

Handheld Computers in the Classroom and Laboratory

Robert L. Avanzato
Penn State Abington

Abstract

Penn State Abington has integrated the student use of personal digital assistant (PDA) technology into several Information Sciences and Technology and engineering courses in order to foster active and collaborative learning experiences in the classroom and laboratory. Activities supported by the use of these handheld computers include electronic team exams, distribution of notes, programming, collaborative database projects, and access to web-based materials. Student access to handheld, mobile computers provides opportunities for improvements in both learning effectiveness and in the efficient delivery of instruction.

1. Introduction

Penn State Abington has integrated the student use of personal digital assistant (PDA) technology to foster active and collaborative learning experiences in the classroom and laboratory. The PDA is an inexpensive, handheld computer that supports database, spreadsheet, document viewing/editing, graphics, programming, and web-browsing software. The Palm™ handheld [1] was selected for the integration effort due to its low cost, intuitive interface, extensive software support, and large user community. This PDA device features an infrared (IR) beaming capability, which allows students to electronically exchange software applications and data.

A brief chronology and overview of the Penn State Abington experiences with Palm handheld integration follows.

Through support from 3Com and Palm, thirty-five students in an introductory Information Sciences and Technology (IST) course were each provided with a Palm IIIx™ handheld computer in the fall of 1999. Classroom activities supported by the use of these handhelds included electronic team quizzes, distribution of notes, interactive software reviews, collaborative database projects, and access to web-based materials. Student teams developed prototypes for commercially feasible PDA applications in areas such as health care, inventory management, and law enforcement. The handheld computer requirement for students in this freshman IST course has continued through a combination of industry support and internal funding. As of spring 2001, over 150 IST students have been provided with Palm handhelds for educational use at Abington. Because students retain ownership of the PDAs, integration in subsequent IST courses can be achieved in a low-cost manner.

In an undergraduate engineering research program, a team of students developed a Palm PDA-based autonomous robot in the spring of 2000 [2]. The Palm device served as the “brain” of the robot, and software instructions could be entered directly on the Palm unit allowing for rapid, flexible development without the use of a PC or laptop. The Palm-controlled robot was entered into a fire-fighting mobile robot competition [3].

Talented high school students in the Pennsylvania Governor's School of Information Technology (University Park, Pa) were provided access to handheld computers to facilitate project-based work and a robotics workshop during the summer of 2000. The Palm-based robot technology developed at Abington was employed at the Governor's School program and was also demonstrated at a National Governor's Association Conference event in July of 2000. Also during the summer of 2000, an independent study course was designed at the Abington campus for a senior computer science major to design and develop custom educational Palm software to be used by students in a French language course. This software will be implemented in the spring of 2001 in a French III course at Penn State Abington.

PDA technology has been integrated into a sophomore-level digital systems engineering course for 24 students in the fall 2000. These engineering students have been evaluating and developing handheld software tools for enhancing learning and instruction in both the lecture and laboratory (digital circuit design) components of the course. Databases, simple CAD tools, C programming, image capture, web-based tools, and robotics applications have been explored. In each application area mentioned above, curriculum was created and the classroom dynamics were suitably modified to take advantage of the Palm PDA capabilities in the lecture and laboratory.

The objectives of this paper are to introduce Palm handheld technology to the educator and highlight examples of successful integration of this technology into the classroom environment. It is hoped that the reader will gain an appreciation of the potential improvements offered by PDA technology in both learning effectiveness and in the efficient delivery of instruction.

2. Palm Handheld Basics

The following sections describe the basic features of the Palm handheld and highlight select software applications that are of interest to the educator in the information technology and engineering fields.

2.1 Palm PDA Specifications

The Palm handheld devices used in the Penn State integration efforts described above have been primarily the Palm IIIx and Palm IIIxe models. The Palm IIIx features 4MB of RAM, and the Palm IIIxe features 8MB of storage. Other than storage capacity, the two models are equivalent.

A select list of key Palm features follows:

- Touch sensitive, gray scale screen (160 x 160 pixels).
- Stylus data entry (character recognition).
- Powered by (2) AAA batteries providing approximately 20-25 hours of normal operation.

- IR “beaming” of data and applications (one PDA to one PDA; units must be within 3 to 6 ft. range and be properly oriented).
- Serial port for external devices (data acquisition, GPS, etc).
- Intuitive interface (shallow learning curve).
- Synchronizes with laptop or desktop PC.
- Built-in personal organizer functions (memo, calendar, to do, address)
- Over 3000 third-party software applications available.
- Development tools are available for creating custom software applications

A key to appreciating the potential of the handheld in the educational environment is to view the device as a general computing platform, which supports a wide range of diverse software applications beyond those of personal organization. Major categories of software support include database, spreadsheet, document viewing and editing, graphics, email, calculators, electronic books, utilities, reference, programming languages, and web-browsers. It should be noted that the utilization of memory on the Palm handheld is quite efficient and applications are generally less than 100K in size.

During synchronization, the PC and the handheld are coupled via a serial cable or an IR link, and data is transferred between the two devices. This data can include documents, applications, data files, spreadsheets, images, email messages, and web pages, etc. Through this mechanism, the handheld can serve as a mobile extension of the PC.

2.2 PDA Software Examples

Two key examples of Palm handheld software that have been demonstrated to be useful in the Penn State integration effort will be briefly presented below. These few examples should prove useful in appreciating the scope of potential applications in the classroom. The reader is invited to explore one of the web sites that offer comprehensive catalogs of Palm handheld applications [1,4]

A. Web Browser Software

The ability to view web documents on a handheld computer is extremely useful in the classroom and laboratory environments. Typically, web information is downloaded to the Palm PDA during a synchronization session with a PC that is connected to the Internet. The designated web pages (text and graphics) are then stored on the handheld unit for future browsing. Figure1 shows Palm screen shots of the Avantgo [5] web



Figure 1a



Figure 1b



Figure 1c

browser product displaying various web pages. Using this product allows students to have classroom access to almost any existing web data including newspapers, electronic magazines, reference materials, tutorials, course syllabus, and course support materials. The hyperlinks are preserved so students can activate links with the stylus for easy navigation. Additionally, students familiar with web page creation can develop their own customized web-based reference materials that can be downloaded and viewed on their handheld computer at any time and in any location.

B. Database Software

Database software for the PDA allows each student to create, manipulate, and view database materials in the classroom. We have experienced success with the HanDBase [6] software tool, although a variety of capable database tools exist. This particular application offers a friendly interface and relatively sophisticated database features, such as sorting, filters, calculated fields, and database linking. Database files on the PDA can be synchronized with PC-based database tools. Entire databases or individual records can be electronically “beamed” from one Palm to another using the IR capabilities of the Palm device. This tool has been successfully used for hands-on classroom database education, creation of engineering reference databases, and collaborative project activities. Screen shots of several PDA databases, developed by Penn State Abington students, are shown in Figure 2 below.

Restaurant	Price	Directions
Steaks And Ho	Low	Turn left on W
Papa Johns Pizz	Low	Busleton and S
Riviera	Low	Turn left on W
Cajun Cafe	Low	Willow grove fo
STEAK & HOAG	Moder	.Turn right on t
Bassetts Turke	Moder	Willow Grove M
Taco Bell	Moder	Willow Grove M
wings 2 go	Moder	Make a right o
Village Deli	Moder	From psu abing

Figure 2a

Restaurant	Steaks And
FoodType	Hoagies Express
	Burgers/Chicken
Rating	10 - (High)
Fast Food	<input checked="" type="checkbox"/>
Dine In	<input checked="" type="checkbox"/>
Distance(min)	10
Price	Low
Directions	<input checked="" type="checkbox"/> Turn left on Wo
Notes	<input checked="" type="checkbox"/> Value meal #3-

Figure 2b

Gates	AND
Chip Number	7408
Algebraic Functi	F = XY
Pin In	1,2/4,5/9,10/12,13
Pin Out	3/6/8/11
SSI	<input checked="" type="checkbox"/>
MSI	<input type="checkbox"/>
Pin Func. (1-7)	N/A
Pin Func. (8-14)	N/A

Figure 2c

3. Classroom Enhancements and Experiences

Many exciting opportunities for innovations in teaching and learning exist when each student and the instructor in a classroom are in possession of a handheld computer. Enhancements can be generally classified into two (often overlapping) categories: 1) active and collaborative learning enhancements, and 2) instructional technology and delivery enhancements. Examples of instructional technology and delivery enhancements would include the electronic distribution of class notes, lab materials, and course materials in text or web format, or the storage and access of student grades and records in a handheld database or spreadsheet by the instructor. On the other hand, enhancements in active and collaborative learning strategies with the PDA involve both the technology and the rethinking of the classroom activities and content to leverage the technology. This section will concentrate on examples of supporting new learning strategies.

With the appropriate technology and an instructional plan, many active and collaborative activities can be integrated into the classroom experience to better achieve and, in some cases exceed, the learning objectives. Examples of some of the successful hands-on classroom learning experiences developed in this program include collaborative database design, electronic (paperless) team exams, and programming activities. Each of these approaches will be concisely outlined below.

In the database activities, students used Palm PDAs to actively design, build, exchange, and access simple databases all within the classroom environment. In one exercise, each student created an individual database record, then the students used the IR beaming feature to electronically merge the records into a complete database. These in-class activities replaced the more traditional lecture delivery in many cases. In a related exercise, the students were instructed to collect and record information at local restaurants and collaboratively merge the data into a single database (see figures 2a and 2b). This notion of collecting data in the real world and interacting with computers in the field is well supported by the use of PDA technology.

Electronic team quizzes were achieved by electronically beaming the text of the quiz from the instructor to one member of each team using the Palm PDAs. The team member would then electronically distribute the quiz to the other members of the team (generally totaling four to six in number.) The quiz questions consisted of multiple choice and short essay. Students within a team were able to enter, cut and paste, and electronically merge solutions using the handhelds. A single composite solution from each team was beamed back to the instructor. In most cases the students taking the quiz needed to consult other resources stored on the handhelds, such as web-based magazine articles. The objective here was to use the Palm technology to enhance student collaboration.

With the use of a C compiler (PocketC product [7]) for the Palm, it is possible to engage each student in an entire class in the design, implementation, testing and execution of small programs. The source code can be entered and modified directly on the Palm device and executed. Source code or sections of source code can also be electronically beamed to other students in a collaborative arrangement. Examples of classroom hands-on projects using C language development in the digital systems course included a program for generating the truth table for a Boolean function and software to convert numbers from various bases. The compelling aspect of this and other classroom activities described is that students now have individual access to useful software tools that would normally be available only in a computer lab.

3. Summary and Conclusions

This paper has exposed the engineering and information technology educator to the basics of handheld computer (PDA) technology, and outlined examples of successful educational experiences using handheld computers in the classroom and laboratory developed at Penn State Abington.

While many of the experiences described above are in the exploratory stages, the results at this point seem very encouraging. Overall, the student reaction to these projects has been very positive, and the faculty participation has been increasing. The current plan is to expand the handheld integration into additional course offerings, and apply assessment tools to monitor and evaluate educational successes.

The effective use of handheld, mobile computer technology can enhance and extend the classroom learning experience, provide hands-on activities, and allow students and instructors to participate, communicate, access information, and collaborate in ways that would not be possible in a traditional classroom or laboratory setting. Judging from the preliminary successes described in this paper, the handheld computer (PDA) will play be an increasingly important role in quality education across many disciplines.

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BOB AVANZATO

Bob Avanzato is an associate professor of engineering at the Penn State Abington College. His interests include mobile robotics, fuzzy logic, expert systems, and curricular enhancement. Prior to his position at Penn State, Bob was a senior engineer at the Advanced Technology Laboratories at Martin Marietta where he was involved in digital signal processing and artificial intelligence research and development. (email: rla5@psu.edu)