HANDHELD COMPUTERS IN EDUCATION

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ABSTRACT

This paper discusses the use of ubiquitous computing by students outside and inside the classroom by asking the following questions. Does the immersion into handheld technology by students hold hope for implementation into the educational arena? Will schools move beyond institutional computers shared by many students in a laboratory situation to one that will allow students to collect data and collaborate with others? Can teachers use digital tools to gain an insight into the models that students hold? Finally, this paper will provide observations from recent research on use of handheld computers in K-12 classrooms in the United States.

INTRODUCTION

When one couples children's game interest with the small handheld computer's powerful new organizational features provided by both Windows CE and Palm OS systems for the businessman and woman, we are not surprised the use of handheld computers has become more visible in education. The discussion in this paper will center on the potential gains of using the handheld computers to improve student learning.

What are the barriers for placing handheld computers into classrooms? What are the benefits for placing handheld computers into classrooms? Will students be intrigued enough to use handheld computers in the classroom for more than playing games? Where is the value added of using ubiquitous [a] computing in classrooms? Will the use of handheld computers in education empower students? Will the use of ubiquitous computing provide insights into student models [b]?

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a Ubiquitous computing implies individual computing anytime…any place. http://www.ubiq.com/hypertext/weiser/UbiHome.html Although wireless computing is just arriving, various units, such as Cybiko (http://www.cybiko.com/what.asp), are rapidly entering the world of computing for children.

b Student models are conceptions that students hold regardless of investigations or interactions within the classroom. By clarifying these conceptions (or misconceptions), teachers are better equipped to determine how instruction will impact the students level of understanding.

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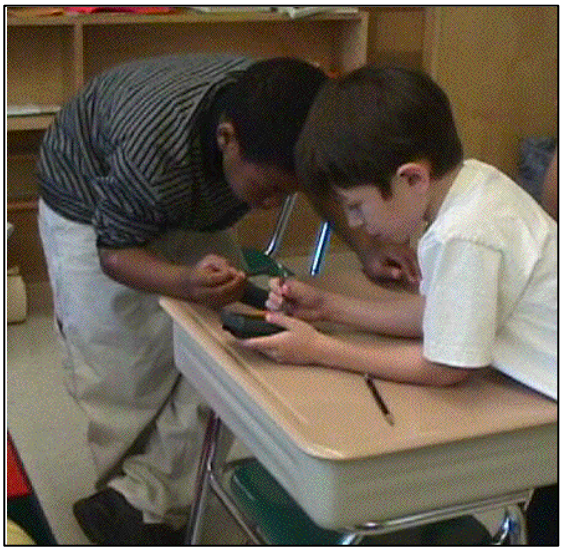
DIGITAL IMMIGRANTS

Digital Immigrant is a term that has been coined by Alan November [1] and Marc Prensky [2]. It implies that the younger generation has grown up and is more comfortable with a different set of technology tools than adults. As Alan explains it, "*Digital Immigrants* talk with an accent for the rest of their life. The *Digital Immigrant* generation really does not know that they are immigrants. They can't let go of the old technologies. Yet, the *Digital Generation* has a joy in learning new technologies. The *Digital Immigrants* can't move forward. They teach through old technologies and can't unlearn old ways. By the time they figure out they are immigrants, it may be too late. Unfortunately, if they teach with the old ways, not only will they be out of jobs, but they will not have prepared the natives (*Digital Generation*) for the world they have to face!"

Whenever new computing tools surface, past users of prior platforms have difficulty in adjusting to a new paradigm. One of the most common complaints of teachers, when faced with the use of handheld computers in the classrooms, is the size of the screen.



This was very apparent during the re CILT [c] research completed in K-12 classes. To secure pilot groups for testing on handheld computers, a second/first grade teacher was approached through the Cambridge School District office in Massachusetts. During an initial after school meeting to introduce the Palm to the teacher, the teacher was shown simple functions on the Palm and given one to "mess around" with at home. About two weeks later in an email, the teacher wrote that she would decline the opportunity to use it in her class. She felt that "…the Palm units were just too small for the little fingers and under developed fine motor skills of the first/second graders. The little pencil and the precise placement on the screen to activate the software could be frustrating for them [3]."

c The **C**enter for **I**nnovative **L**earning **T**echnologies (http://www.cilt.org) is funded by the National Science Foundation (NSF) has various themes. The Concord Consortium (http://www.concord.org) heads the Ubiquitous Computing theme (http://www.cilt.org/ubiquitous/ubiquitous.html).

Immediately another second grade teacher [d] was approached in the same school district. She showed an authentic enthusiasm for trying the handheld computers in her classroom. She requested to take one home and within two days responded that she was willing to try the Palm™ with her second grade class. The only condition that she insisted on was that the students not use **Grafetti**™, since she felt it would impair their cursive writing skills. She felt that the electronic keyboard could be called up on the screen and preferred that the students use this tool to write on the screen.

Both the teacher and the researchers were not prepared for what happened when the handheld computers were passed out to the students. Imagine twenty-five students waiting patiently for their computers while sitting (okay …jumping up and down excitedly) in assigned positions on the floor. We had imagined that the students would quickly grab the computers, but would need instruction on how to turn it on, move through applications, and find the stylus. What amazed us was the lack of questions. Students were giggling and moving around to share their screen displays with students around them. Many had found the stylus, but some of the students were using their fingers or thumbs to navigate around the screen! When one young boy raised his hand impatiently, to our surprise his question was not about how the handheld worked or why was the screen so small, but rather "Why isn't it in color?"

It immediately became apparent that the students already were familiar with a miniaturized computer. In fact, one such handheld computer has an even smaller screen than the Palm™…the GameBoy™ [4]! Students spend endless hours mesmerized by the different intricate simulations that they seem to navigate so easily by pushing buttons that are not directly on the screen.

So will children be enticed to use the handheld computer versus the GameBoy™? If the first attempt with younger students was any indication, they are thrilled with all types of handheld devices. The size of screen and their touch sensitive screens are among the benefits of both the GameBoy™ and the Palm™ [e]. This freedom to jump easily to a smaller device appears to be related to past experience. If an adult has worked many years on a larger screen of a desktop computer, they have the tendency to dismiss the power of the handheld computer. They surmise that it must be lacking functionality. We fail to realize that the smaller devices offer different benefits that may just be the reason why students are more willing to use this technology tool than

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d The second grade teacher was Shivanthy Srikanthan at Morse School, Cambridge Schools, Massachusetts that was willing to test within her classroom.

e The Concord Consortium has continued to work with several different platforms of handheld computers. For the Models and Data Project (funded also through NSF), researchers are testing the use of wireless iPAQ Pocket PC for data collection. See http://www.concord.org/library/2001spring/newscience.html

others. As much of our research has shown, adults are truly digital immigrants into the world that the students already inhabit. They expect, no actually they demand, more from their devices.

STUDENT NEEDS

In an age when most schools still have institutionalized computers [f], is it possible to provide a learning space for students with small devices designed primarily for gaming or organization in mind? To best answer this, let's reflect on the characteristics of the small gaming devices.

Why is the GameBoy™ so appealing to children? Packaging has a lot to do with it. The devices are designed to be personal and portable. They are very user friendly. To play a new game, the child only has to slip a new game cartridge into a slot on the backside of the GameBoy™. Recently, the GameBoy™ camera has been added as a SMART [g] device, so that, when popped into the GameBoy™, it instantly waves at you from the screen. Another feature of the packaging of the GameBoy™ is that it is hard to damage. The construction of the device is designed in molded plastic and is extremely durable. The whole device fits into a child's hand. This may appear to be insignificant, yet this extremely personal device now fits into a pocket and can be carried anywhere. It is truly a personal and portable device.

Children interact with the GameBoy™ in a limited fashion by scoring on the games and possibly capturing pictures. Although rewarding for the time, many of the features used by the business handheld computers, such as the Palm™, would further extend the capabilities for student learning. This tool feels much like the "toy" of a GameBoy™. Recent improvements in the design have increased the handheld computers durability by replacing the glass screen with a plastic one on the Palm OS [h] units. All of the Palm™ handheld computers can be expanded with cameras, probes, modems, etc. through the serial port to increase their capabilities. The Visor™ by HandSpring™ [i] allows for Springboard Modules to be added, by using a slot much like that found on a GameBoy™. These modules include the addition of MP3 players, mobile phones, GPS units, etc. The more expensive Pocket PC [j] versions have additional memory [k] and many additional add-on devices including microphones, video recorders, etc.

By using handheld computer with appropriate software, the student can interact in a deeper, richer way by creating and inventing their own artifacts. Much in the way businessman or woman records his or her schedule, and creates memos from their meetings, the child can use the handheld for administrative purposes. Where should you be for fourth period? What was my

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f An institutionalized computer is one that many students have access to either in a computer lab or one of few found in the classroom. The students have space on the school's network to store their work, thoughts, ideas, data, and drawings. This information is not usually available to the student at home or in their neighborhood.

g SMART devices load instantly and are recognized exclusively by the system. Other devices such as SmartProbes have been developed at the Concord Consortium so that power, programming, and calibration needs are built into the sensors. http://slic.concord.org/smartprobe.html

h The m105 Handheld was developed to facilitate a wider and safer use within the classroom. http://www.palm.com/products/palmm105

i Learn about the SpringBoard Modules at http://www.handspring.com/products/sbmodules/index.jhtml .

j View some of the most common Pocket PC operating with Windows CE at http://probesight.concord.org/supplier/handheld.htm .

k Pocket PC start with 32 MB of memory, where traditionally the Palm OS handheld computers range from between 2 and 8 MB.

assignment in Social Studies? How do I contact Josh and Amy to work on my science lab report? Besides games that provided the limited interaction previously mentioned, only business applications targeting organizational skills on the handheld computers existed until recently. But during the past three years, numerous additional educational applications beyond basic databases exploded onto the market.

VALUE ADDED?

But what about the student that wants to create a drawing or design a survey or invent his or her own solution to a community problem? We want to support true inquiry, but what tools do we provide in education for students to collect data anytime or at any place? Is there any other relatively inexpensive device [l] that will allow students to work in private, share data with other students, and ultimately publish to a larger audience possibly on the web?

Science and math teachers in the past were fortunate to use the graphing calculator and the portable Calculator Based Laboratory (CBL) [5] from Texas Instruments to collect data in the field. But not until the handheld computer were introduced into the science lab were students allowed to annotate and create their own sketches and notes on the technology tool while in the field. ImagiWorks ™ [m] provides these added features and will interface with a handheld spreadsheet and calculator, allowing for true analysis in the field. Now the student can ponder the phenomenon, ask the questions, test and retest their hypotheses, and draw their own conclusions.

What is so spectacular is that the student then is able to share and publish their results, either by beaming [n] or synching [o] to a lap or desktop computer. Students willingly share results in classrooms through collaboration within and among groups [p] after serious personal reflection. For some reason, sharing individual student work on paper does not seem to equal the rich results and level of detail that sharing by beaming invokes. Students are not only proud to share their thoughts, but are encouraged to respond to the thoughts of others.

EMPOWERING STUDENTS

The sense of responsibility for learning shifts from the teacher to the student. Although in the research over the past several years, I have heard the equivalent of… "Sorry, the dog ate my homework!"[q] with the handheld, yet truthfully this is rare. Most students look at the handheld as tool to extend their learning in and outside of the classroom. One good example is the classrooms

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l The price of handheld computers has dropped drastically during the past several years. Palm™ especially has promoted classroom sets of handheld computers (depending on the memory) for reduced pricing in the range of $120 - $200. Initial prices of Palm OS handheld computers were in the $400 range.

m ImagiWorks provides software, curriculum, an interface, and a variety of sensors to do contextual learning using Palm OS handheld computers (including the Visor™). http://imagiworks.com

n Beaming is the process of transferring files between handheld computers through IR ports.

o If you have installed the proper software on your laptop or desktop computer, all handheld computers can be synchronized with them by placing all handheld computers in a cradle.

p Active learning activities such as, think/pair/share or mind dumps, are quickly and easily completed by beaming between members of a group.

q The equivalent would be… "My Palm™ crashed and I had forgot to synch it!"

of health students [r] that use the Palm™ all semester long to log their food intake and exercise output. They design a fitness plan on the handheld and calculate their calories and fat consumption and compare it to their output during exercise using an interface from Vivonic [6]. By using the portable handheld, students expand their learning environment to include the world in which they live.

This expansion of their knowledge pool allows the students to experience deeper contextual learning. New educational applications [s] on handheld computers promote student reflection by providing ways to display multiple representations of formulas, graphs and tables, multiple inputs from sensors, cameras and beaming, and multiple outputs to printers or other handheld computers through beaming or even to net browsers on the desktop. How the students tackle this mound of knowledge will provide a powerful insight into how they learn.

TEACHERS AS RESEARCHERS

As the students are actively engaged in asking and answering their own questions about their world, the students are making their own meaning out of their experiences. Student note-taking, sketch-making, design and analysis is extremely personal and significant in the understanding of student models. This style of learning is student-directed instead of teacher-directed. Students become part of the learning community by explaining their experiences in their own words. Students willingly seek justifications for their own beliefs.

By using critical and logical thinking, the students are able to consider alternative explanations and concentrate on resolving conflicts [t] that occur. This provides a powerful window for the teacher to glimpse at the student models. By tracking the artifacts students select to record and collect, steps students choose to follow through the software, and the actual tools the students decide to use [u], the teacher can discover student conceptions (or misconceptions) and promote building a stronger foundation for future learning.

BEYOND GAMES

As a *Digital Immigrant* and former teacher that knew instantly that handheld computers provided a technology that would excite students, I must confess that I still don't use a handheld to keep addresses or phone numbers. I do, however, daily use the handheld to collect data with sensors, take notes during meetings, and draw pictures (especially for directions). But compared to the children observed during research, I am just a novice! This was made painfully clear during a recent, weeklong space camp with fourth through sixth graders in Chicago. Students were logging their daily tasks for twenty-four hours. Students listed and shared their logs through the use of a

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r This activity was designed by health teacher, Barbara Walaszek (BWalaszek@d230.org) in District 230, Orland Park, Chicago, Il.

s Visit http://pie.concord.org for teacher-written reviews, project starters, companion applications, and correlation to standards for educational applications on the Palm.

t Concord Consortium researchers use models and handheld computers to investigate how students learn science http://www.concord.org/library/2001spring/evidence.html

u The Concord Consortium is presently developing Pedagogica. This hypermodel approach to technology allows teachers and researchers to have a better understanding of the learning environment. http://www.concord.org/library/2001spring/perspective.html

spreadsheet [v] on the Palm™. Students used the calculator (found also on the Palm™) to determine the percentage of hours for their daily logs and to display their line graphs, bar graphs, and pie charts, although they had not been shown how to make the graphs. Students had been investigating the potential of the spreadsheet during lunch and had learned from each other how to graph the data and label it with a legend! What really struck home was that I had tried to personally make a pie chart and had failed to display a meaningful graph. I must say, that I willingly took instruction from a *Digital Native* (child) to learn how.

It has been over four years since the Concord Consortium started research into the potential of handheld computers [7, 8] in the classroom. Each year the number of educational applications that promote collaboration, mobile data collection and display, and the creation of student artifacts increase. The cost of the handheld computer decrease and their memory size increase. The only characteristic that doesn't change is the excitement when you place one in the hands of the child for truly educational purposes. The enticement of using a "cool" tool that has the feel and the look of a toy to promote educational applications in the classroom, has definite promise to being the personal computer of choice for the students of today and tomorrow.

REFERENCES

1 November, A. See http://www.anovember.com/

2 Prensky, M. (2001). See http://www.twitchspeed.com/site/article.html

3 Rizzuto,M.(1999) "Mary Rizzuto/palm pilots", email transmission on 2/7/99

4 http://www.komkon.org/fms/GameBoy/

5 http://education.ti.com/product/tech/cbl/features/features.html

6 http://www.vivonic.com

7 Staudt, C. (1998) "Mobile Computing Accelerates Learning: Portables improve math and science performance", *@CONCORD*, Fall 1998, p. 6+

8 Staudt, C. (1999) "Probing Untested Ground: Young Students Learn to Use Handheld Computers", *@CONCORD*, Fall 1999, p.1. (available at http://www.concord.org/newsletter/)

v Cutting Edge Software provides spreadsheet (QuickSheet) and data visualization for importing data directly on the Palm™. http://www.cesinc.com