Integrating Mobile Technology into the GIS Classroom

Teri C. Dowdy[1], Richard C. Warner[1], Stephen R. Workman[1], Robert L. Fehr[1],
Carmen T. Agouridis[1], and Ryan Kelly[2]
[1]Biosystems and Agricultural Engineering, University of Kentucky
[2]Lexington Community College
Lexington, Kentucky

Abstract:
The University of Kentucky Biosystems and Agricultural Engineering Department received a HP Technology for Teaching Grant that provided 20 tablet PC's for use in undergraduate courses and extension activities. The use of this mobile technology allows the curricula to provide more interactive based participation in the classroom and integration of real-world problems that transcends traditional classroom experiences. Additionally, it provides the means of studying the complexity of certain subjects by engaging different resources that can aid in the analysis of a particular problem. This paper will discuss aspects of the grant that include the application of tablet PCs to the classroom environment in a series of courses that utilize GIS applications in both traditional and non-traditional classroom settings.

Introduction:
The University of Kentucky (UK) has implemented many new technologies to enhance the learning environment from both the professor's and the student's perspective. Like many other institutes of higher learning, UK has "smart" classrooms equipped with computer-projection equipment and PowerPoint lecture presentations have become commonplace. Blackboard Learning System™ enabled classes allow for e-learning interaction between the instructor and student and distance learning opportunities are becoming more prevalent. Wireless network technology exists intermittently across campus and allows both faculty and students to access email and the internet with their university *U-Connect* account information.

Mobile technology has the potential to expand and enhance interaction in the classroom, enable more real-world field (outdoor) activities, improve learning environments and engage students in new and exciting ways. Successful implementation of mobile technology into the GIS classroom is both a teaching enhancement and the means for giving students a broader understanding of potential of this technology to the growing spectrum of disciplines utilizing GIS. The Biosystems and Agricultural Engineering (BAE) Department has become a leader in GIS usage and training at the University of Kentucky. One of the fundamental problems inherent in teaching this type of technology to students is the cost of the hardware involved.

In May 2004, a team of instructors from BAE and a colleague from Lexington Community College (LCC) received an equipment grant from Hewlett Packard (HP) as part of its Mobile Technology for Teaching Initiative. This grant provided the department with the opportunity to augment and expand its training efforts using state-of-the-art mobile equipment. Twenty-one tablet PCs (Fig. 1a), eleven docking stations (Fig 1b.) and miscellaneous support equipment provided for each team member to have a tablet PC for course material development and presentation and a shared mobile classroom configuration of 15 tablet PCs for use by students in the classroom or in the field.

Figure 1. a) HP TC1100 with detachable keyboard and b) Docking station.

The tablet PC is quite powerful for the size with 512Mb of memory standard and a 40Gb hard drive. Equipped with Intel Pentium M processors and Windows XP Tablet PC Edition, the HP TC1100 has 2 USB ports, an external monitor port, LAN and modem ports, a PCMCIA card slot, a Secure Digital card slot, wireless adapter, and Bluetooth capability. The docking stations contain the optical drive and additional peripheral ports. The extreme portability of the TC1100 makes it ideal for integrating field activities into our courses.

The Department of Biosystems and Agricultural Engineering (BAE) provides courses that are attended by students in both the Colleges of Engineering and Agriculture thereby facilitating adoption to a wide spectrum of users. A new course, "GIS Applications in Water Resources", was introduced by two team members, Dr. Richard Warner and Ms. Teri Dowdy for the Spring 2004 semester. Modeled after a course taught by Dr. David Maidment at University of Texas at Austin, this course had been taught in a smart classroom/ computer lab. For one exercise, the instructors borrowed mobile equipment from another professor (iPAQs loaded with ArcPad and handheld GPS units) to allow students to explore the capabilities of GIS and GPS hardware and software first-hand. Modules developed for the HP grant included the introduction of GPS and handheld collection devices utilized in field situations to gather and convert data into formats which can be analyzed in the classroom.

LCC had previously implemented a GIS certificate program, administered by team member Ryan Kelly, which includes three core GIS courses: "Spatial Data Analysis and Map Interpretation"; "Introduction to Geographic Information Systems"; and "Advanced Topics in GIS". Field experiences were generally restricted to the GPS course, where handheld Trimble GPS units were utilized to collect data points in the field that were then transported back into the classroom for editing and attribute assignment.

Implementation:
Our grant team members have been very successful in integrating the grant equipment and technology into our teaching program. Student concerns expressed on end-of-term course evaluations in prior semesters had included issues regarding the large amount of materials presented and the lack of opportunity to incorporate material into real-life projects. Tablet PCs from the HP grant have facilitated more effective presentations, which enabled more classroom interaction and allowed the instructor to be more time effective. The saved time and use of tablet PCs helped resolve these issues.

An excellent example of the integration of this mobile technology into our classrooms at BAE is the GIS course – "GIS Applications in Water Resources". The students in this course were a combination of upper division undergraduate and graduate students from a wide variety of program backgrounds including Agricultural, Civil, and Environmental Engineering; Geology; and Geography. Originally intended as a blended course of classroom lecture, computer labs and two mobile modules, the decision to conduct the class using tablet PCs as the main computing resource was made after ArcGIS 9.0 was not installed in the computer lab scheduled for the course. The tablet PCs were pre-configured with Microsoft Office 2003, Microsoft One Note, Classroom Presenter, ArcGIS 9.0, GPS Tools, ArcHydro Extension, PythonWin, Holux GPS Viewer, HecHMS, HecRAS, and ArcView 3.x.

A standard classroom was utilized and the student tablet PCs wheeled to the class via a mobile cart (Fig. 2). Each tablet PC was assigned a unique ID, allowing students to use the same computer for each course session. To prevent data loss, students were advised to acquire a USB flash drive.

Figure 2. Tablet Storage Cart

Wireless connectivity to the departmental network and the classroom projector allowed the instructors the freedom to move about rather than be tied to the lectern. Several lecture delivery methods were tested during the first semester of classes with the new equipment including Microsoft One Note, Microsoft Journal Writer, Classroom Presenter and live ArcGIS and Internet demonstrations via tablet PC.

Microsoft One Note allowed the instructor to write class notes on the tablet PC, most frequently in advance, rather than on a chalkboard/whiteboard. Notes could then be converted into PDF files and made available for students to download prior to class or at a later time, eliminating much of the need for note taking and increasing the amount of time spent in discussion of the subject material.

To make use of previously prepared PowerPoint lecture presentations, the instructor made use of "Classroom Presenter", a distributed presentation system for tablet PCs under development at the University of Washington. This system is designed to provide an integration of computer generated slides and ink to allow instructors to be

flexible in delivery (Fig. 3) and also allow for potential interaction with the audience when student tablet PCs are also equipped with the same version of Classroom Presenter software. In addition to the PowerPoint slides, now a "slide deck", the instructor can switch to white board and ink to emphasize, illustrate or even "reteach" important points.
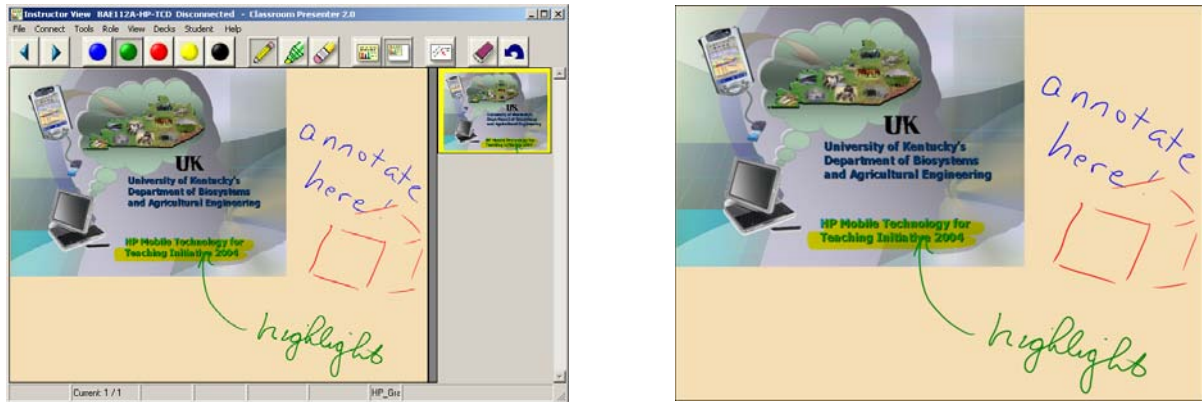

Figure 3. Examples of Classroom Presenter being utilized in the classroom. On the left is the Instructor's view of the slide, tools and slide selector. On the right is the public (or projector) view.

Students also used the tablet PCs in brainstorming sessions to generate solutions to problems posed in lecture and discussions, such as sketching out the steps for building a geodatabase, or developing the steps for a site evaluation study within a GIS.

Students had several opportunities to get into the "field" with mobile technology. One session in the"Spatial Data Analysis and Map Interpretation" (LCC) had students collecting GPS data in the field with a Trimble GPS unit and using the tablet PC for the Pathfinder Office software for validation and conversion in the field (Figs. 4 & 5).

Figure 4. Students collect GPS data with Trimble unit.

Figure 5. Students use the Tablet PC for GPS download of GPS data and conversion with Trimble's Pathfinder Office software.

BAE's "GIS Applications in Water Resources" class had the opportunity to use individual, integrated GPS/GIS for data collection in a module developed utilizing the tablet PCs (Fig. 6) equipped with Holux GM-270 Ultra CF Card GPS units (Figs. 6 & 7) connected through the PCI interface and a CF card adapter. This integrated system allowed students to collect GPS points, create and edit attribute data and overlay the newly collected information with existing datasets and rasters completely within ArcGIS while in the field (Fig. 8).

Figure 6. Tablet PCs with GPS receivers attached. With the keyboards detached, the tablet PCs are very portable.

Figure 7. Holux CF Card GPS receiver.

Figure 8. Students receive instructions and background for data collection exercise.

The University of Kentucky and the Lexington-Fayette Urban County Government jointly administer an Arboretum adjacent to the university. This park covers 100 acres and has approximately two miles of walking trails. It is undergoing expansion as the university and the Urban County Government upgrade this popular family-oriented facility.

The class was given the assignment of creating parcel and basemap datasets that could be used by park administrators. Students brainstormed about the types of information that would be beneficial, such as walking trails, demonstration garden and parking lot boundaries, tree data and bench locations. Using digital topographic maps, orthophotography, 14-digit HUCs from the National Hydrography Dataset (NHD) and USGS elevation markers collected in previous in-class exercises as background data, students created the ArcMap project files they would need to take into the field with them. Then working in teams, the students delineated the park boundary and calculated acreage, walk newly created trails while recording GPS points, located specimen trees and recorded location and tree information, navigated to given coordinates of known bench stations and edited the existing attributes of those stations, and also estimated the amount of fill material to be removed from a recent construction area adjacent to the demonstration gardens (Fig. 9).

Figure 9. Screen shot of student Tablet PC showing collected GPS data points, inked boundary and additional notes made with ink capabilities of the Tablet PC within ArcGIS.

Utilizing the GPS toolbar (Fig. 10a), students were able to view real-time GPS data and see the points as they were collected (Fig. 9). Time did not permit students to accomplish all the tasks in the field, so the data collected in the field was taken back to the classroom for further exercises in data manipulation, editing and analysis, using both traditional Editor and Tablet Tools toolbars (Fig. 10b).
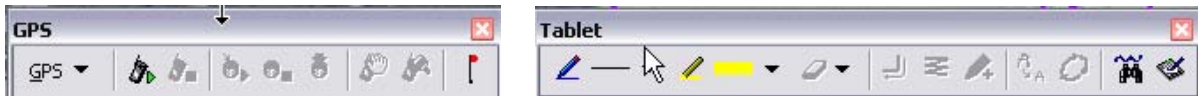

Figure 10. a) GPS toolbar – allows user to connect to and control collection of GPS points from an attached receiver. b) Tablet Tools toolbar – if used in a regular edit sessions, can be used to create and edit features. Otherwise, ink sketches are rendered as graphics.

Students were provided tablet PCs to use at every class session (Fig. 11) for brainstorming sessions, exercises, and even quizzes. They were also encouraged to take advantage of the tablet PCs for collaboration and presentations of course

Figure 11. Students used the tablet PCs during in-class exercises, quizzes and open labs. ArcGIS USB keys allowed students to take full advantage of the ArcInfo level functionality of ArcGIS. For those students still reluctant to use the pen as their cursor device, a USB mouse was provided.

projects. Given the opportunity to "check-out" tablet PCs over weekends during the semester, students were able to work on their projects and presentations at locations convenient to them and were eager to experiment with the tablet PCs capabilities. Many expressed reluctance at having their experience with the tablet PCs end.

Once exposed to tablet PC capabilities, especially when dealing with outdoor data analysis, students found their learning experiences were greatly enhanced. Based on their initial exposure to this mobile technology, student demand for similar learning experiences has increased. This was especially true for our "non-traditional" students, who are also professional engineers and architects.

There was a learning curve on tablet PC functionality, which could be alleviated by having more equipment available to students in additional classes. Through workshops and informal faculty discussions, we found word about our project spread leading to the incorporation of outreach projects in other areas in the department.

Conclusions:

Tablet PCs have also been found to reduce lecture presentation time which expands time for classroom interaction. The advantage of using this equipment in the field provides immediate feedback to students and enables development of alternative design solutions. Students benefit in multiple ways: 1) by faculty being more productive in teaching (less time at the blackboard); 2) highly integrating outdoor laboratories and activities; and 3) using tablet PCs in multiple classes will share the learning curve on equipment across classes.

Mobile technology can expand interaction in the classroom, enable field (outdoor) activities and allow for individual student learning projects. One of the biggest drawbacks to implementation of mobile technology, which was partially addressed by this grant, is the cost of the hardware and in meeting the demand of other instructors. The integration of mobile technology into GIS education is a natural fit. With the speed of advancements being made in this field, it is important for students to be exposed to the latest advances in hardware as well as the software they will be expected to use in their future careers.

Another learning issue addressed by this project is guiding students to work as a team to solve problems. Ink capabilities allow students to brainstorm solutions on tablet PCs and share their work with each other and the instructor. Fundamental teaching issues addressed by this project begin with the decreased presentation time required for the instructor. Our initial project showed that by using the tablet PC to prepare lecture notes in advance and using the tablet PC for lectures, an instructor could gain valuable teaching time, provide more contact with students, and, as an added benefit to students, make lecture notes available electronically.

Author Information:
Ms. Teri C. Dowdy, GIS Specialist / Lecturer
Biosystems and Agricultural Engineering
University of Kentucky
Lexington, KY 40546
859-257-3000 x112
Email: tdowdy@bae.uky.edu

Dr. Richard C. Warner, Extension Professor
Biosystems and Agricultural Engineering
University of Kentucky
Lexington, KY 40546
859-257-3000 x217
Email: rwarner@bae.uky.edu

Dr. Stephen R. Workman, Associate Professor
Biosystems and Agricultural Engineering
University of Kentucky
Lexington, KY 40546
859-257-3000 x105
Email: sworkman@bae.uky.edu

Dr. Robert L. Fehr, Extension Professor
Biosystems and Agricultural Engineering
University of Kentucky
Lexington, KY 40546
859-257-3000 x203
Email: rfehr@uky.edu

Dr. Carmen T. Agouridis, Engineer Associate IV / Research
Biosystems and Agricultural Engineering
University of Kentucky
Lexington, KY 40546
859-257-3000 x207
Email: cagourid@bae.uky.edu

Mr. Ryan Kelly, Assistant Professor
Geography and GIS
Lexington Community College
Lexington, KY 40506
859-257-4872 x4209
Email: ryan.kelly@kctcs.edu