what had been learned. A majority agreed or strongly agreed that "group decisions are often better than individual decisions" and "solving problems in groups leads to better decisions than solving problems alone."

5.1.1.2 Spring 05 sections.

Prior experience with the technologies.

A substantial majority said they were "comfortable" or "very comfortable" with computers and a majority said that they either "owned" or had "reliable access" to a computer beyond access to university computing labs. As with the Fall 04 courses, software and application experience tended to be limited to using email and web browsing, to which a substantial majority responded that they had "high" or "extensive" experience. A bare majority claimed similar experience with spreadsheets, and less than a quarter claimed similar experience with databases and statistical software. About a third of the respondents claimed "high" or "extensive" experience with wireless laptop computers and digital cameras, but reported experience with PDAs, Tablet PCs, and GPS devices was less than 10% in all courses surveyed.

Prior experience with collaborative (group) work.

A substantial majority agreed or strongly agreed that they had experience working in groups and were comfortable working in groups. A majority believed that working in groups would enhance their

educational experience. A majority also expressed the belief that using the technologies on their own or in groups would enhance their educational experience. A substantial majority expressed the following beliefs: that the ability to collaborate with peers was necessary to be successful as a student; that the ability to collaborate was a valuable skill; that they had a positive attitude towards collaborating with fellow students; that collaborating with peers will help them in their career; that solving problems in a group is an effective way to learn; and that solving problems in a group is an effective way to practice what had been learned. A bare majority agreed or strongly agreed that "group decisions are often better than individual decisions" but unlike the Fall 2004 courses the majority did not believe that "solving problems in groups leads to better decisions than solving problems alone."

5.1.2 Post-course survey results

5.1.2.1 Fall 04 Sections

Post-project surveys of students who participated in Fall 2004 courses indicate that a majority of them used the supplied laptops "more than half the time" or "almost always" for coursework beyond the courses involved in the WII project. A substantial majority believed that having access to the equipment in their class improved their educational experience, that their courses that participated in the WII project met or exceeded their expectations, and that they would like the opportunity to use the equipment in other classes, too. A substantial majority also agreed that working in groups in their WII class improved their educational experience, and a majority indicated that they liked or loved their overall experience using the technology. Only one of the 54 respondents to the question stated they disliked using the technology.

5.1.2.2 Spring 05 Sections

Post-project surveys of students who participated in Spring 2005 courses were divided between those that used laptop computers exclusively and those that used Tablet PCs, PDAs and GPS units. In the laptop-only group, a substantial majority of students "often" or "almost always" took their laptop to on-campus classes, used it in on-campus classes, and used it outside of class. A majority also took the laptop to field-based class meetings, but not all of them used it while in the field. A substantial majority said that "most" or "all" of their instructors incorporated the wireless laptop capabilities in their classes, and "agreed" or "strongly agreed" that the technology generally worked. A substantial majority believed that having access to the equipment in their class improved their educational experience, and that they would like the opportunity to use the equipment in other classes, too. A substantial majority also agreed that working in groups in their WII class improved their educational experience, and that they liked or loved their overall experience using the technology. None stated they disliked using the technology. In the groups that used the Tablet PCs and PDAs, a substantial majority indicated they were "comfortable" or "very comfortable" with the Tablet PCs, but only a third indicated they were "comfortable" or "very comfortable" with the PDAs, and less than a quarter indicated they were "comfortable" or "very comfortable" with the CF digital camera that was used with the PDA. None of them were comfortable with the GPS units. A substantial majority took their Tablet PC to class "often" or "almost always" and about two-thirds stated they "often" or "almost always" used it in class. In the Tablet PC group the majority of students **did not** use the Tablet PC for their other classes or outside of classes. A substantial majority "never" or "rarely" took their PDA to class, used it during class, used it for outdoor activities in the class, or used it outside of class. Of the 16 applications or activities listed for the course, a substantial majority of students **never** used the Tablet PC for 9 of them. In fact the only activities for which a majority used the Tablet PC several times a week or more were to send and receive email, browse the web, and access the course site in Blackboard. Of the 12 applications or activities listed for the PDA, a majority **never** used the PDA for 10 of them. In fact, there was no activity involving the PDAs in which the majority of the students said they used the PDA more than "several times a month." Nonetheless, a majority agreed or strongly agreed that using the wireless equipment on their own and in groups in the class improved their learning experience, and that using the wireless equipment on their own and in groups outside of class improved their learning experience. In this group of students, only about a quarter agreed or strongly agreed that the equipment generally worked. Nonetheless, a majority stated that they liked or loved the experience and would like the opportunity to use the equipment again.

Comments from students were overwhelmingly positive about their experiences. In response to open-ended questions, many students expressed the view that using the supplied technologies and working in groups helped them as students and also helped to better prepare them for careers in their chosen field.

Sample student comments include: “The ability to do work, computer work anytime, anywhere was the best part.” “It was great to have access to the (course) website in between classes.” “Having access to the equipment and the wireless network greatly enhanced my learning experience.” “I am very excited that the University of Tennessee has concern to introduce students to the technology of the future. To be successful in this century, knowledge of technology is very important.”

Comments from faculty participants have also been overwhelmingly positive. One participant from the fall semester remarked during his exit interview that “There's no question in my mind that it improved their problem-solving skills and their teamwork skills, and you could see that as they went along.” Another observed that, “The help the ITC provided to retool the collaborative assignment process resulted in a better end product. Students clearly had a better understanding of the content areas of the assignment, resulting in a more global understanding of the issues.” A theme that emerged from faculty interviews and post project reports is the importance of the ongoing training and support that the ITC provided to the faculty and students. While the faculty are unquestionably subject matter experts in their fields, for many of them the technologies are relatively new. One faculty member pointed out that the ability to use a technology and the ability to teach that technology are different. “Although at the time I had a great deal of experience with ArcPAD conducting field based GIS, I was much less experienced with teaching the technology. It was more difficult than I had expected, especially since there was no way to project the PDA screen outside of the classroom. [Still] I really enjoyed using the PDA with the GPS once it was all working okay, and I figured out how to avoid memory issues. The PDA/GPS/ArcPAD experience is so vital to the workplace and securing employment in the environmental science fields. Even with the bugs, the students saw this.” Finally, one faculty member chided us for providing laptops to the juniors, then taking them away during the senior year. “A weakness of the project is, they will have to give them back at the end of the year. It is kind of a dirty trick to hand out laptops, encourage the students to make them central to their learning style, and then take them away for the senior year.” (Note: This did NOT happen. As a result of the success reported by faculty and students in this project, the entire junior cohort was permitted to retain the laptop computers for their senior year, and this year’s incoming junior cohort received a supply of new computers which they will also retain through their senior year.)

5.2 Outcomes

Outcomes observed by both faculty participants and WII team members include:

- The relevance of the technology and application of course content to professional realms. Several students and faculty members have noted that WII activities and equipment closely mimic actual experiences relevant to their field and offer the opportunity to teach skills valued by employers.
- A desire to increase the integration of technology into the curriculum experienced through the project. Many faculty participants have begun formulating plans to sustain and expand upon their projects and activities from the current year.
- Students engaging to educate/help each other. Despite language barriers and differences in content knowledge, collaborative projects have apparently helped foster a sense of shared responsibility and investment in both the process and product.
- Increased efficiency as the semester progressed. Students became more proficient in their technology use and group work during the course of the semester, and echoed this observation in their survey responses.
- Non-intuitive student leadership patterns emerged. Several group experiences led to the development of separate and distinct roles of team leaders and motivators.

6. Conclusions

A few specific items appear to be critical to successful outcomes in a project of this nature:

- The importance of faculty training cannot be overemphasized. It is likely the most crucial element affecting the success of such a project; even unbridled enthusiasm cannot compensate for familiarity and preparation.
- The need for stable computing platforms is paramount. The WII wireless PDAs experienced several network connectivity glitches that severely limited their utility for activities, and their limited power supply was an unfortunate constraint for field-based activities.

- Instructors cannot assume student familiarity with technology. While the great majority of students claimed to be "comfortable" or "very comfortable" with computers, their application experience was primarily with email and web browsing. In this project, student inexperience with PDAs and Tablet PCs resulted in frustration and, ultimately, very limited use.
- Don't take equipment compatibility for granted. Several of our SD cards, and even Flash USB memory drives, were not compatible across all devices. This led to the need for last-minute workarounds for preconfigured activities.
- Despite the inevitable technical problems, periodic frustrations, and occasional failure, students are resilient, persistent, and optimistic. They recognize that the ability to use technologies well is important to their academic career and eventually to their career in their chosen field. The following comments summarize what we believe to be a pervasive feeling among the students who participated in this project. "For once I feel that UT is really going the extra mile to support their student body." And, "…having a laptop computer for the past year has proven to be a very efficient educational tool. There are no words to describe or thank everyone who made this opportunity possible. Thanks to each and every one of you."

7. References

Chickering A and Gamson Z (1991). *Applying the Seven Principles for Good Practice in Undergraduate Education.* Jossey-Bass.