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In this issue:

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Wearing Software Hats: Teaching Introductory Technology through Software Interactions

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Abstract

Students use computer software to accomplish many tasks that are part of their daily routines. This paper describes an innovative approach to teaching an introductory technology course in which students who had some previous experience expanded their knowledge by interacting with different types of software applications, and by analyzing their roles in relationship to those applications. Students purchased Pocket PCs to use along with their laptops for this course; no printed text books were used. This active-learning approach enabled students to learn the traditional course topics in a way that made them relevant and engaging. Additional benefits included students creatively using their Pocket PCs for both personal and educational purposes, allowing them to apply the technologies they learned in the classroom to the contexts of their own lives.

Keywords: Introductory Technology Course, Pocket PC, PDA, handheld computers, software roles, education

1. INTRODUCTION

As the use of computers increases at home and in high schools, so does the number of students who arrive on college campuses with some previous computer proficiency (Meirtschin and Willis, 2003, Baugh, 2004). Many students already have some familiarity with the topics taught in introductory technology or computer literacy/fluency courses. These courses allow incoming students to develop basic computer skills that they will need throughout their college careers. As a result of increased student experience with computers, colleges are faced with the challenge of gearing their introductory courses to meet the needs of self-proclaimed "advanced" students. (Meirtschin and Willis, 2003, Frydenberg, 2005).

A common approach in this situation would be to "teach more advanced skills in applications already included in traditional computer literacy courses." (Hoffman, 2005) Learning advanced features of particular office productivity packages, for example, is

one approach to make users more productive. As an innovative alternative to the "power user" approach, Hoffman suggests, and we agree, that a "critical computer literacy" approach is more useful. This approach builds upon the familiarity that computer-literate students already have with "native applications" (email, word processing, web browsers) learned at home, and gives them "the ability to incorporate computing technology in support of critical thinking" (Hoffman, M. et. al., 2005).

Through an interactive approach that builds upon and reinforces earlier learning, while using multiple hardware platforms, students come to discover new avenues for applying technology. This approach provides new opportunities for critical thinking as students apply course concepts to their own lives.

2. BACKGROUND

This study encourages critical thinking in developing computer literacy by describing a completely hands-on approach to an Intro-

duction to Technology course (IT 101). In this course, students experience different roles as they interact with software applications using both laptops and Pocket PCs.

Two experimental "technology intensive" sections of IT 101 were offered in both the Fall 2004, and Spring 2005 semesters. Students who chose to register for these sections were required to purchase Dell Axim X30 Pocket PCs, which along with their laptops, e-books from the library's web site, and other web resources, set the foundation for a hands-on approach to learning the course topics. No traditional printed textbooks were used. Instead, students purchased Dell Axim Pocket PCs, equipped with integrated 802.11 wireless Internet access and Bluetooth, running the Microsoft Windows CE operating system. Many chose to purchase an optional Secure Digital card in order to store and access their data, music, and pictures.

Personal Digital Assistants (PDAs) such as Pocket PCs and Palm™ Organizers have been used in higher education for mobile access to domain-specific knowledge databases or documents, e-books, or other simulations. (Allert, 2003; Waycott and Kukulska-Hulme, 2003) Many have debated whether the benefit of the mobility factor outweighs the difficulty of the small screen and stylus input devices.

The results of Johnson and Rudd's (2003) study evaluating student learning from reading e-documents on PDAs versus reading traditional textbooks suggest "there are serious roadblocks to a successful college career for PDAs." (Johnson and Rudd, 2003) Our study shows that PDAs, when used with a critical literacy learning approach, can be successful tools for teaching and learning technology concepts at the college level.

3. COURSE DESCRIPTION

IT 101 is a required course for first-year students at our institution, a New England college which blends technology and business. The traditional (standard) section uses a "concept" text book (Shelley, Cashman, and Vermatt, 2005; Beekman and Rathswohl, 2004) that provides information about technology topics in a discrete, sequential format. Pages are magazine-like, with large glossy photographs and sidebars.

Chapters often contain bolded terms in the margins and definition exercises at the end of each section. Because of this structure, standard IT 101 student learning is often measured by memorization of key terms in the chapter or keystrokes in particular software packages in order to correctly answer end-of-chapter multiple choice questions. Student feedback suggests that this may lead to good grades but insufficient deep understanding of the real meaning of the concepts. The standard sections teach discrete topics rather than presenting the students with the opportunity to integrate their knowledge in support of critical thinking. Our approach allows students in the technology intensive sections to learn the course concepts by experiencing the different roles associated with various software and hardware products.

IT 101 covers such topics as using the Windows XP operating system, computer hardware, software, and peripherals, networking concepts, personal computer maintenance, basic HTML, spreadsheets, current events related to technology, Internet architecture, and ethics as related to the use of technology.

4. WEARING SOFTWARE HATS: A RATIONALE FOR IT LEARNING

By using, installing, evaluating, and creating original software applications, students gained an appreciation of the many different ways they could use their Pocket PCs and their laptops. As students wear different "hats" in their interactions with the various software packages, this progression from simply using "off the shelf" applications to learning how to write simple applications that they could put "on the shelf" for others to use provides an opportunity to experience a full circle of software applications and processes, and the different associated roles associated with each.

Table 1 (at end) lists many of the roles and software interactions as they relate to course topics taught in IT 101. Each major assignment in the course focuses on a different way to interact with software applications in increasing complexity. The sections that follow explore some of these roles in more detail.

Software Role	Interaction	IT 101 Course Topics
User	Configure laptop and Pocket PC, Browse the Web Navigate Windows XP	Operating Systems Overview Configuring Systems
Mobile User	Enter data into Tasks and Scheduling Beam Contact Information Synchronize Pocket PC and Laptop Set up wireless and Email	Pocket PC Basics Wireless and Infrared Communi- cations Computer Networks Email Programs and Protocols
Productivity User	Create Presentation with Microsoft PowerPoint Create Spreadsheets, Charts, and Formulas with Microsoft Excel	Modeling Data and Problem Solving Using Spreadsheets
Consumer	Configure Hardware Devices Recommend and Evaluate Software Packages	Hardware Software Memory Peripherals
Network Admin- istrator	Configure Wireless Networking Synchronize Data Between PC and Pocket PC	Networking Technologies, Wireless Protocols
System Adminis- trator	Scan Computer for Viruses Detect Spyware Delete Cache and Cookies Perform Backups Defragment Disk	Data Storage Privacy Computer Maintenance
Researcher	Perseus Mobile Survey	Integrating Technologies
Web Designer	Create HTML Web Pages with Notepad View Pages on PC and Pocket PC	HTML, Graphics, Internet Technologies Web Browsing
Multimedia De- signer	Design Multimedia Presentation with Microsoft PhotoStory	Multimedia, Data Compression
Software Devel- oper	Create simple game programs using Visual Basic.NET	Programs, Compilers, Deployment

Table 1: Brief Summary of Software Interactions and Software Roles

Users

As software “users,” students learn the “basics” of native applications on their laptops and PDAs, and demonstrate proficiency in skill-based applications. A first assignment encourages students to become familiar with their Pocket PCs by using the native Calendar, Tasks, and Contacts applications. In the role of “mobile users,” students immediately learn the benefit of using technology to manage and their daily lives. Students use their Pocket PCs to beam their contact information to others in the class, enter their

schedules, keep track of their homework assignments, and connect to the Internet.

As part of the course, these students also used web logs (blogs) to post weekly entries describing how they interacted with various technologies, or their opinions of them. This process of writing about experiences also promoted student learning and critical thinking.

In their blogs, many students commented that they felt they had become more organized and connected thanks to their new Pocket PCs. This student’s blog entry is rep-

representative of many students after they first received their Pocket PCs.

"We got our Pocket PC's this week ... I feel as if it will help me with managing my life without a planner. So far, I put my class schedule in and have entered all my homework assignments that are due as well. Along with all this, I installed AIM, Calendar+, Adobe, Remote Display, and set-up wireless. It is all coming together it seems. I am excited to see just how much the Pocket PC can do. I hope to be able to surf the web, keep appointments, schedules, homework assignments, and I of other stuff that is I with my Pocket PC. It is much easier to be carrying a Pocket PC than a planner, and much less bulky. It is a change that will take some getting used to; but, when I am used to it, it will probably be well worth the struggle."

This student installed and started using the software applications that were demonstrated in class with much success. It is interesting to note that with the exception of web browsing, what this student sees himself doing with his Pocket PC is limited to the basic functions of a PDA (scheduling and task management.) This limited view, typical of most students at the beginning of the course, expands as students experience other roles throughout the semester.

Consumers

Shortly after they receive their Pocket PCs, students spend part of one class period installing software packages that they will use during the course. The next assignment requires students to act as consumers, finding and evaluating software applications that take advantage of the wireless features or mobility factor of their handhelds. The students share their findings with the class with both a PowerPoint presentation and a live demonstration. Group presentations take place in two consecutive class sessions. The following week, students individually select one of the applications presented by another group to install and evaluate on their own Pocket PCs, and perform their own evaluation. This approach encourages students to learn from each other.

Intrigued by the challenge of exploiting the wireless capabilities of their Pocket PCs, one group chose an application that streams au-

dio from a PC to the Pocket PC over a wireless network. This, in effect, makes the Pocket PC function as an MP3 player which has wireless access to music stored on the student's laptop located elsewhere.

Faced with how to demonstrate this application in a classroom that did not have wireless Internet access, a clever student gave his presentation from the lobby of the building, where wireless access to the Internet is available. There he connected his Pocket PC remotely to the laptop in his dorm room, so he could use the application to browse its files and listen to music. At the same time, he also wirelessly connected his Pocket PC to the podium computer in the classroom, where he used a remote display host, to display the image on his Pocket PC so it could be projected for the class to see. Finally, he called his partner in the classroom, so he could talk through the demonstration, and let everyone in the class hear the music playing on his Pocket PC.

This episode required this student to analyze how to solve a problem using the tools and technologies available to him in spite of known network limitations. In general, the process of selecting an application, making it work, and then figuring out how convey that to others develops students understanding at a deeper level.

Administrators

As administrators, students configure email, wireless, and other services to function correctly on their devices. They learn basics of networking and system administration through hands-on configuration and maintenance activities that should become part of their daily routines. For many students, the course fills gaps in their knowledge, providing the underlying technology concepts that enable them to make informed decisions as they manage their own machines.

One student remarked in his blog, "I use Ad-Aware [to scan for spyware] at least three times a week, and I think that everyone should do the same. In a few minutes Ad-Aware ... found 21 negligible objects, which isn't too bad. After searching my computer for viruses and spyware, I performed a disk cleanup and I was surprised to see that I had 14,569 KB of temporary internet files on my drive. That showed me that I must have

visited a lot of sites, but it also showed me that I need to clean my computer more often."

Researchers

Later units of the course allow students to create different types of applications on their laptops that could then be used on their Pocket PCs. As researchers, students use Perseus™ and Perseus Mobile Survey to create surveys on their laptops that they transfer to their Pocket PCs to administer. After each student interviews at least ten subjects, and transfers the results to his or her laptop, the student exports them into Excel. The group merges individual results with those from other group members, analyzes the data using Excel, and presents a summary of their findings including graphs and screen shots, and conclusions about the resulting data, on a web page.

This assignment gives students the unique opportunity to integrate many of the technology tools discussed in the class already, and apply critical thinking in a situational context. Students chose to create surveys related to such topics as their clubs and organizations, jobs, and sports.

The survey assignment goes beyond how to use technology to create surveys.

Students learn that in order to obtain data that would be easy to analyze later, they must take care in posing their questions. For example, using a fill-in-the-blank question to record responses to "What's your favorite baseball team?" on a mobile survey administered to students at a Boston-area college the week after the Red Sox won the World Series, takes a lot of effort to repeatedly write the same few anticipated responses. It also increases the likelihood of data inconsistencies ("Sox", "Red Sox", "redsox", etc.) in the results. These could be avoided by using a "pick one multiple-choice" question that specifies several probable alternatives and a blank line to fill in an unnamed alternative response.

Students appreciated the power and convenience of using mobile devices for data collection by administering mobile surveys. In his web log, one student summarized his experience as follows:

"Being able to walk around and give surveys is the way they were meant to be taken and given. No more paper, no more copies, no more collection routes... I've seen a few people giving their surveys in the lunch room and around our floor, and it seems quite aggravating. A girl on my floor gave everyone two sheets. The real problem for her was collecting the data. She had to make another round after an hour. I posted my answers to the door because I had to leave, but I just as easily could have forgotten about it, leaving her out on a limb.

[With Perseus Mobile,] we quickly put together our survey (which is about video games), loaded it on our mobile devices and took off. It is configured very well and allows each entry to be entered quickly and easily.

The aspect that really stood out for me was it being so functional. Surveys are given all the time in the real world and doing it on a Pocket PC really is one of the best ways to collect all this data... Perseus really made me look at what we are doing in a new light."

This project was one of the first where students used their Pocket PCs in a way that really demonstrated how a familiar process (taking surveys) usually done on paper can be improved with mobile technology. For most, this was also their first time using a software application on their PCs to create a software tool that ran on their Pocket PCs. The result was using technology in a way that was more usable and less error-prone than traditional methods for data collection.

Designers

In the role of Web Designers, students created web sites using elementary HTML tags, designing attractive pages that take into account the different form factors when displaying on both laptops and Pocket PCs. As multimedia designers, students downloaded the free Microsoft PhotoStory application to create presentations that can be viewed on both their laptops and Pocket PCs.

This lesson also serves as a discussion of issues related to multimedia processing; including various audio, video, and graphics file formats, data compression, and media players. As some students' Axims shipped

with Windows Media Player 9, and others had Media Player 10, those with the earlier version also learned a valuable lesson about how to perform the lengthy ROM upgrade.

While the use of digital cameras was not required for this assignment, most students owned or had access to them. That made this one of the most popular projects in the course, as students could express their own creativity and use their digital photographs in new ways. One student stated in his web log, "PhotoStory has become a new form of expression for my photography hobby. I'm pondering the idea of introducing them into the online edition" of the student newspaper.

Software Developers

Although application development is not often included in a first year Introduction to Technology course, there are several good reasons for doing so. First, even the simplest logic and constructs required for writing programs encourages analytical thinking and builds on their experience writing formulas and functions while using Microsoft Excel earlier in the course. Programming also provides a tangible introduction to concepts related to objects, as well as the opportunity to interact with source code, object code, and compilers. Those students in the class who are considering a major in a technology field have a chance to "see what it takes" in a supportive environment. Teaching students to write simple programs also creates opportunities for "learnable moments", as students try to bring life to their ideas on a computer screen, and need to learn or figure out a step, concept, or technique in order to do so. Their motivation is increased, as they are dealing with more "real world"-type tasks. Finally, and most importantly, there is a feeling of intense accomplishment that every student should experience the first time that he or she turns original ideas into functioning software applications, and the pride that accompanies sharing those applications with others.

Microsoft Visual Studio.Net has built in a SmartDeviceApplication type that simplifies the process of creating applications that run on Pocket PCs. The course spends four sessions on programming in a PC-teaching lab style classroom with Visual Basic.Net and Visual Studio already installed. After getting used to the environment and writing "Hello

World!" in the first session, the second session makes the leap from Excel to programming applications by writing programs that do numeric calculations based on user-entered values (such as the amount of a tip at a restaurant and dividing the bill equally by the number of guests). The remaining two class sessions introduce tools necessary for creating simple games: timers for simple animation and counting down, tests for determining when two objects are overlapping, and using random numbers.

Equipped with these tools, students are asked to create a simple game or other amusement. They must implement their ideas given the limited toolset presented in class. Student games included classic "guess the number" games, as well as various "scratch and match" puzzles. One student wrote Car Driving game, where boulders randomly appear on the road, and the careful driver must navigate the car to the left or right to avoid them. (See Figure 1.)

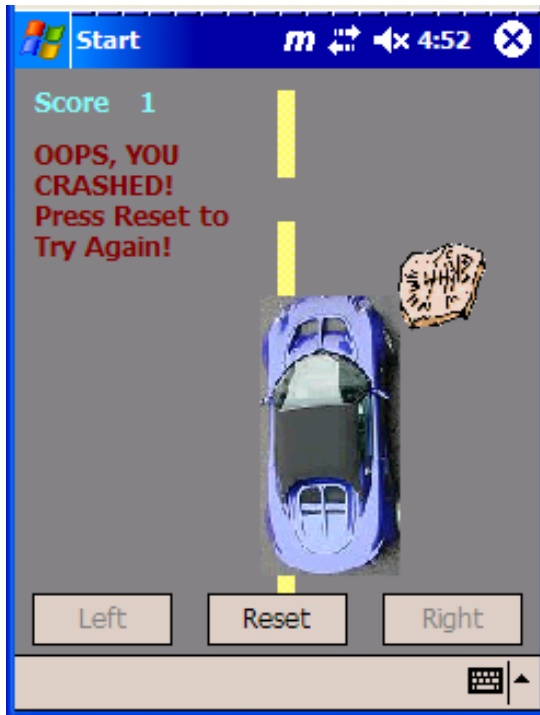


Figure 1. Car Game.

Students demonstrated their games in class and posted executable versions to their web sites for others to share. Most found this to be the most challenging assignment of the semester. As they reflected in their blog entries on their experiences with programming, many students acknowledged both the sense

of frustration they felt while writing their programs, and the profound sense of accomplishment they felt when their programs finally worked. One student wrote:

"Wow, programming isn't easy. I couldn't get the [first] assignment to work, so I wasn't very confident about writing my own game. However, with basically only a few hours of work, I was able to pound out a pretty well programmed game. It's pretty simple, but so is my knowledge of the Visual Basic language. It took a lot of work and some intense debugging, but I felt great after I got my game to function properly.

It was also very satisfying to realize that I was able to communicate with a computer on the most basic and fundamental level—and make it do what I wanted it to. That is, after all, why we have computers—to have them make our lives easier. Overall the assignment was very successful; I got a functional game, and the insight as to what it takes to write computer programs."

This student, like most, recognized the qualities of creativity, patience, and analytical thinking that are required to become a successful software developer. For some, trying on the "software developer hat" cemented their choice to further explore (or stay away from!) an information technology-oriented major or minor course of study.

5. ADDITIONAL BENEFITS AND CONSIDERATIONS OF A CRITICAL LITERACY APPROACH

Many of the interactions in this hands-on approach introduced students to areas of study involving technology in which they might wish to major or minor. One student wrote, "This course opened my eyes, and now I am looking into doing a CIS minor, as I think it is very important in the workplace to have skills with computers."

The challenge for most technology based courses – for students as well as for instructors – is the rapidly changing nature of the material. The no-books approach challenges the instructor to seek up-to-date course content. Many of the technologies "look easy" when they work, but configuring them behind the scenes can be time consuming.

For the instructor, an additional benefit of offering this course has been the develop-

ment of a cadre of student "technology enthusiasts." Several IT 101 alumni have volunteered to be on call to assist students in next year's class, many of whom will undoubtedly face the same challenges configuring wireless, email, and installing other software packages on their devices.

6. IMPACT OF POCKET PCs ON LEARNING TECHNOLOGY

This approach to the IT 101 curriculum was developed in response to increasing numbers of students who had previous exposure to computing prior to arriving on campus. The Pocket PC has shown to be a major motivation for students with some self-assessed degree of prior computer fluency, and the "technology intensive" course curriculum was designed around integrating its use into many learning areas. The "cool factor" of the Pocket PC entices students to make the most of their new devices; the mobility and small form factor creates new opportunities for using technology both in the classroom and on the run. In addition, having full control over two computing devices provides a natural introduction to client/server and other networking concepts, and allows students to compare and contrast different versions of the same software applications on both devices. They discovered how the Pocket PC versions of their favorite native applications such as Instant Messenger, Internet Explorer and Microsoft Word and Excel, captured the essence of their "full sized" counterparts, yet often had limited features.

Most practically, an overwhelming number of students have stated that they feel more organized as a result of maintaining their schedules using their Pocket PCs.

The substance of the technology intensive course, however, lies in the hands-on, "software hats" approach to teaching and learning technology concepts. The Pocket PC is a vehicle for promoting creative thinking while enhancing experiences with using and learning about technology on multiple platforms.

To assess learning outcomes, a common final exam was given to two standard sections following the traditional "concept book approach" and two technology intensive sections. The instructor of two technology in-

tensive sections, and the instructor of two standard sections each developed half of the questions on predetermined subject areas, and then reviewed each other's questions, together rewording or replacing those that either thought potentially inappropriate for one class or the other. Most questions were asked in multiple choice or short answer format. For the few questions for which partial credit would be awarded (on Excel formulas, or HTML coding), the two instructors together graded ten randomly chosen exams to determine uniform policies prior to grading the remainder of the exams. The results showed that the standard sections scored an average of 65% on the common final exam, while the technology intensive students scored an average of 85% on the common final exam. Students in the technology intensive sections following the experiential learning approach learned more about core information technology concepts than students in the standard sections, even though the students in the standard sections had a concept-based text book from which to learn.

7. FUTURE RESEARCH

With some modification, and perhaps a bit more guidance, it would be an interesting exercise to offer an IT 101 course that followed this hands-on approach (with or without the benefit of Pocket PCs) to a randomly selected group of students to note how experiential learning fares when compared with more traditional, text-based approaches to teaching this course.

As prices continue to drop on Tablet PCs, making their cost comparable to that of laptops, it would be a useful study to offer a similar course following the technology intensive format using only Tablet PCs to students in an introductory course who do not claim to have previous computing experience. Some assignments would require minor modifications to make full use of the specific features of these devices. Such a study would examine the effectiveness of this approach without requiring the additional expense of purchasing Pocket PCs. (In fact, it would save students money, as no printed texts would be used.) Students would lose the mobility experience and convenience of using Pocket PCs for on-the-go daily life management, and the advantages of multi-platform access, but the increased

popularity, functionality, and availability of Tablet PCs and specialized software applications make them a viable device for learning technology using this approach.

8. CONCLUSION

Throughout the course, students were able to relate with application software packages in different ways: from exclusively being users of native applications that provide information for them (but they could not modify), to being consumers recommending software applications, to administrators maintaining and configuring their devices, to designers of multimedia applications and web pages, to researchers using productivity packages to gather, analyze, and report findings on original data, to developers, actually creating original programs that would run on their own Pocket PCs. Framing the use of these applications and tasks in terms of "wearing software hats" promoted formal and informal discussions about new ways to use familiar software tools, possible career opportunities, and courses of study where students could learn more.

The Pocket PC was a motivational tool that helped make many course concepts real. Most students quickly became aware that having Pocket PCs set them apart from others in the standard sections, where laptops and textbooks were used. The active learning approach of using electronic books and Internet resources rather than printed textbooks enforces the notion of using technology to learn about technology, and promoted critical thinking about the sources of the online material. The course met the needs of an increasing number of technologically-savvy students who learned to apply IT 101 concepts outside the classroom in order to live technology-enabled lives.

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