

## **Using Handheld Computers to Teach Information Technology and Problem Solving**

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### **1. Introduction**

Handheld computing has reached a point in its evolution where we believe that it is necessary to incorporate mobile information devices, such as, PDAs, mobile phones, and text messengers, in computer science and information technology courses. Furthermore, we believe that handheld computing should be considered also for use in non-computer related courses in the same way that personal computers, laptops, multimedia, and other information technologies have been considered in non-technical courses. Handheld computers represent the latest evolution of personal computing. Their low price and portability offer opportunities for learning activities both in the class and outside of the class. We are actively exploring these opportunities. We believe that handheld computing has a place in computer science and information technology education, and we are attempting to determine to what extent they should be used and how they should be used. This paper discusses our ideas for using handheld computers in college education, our experiences in introducing handheld computing in computer-related courses, and the results of our efforts.

### **2. Background**

Handheld devices vary in their capabilities but many share some of the same functions. Handhelds typically offer some kind of personal information software that allows the user to manage appointments, tasks, and contact information. Some devices are designed to be always connected to a network, such as text messengers. Text messengers allow users to send and receive small text messages over a wireless network. Others, like PDAs, can connect to a network with additional hardware and software. Palm PDAs and PocketPC PDAs can be connected to a PC via a cradle and a USB port to synchronize data with Lotus Notes or Microsoft Outlook. Some mobile phones can access web services via a radio packet switch network. Although mobile phones are designed specifically to make wireless telephone calls, most phones are equipped with personal information management software. Some PDAs can act as a mobile phone with additional hardware and software, whereas some PDAs are designed as a combination mobile phone/PDA. Many PDAs have expansion slots that allow the user to insert modules that add more functionality or memory. By inserting modules, a user can use the PDA as a GPS, a digital camera, or an MP3 player. Prices for these devices range from \$50 - \$700. The following table summarizes and illustrates the different devices and their functions:

<b>Device Type</b>	<b>Description</b>
<b>Text Messenger</b>  Example Devices: RIM Blackberry Some mobile phones	Can send and receive text messages. Usually always connected to a wireless network.
<b>PDA</b>  Example Devices: Palm Sony Clie RIM Blackberry Handspring Visor HP Jornada Compaq iPaq Some mobile phones	Used primarily for managing personal information, such as, address lists, calendars, and to-do lists. Can send and receive email when connected to a PC. Most can be connected wirelessly to a network with additional hardware. Making headway into corporate IT infrastructure architectures. Can attach hardware for taking photographs. Can be used as a cell phone, GPS, or MP3 player with additional hardware and software.
<b>Mobile Phones</b>	Used primarily for making telephone calls. Some phones can send and receive text messages using a radio packet switched network. Some phones are also a PDA, or a PDA that has additional hardware that enable the PDA to act as a cell phone. Some phones can browse web content and access web services.

Handheld computers are characterized by their portability. This portability comes at a cost. Processing power, memory, input, and output have been reduced to achieve this portability while keeping devices affordable. Therefore, handheld computing presents a computing paradigm that is distinct from desktop computing. The screen is much smaller and less capable than PC monitors, so the user interface models that apply to desktop computers do not fit the small screen size of most handheld devices. Computer users are typically use a keyboard and a mouse to interact with PCs, but handheld computer users must use either a pointing device, buttons, or a wheel to interact with the device instead. Software developers and system engineers must consider these form factors, which vary between devices, when developing handheld systems and applications. Unlike the WIMP GUI interface that is common to all PCs, there is no common interface for handhelds. Information technology managers in business must consider these issues when deciding what technologies to adopt and to deploy.

Handheld computers are everywhere on the West Point campus. The school has made a determined effort to make information technology available to students. All West Point students live on campus and own a personal computer that is connected to the campus local area network and the Internet. Last year, all upper division computer science majors were given a PDA to use. This year, all incoming freshmen purchased a PDA. Thus, all freshmen and all computer science majors have at least one PDA. The freshmen received their PDAs two weeks before classes began in the fall. They did not receive any formal training from the university on using their PDAs before the semester began.

The Department of Electrical Engineering and Computer Science has encouraged the use of PDAs by its faculty. Each faculty member can request a PDA to personally use. Faculty who teach the introduction to computing course that all freshmen must take are highly encouraged to use a PDA. Instructors can also sign out additional PDAs, folding keyboards, GPS modules, camera expansion modules, and wireless ethernet modules for classroom projects, exercises, and demonstrations. The department has also set up a wireless network so that students in computing courses can access the school's local area network and the Internet wirelessly. The department's wireless network is part of the school's plan to eventually interconnect the entire campus via a wireless network.

### 3. Motivation

Despite the fact that all freshmen have PDAs, we found that, for the most part, the freshmen were not using their PDAs. When asked to bring their PDAs to class after a few weeks into the fall semester, many students said that they could not find them. Some students had broken or damaged their PDA. The two most common causes of damage was dropping it on the floor or crushing the display by putting the PDA inside of a book bag. Most students said that they experimented with the device when they first got it, but that they stopped using it when the semester began. The students said that they did not have time to learn how to use it.

The fact that the students had abandoned their PDAs is not the issue. Not everyone benefits from using a PDA, and deciding to use a PDA is a personal choice. Our concern, however, is that the students did not know enough about handheld computing to make a choice. We found that most students view the PDA simply as an electronic day planner or as an expensive way to do what they can already do using a pen and paper. In many ways this is true, but imagine dismissing the PC for the same reasons. Upon further investigation, we found that the students did not know a lot about their PDAs. For example, students did not know that they could download additional software like foreign language dictionaries, encyclopedias, and course management software. They did not know that they could also take pictures, write papers, read books, surf the web, listen to music, beam notes and contact information to each other, or make phone calls using their PDAs. The students also had no idea how mobile interconnected information devices are affecting society and business. This is a concern because the technology is increasingly becoming more important and prevalent in modern society. Computing is becoming more portable, more interconnected, and more personal as the technology evolves. Businesses are making capital investments in infrastructure based upon the promise of wireless mobile computing technology. The military has embraced the technology, because America's leaders believe that portable interconnected computers contribute to the establishment of a more mobile force that can achieve information superiority. Students should be introduced to this facet of computing as part of their overall education about information technology and computers.

In addition to preparing students to think critically about handheld computers, learning about handheld computing will enable students to make choices about handheld computing today that may enhance their personal and academic lives while still in college. We feel that as more students become more knowledgeable about the technology, the opportunities and likelihood that handheld computers will be used in undergraduate education increases. Some work involving

handheld computers and collaboration has already been explored.<sup>1,2,3</sup> We feel that other opportunities for using handheld computers in classroom activities will increase as instructors and students become more familiar and comfortable with the technology.

#### 4. Method

Our goal this year was to try different methods for introducing handheld computers in the classroom, to evaluate the effectiveness of using these devices in the classroom, and to evaluate the effectiveness of the teaching methodologies we used. Most of our efforts were focused on the freshmen during an introduction to computing course that also teaches problem solving with information technology. However, we also used handheld devices in several computer science senior student projects.

We started by giving each of the instructors who teach the introduction to computing course a PDA if they did not already own one. Instructors were highly encouraged to use their PDAs, so that they would become expert users. We also equipped each lab with one PDA and one sync cradle per every three students. Labs were also equipped with various hardware attachments and software for the PDA. Each lab had at least a GPS module, several folding keyboards, a digital camera module, and a wireless ethernet module. The Palm Operating System Emulator (available for download from [www.palm.com](http://www.palm.com)) was installed on the instructor station in the lab, so that the instructor could show how to use a PDA by projecting the emulator on the overhead projector. The emulator enables the instructor to run a Palm PDA on a PC, and when projected on the overhead the instructor can show the students how to use the PDA with a fully functional PDA that is about five feet tall. Each lab was equipped with a printer with an infrared port, and each lab had access to the campus local area network and the Internet via a wireless network access hub.

Instructors introduced the PDA on the first day of class and demonstrated them by beaming their office hours and contact information to students who had brought their PDAs to class. Students who did not have their PDAs could write down this information from the board, and the distinction between the process for those who brought their PDAs and those who did not bring their PDA was made clear. The first day of class is usually spent talking about administrative matters related to the course, most of which, is available online via the course website. Students were also shown that the course website could be browsed wirelessly with a Palm or downloaded for offline viewing.

One class during the semester was set aside for conducting a one hour hands-on lab using handheld computers. This lab was conducted midway through the semester. To lead up to that lesson and to encourage students to explore handheld computing, instructors would periodically discuss and demonstrate PDA applications or tasks during the first three to five minutes of class. Students were also occasionally asked or requested to volunteer to explain and demonstrate typical PDA tasks, like making an appointment or writing a note, to the rest of the class.

The lab was set up so that each student had access to a sync cradle. We showed the students the various PDA peripherals like folding keyboards, cameras, GPS devices, and network interface cards, and we let them use them during the lab. We established a wireless network so

that the students could access the network wirelessly when in class. During the lab, the students worked in groups and were given tasks to accomplish with the PDA. The groups followed a realistic scenario that required the groups to make an appointment, read email, write email, move an appointment, add a task to the to-do list, take a picture, check off the task from the to-do list, write a note, beam a note, and create a new contact and populate the contact fields by copying and pasting some of the information from the note. The groups were also shown how to download an application from the World Wide Web. Then they had to find an application, download and install it, and then present their application to the class.

During the semester, the students also completed a group project that required the students to solve an IT problem. Though not explicitly stated in the assignment, the result of the IT project was ideally a local area network. The students were given a general problem statement and a budget to work with. They were given 13 days to research and design a solution and then present their recommendation to the class in an eight minute presentation. The IT project was designed so that the students had to address mobile computing IT issues.

The upper division students worked on three senior projects that have resulted in solutions that involved PDAs. One project developed self-assessment tools for the PDA. The goal of this project was to assess the best methods for students self-assessment on the PDA that help prepare them for class. Self-assessment on the PDA can provide students with feedback concerning their understanding of the course material. The second project developed an inventory system that runs over wireless network using PDAs equipped with barcode scanners and built-in wireless ethernet capabilities. The third project developed a handheld terminal for requesting artillery fire by soldiers on the battlefield. All three projects were supported by clients who have a real interest in using these application in their organizations.

Outside of the electrical engineering and computer science department, we have provided other departments with instruction and tips on how to use the Palm operating system emulator for class demos. We have also shown instructors from other departments how to use the PDA and how to use the various modules that extend the PDA's functionality. Furthermore, we have asked instructors from other departments for input on how PDAs could be useful in their courses. So far, very little input has been received from other departments.

## 5. Future Work

We are putting together a software bundle that the freshmen will be required to download and install in class during the first two weeks of the semester. The bundle will include a self-assessment application, a dictionary, a thesaurus, a graphing application, the course syllabus, and course reference material. We are trying still trying to find the right software. The software must be free or simple enough to be developed by the instructors, while robust and useful enough to encourage the students to use the software.

We found that the students must be exposed to handheld computers more throughout the course. We will continue to seek the right assignments and activities that will effectively introduce students to handheld computing. We do not think we are there yet, and we are in the process of developing our plans for next year. We will survey this year's class of freshmen at

the end of the year in order to assess the effectiveness of our methodology for introducing handheld computing.

We are looking for more relevant projects and clients for computer science senior projects. By taking on these projects, we can explore the capabilities of the PDA that go beyond just the personal information management tasks.

We will also survey the students who received PDAs last year but have not received any training on the devices. It would be interesting to see whether or not the usage is any different than the freshmen who were exposed to the PDA during class.

## 6. Conclusions

It is too early to evaluate the long term effectiveness of our efforts to incorporate handheld computers into technology-related courses and projects, but the immediate response has been positive. Students appear motivated to learn about handheld computing. The students were actively engaged during the labs, and their presentations were well-informed. We do not know, however, if the number of students who use PDAs has increased. We believe that if PDA usage by the freshmen increased, then it was marginal since it did not appear that more students were bringing their PDAs to class by the end of the semester. We are not suggesting that PDA usage reflects the effectiveness of our methods. The goal was not to increase PDA usage, but rather to educate the students about handheld computing. Awareness and knowledge about PDAs do not necessarily translate into an immediate increase in usage.

More research needs to be done in this area. Handheld technology is rapidly evolving. Devices are becoming more powerful, less expensive, more mobile and more interconnected. Students need to have requisite knowledge to take advantage of the technology and to explore the advantages offered by interconnected mobile information devices. Educators also must be smart about handheld technology, and they must have hands-on experience with the technology so that they can share the knowledge with their students.

## References

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