Ubiquitous Computing Projects: A Brief History

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Introduction

The term "ubiquitous computing" was first used by the late Mark Weiser at Xerox Palo Alto Research Center (PARC) to describe a vision of future technology that would be always available, often monitoring or anticipating the user's needs, even when the user was not explicitly aware of the technology (Weiser, 1991). This vision has launched a number of less ambitious models, such as pervasive computing (IBM, 1999), where computing function would be available whenever and wherever needed. The annual Ubicomp conference is an international gathering where scientists who share this vision present the results of their research (see http://www.ubicomp.org) .

For our purposes, the definition is somewhat less ambitious and specifically refers to environments where K-12 teachers and students have access at school (and preferably at home) to portable and connected computing capability.

The history of ubiquitous computer applications in mathematics and science education has two major periods – the era prior to the dawn of the World Wide Web, and the current era beginning in 1995. The introduction of the Web was accompanied by three amplifying trends: the emergence of inexpensive technology in a portable package; accelerating improvement in (often wireless) communications capability; and the invention of standard, easily-learned browsers that allowed users to explore a worldwide (and searchable) knowledge resource. This combination of resources established a

quantum leap in capability, and has resulted in a paradigm shift in the way that teachers and students think about learning with technology (Dede, 2000).

Prior to the Web, most ubiquitous applications were designed to make some level of computer-based education (CBE) available to students. Connectivity was not particularly important and often consisted of "beaming" – using an infrared serial communication capability that would allow a teacher to transmit questions, or schedule information, or other data to students, and let students send back results for printing or analysis by the teacher (Byrom & Bingham, 2002). The Web made it possible for students to do all of those things, as well as to connect to vast resources of knowledge, to learning applications, and to each other. These capabilities have had a powerful effect on the growth of ubiquitous computing in K-12 education.

1985 – 1994 (Pre-WWW Era) Projects

Living in 21st century America, it is easy to forget that less than 20 years ago personal computers were bulky, slow, and expensive. The few classroom networks that existed were slow, and software was mostly text-based. Then Apple Computer Corporation introduced the Macintosh computer, and set a new standard for graphics, connectability, and ease of use. Some educational technology advocates began to wonder what would happen if all students and teachers could have access to this technology.

Apple Classroom of Tomorrow (ACOT)

The ACOT project began in 1985, shortly after the introduction of the Macintosh computer, and was designed as a research opportunity to explore the effects on learning

when computers were available to all students and teachers. In ACOT classrooms, students and teachers had immediate access to a wide range of technologies, including computers, videodisc players, video cameras, scanners, CD-ROM drives, modems, and on-line communications services. In addition, students could use an assortment of software programs and tools, including word processors, databases, spreadsheets, and graphics packages. In ACOT classrooms, technology was viewed as a tool for learning and a medium for thinking, collaborating, and communicating (Apple Computer, 1995). Teachers began to share information on national bulletin board systems like Prodigy and Quantum; in 1989, Quantum renamed itself America Online, and in 1992 Apple introduced a competing eWorld service (terminated in 1995).

The Buddy Project

The Buddy Project began in Indiana in 1988 as a project that provided computers to all fourth grade students in participating classrooms. A major objective of the program was to use technology to involve the whole family in a student's learning. The project has since evolved into Buddy^2, and retains its belief that all families, regardless of financial circumstances, need access to information, technology, and training to enhance learning in school, home and the community (Buddy^2, 2003). (See Table 1.) More than 30,000 students have been involved in the Buddy Project.

Newton

The Newton MessagePad, the first hand-held Personal Digital Assistant (PDA) product, was introduced by Apple Computer Corporation in 1993. Although 200,000 Newton MessagePads were produced, the system had a number of cost and design

problems; in 1998 Apple discontinued the product. The Apple eMate portable computer grew out of the Newton design effort, and uses the Newton operating system. The eMate was promoted by Apple as a 1:1 candidate for K-12 education and was an early sub-$1000 portable computer in ubiquitous computing applications. Apple's withdrawal of support for the eMate is an ongoing source of concern for early adopters (Shear, 2000).

Table 1 – Change in Buddy^2 Emphasis over Time

Then...1988-2000	Now...2000- Present
Emphasized state sponsorship.	Emphasis on local community sponsorship.
Focused on classroom curriculum integration of technology to meet student and teacher choice of topics.	Focuses on core values and extending learning to home and community to support achievement of academic standards.
Trained teachers.	Support teachers in parent/family training.
Exclusively available in state-specified grade levels.	Total school involvement or locally targeted grade levels or programs.
Provided home technology for all, regardless of existing home technology resources.	Use existing home and community-based technologies but promote access for all.
Homework is practiced – students reinforce what is learned at school by using technology.	Extending and elaborating upon school learning by using technology.
Building administrators had little or no input into local project direction and implementation.	Building administrators are pivotal in deciding curricular direction and program design.
Buddy was a single "project" - all member schools signed up for the "same thing."	Buddy is multifaceted, with a variety of projects and services offered that exemplify and magnify shared core values.
Facilitation services were evenly distributed among all participating schools.	Facilitation services are linked to specific project involvement.
Conferences were held twice yearly and were targeted to member school participation.	Events are held as appropriate to support and share Buddy^2 initiatives.
An annual site implementation plan was required.	A brief annual application form required.

Palm

The Palm Pilot PDA had less financial backing than the Apple Newton MessagePad, and did not appear commercially until 1996. However, the Palm did not try to recognize natural handwriting; instead it relied on a simplified approach called Graffiti and included a built-in training program to help users learn the Graffiti system. The Palm quickly became a major success, and probably contributed to the demise of the Newton, at which time the Palm development team attracted a number of development leaders from the Apple Newton design team. The Palm OS supports the attachment of a number of devices, including instruments and probes. At least two major educational research consortia — the Center for Innovative Learning Technologies (CILT), a consortium that includes SRI International, UC-Berkely, Stanford University, Vanderbilt University (see http://www.cilt.org), and the Center for Highly Interactive Computers in Education (HICE) at the University of Michigan (see http://www.hi-ce.org/) — are currently using Palm and compatible devices in K-12 learning environments, including mathematics and science education.

Other

At least one other technology deserves mention – the handheld graphing calculator. These devices — introduced by Texas Instruments, Hewlett Packard, and Casio – are scientific calculators with a small display that allow the user to dynamically graph values as they are calculated. While limited in overall data processing function, the devices enhanced capability provided by other available technologies, and could be offered at prices that were affordable by schools and many parents. As a result, millions

of graphing calculators have been sold, and in many mathematics and science classrooms the devices are ubiquitous. With the advent of flash memory and downloadable software for graphing calculators, the dividing line beween these specialized devices and more general purpose handhelds has begun to blur. Video output from some graphing calculators can be fed to a TV or LCD projector for classroom viewing.

Current Ubiquitous Projects

The development of the World Wide Web amplified the utility of one-to-one computing by providing students and teachers immediate access to vast information resources. Overnight, the basic problem in gathering data changed. As John Naisbitt phrased it, "We are drowning in information but starved for knowledge" (Naisbitt, 1984).

Cost has been most often cited as the major impediment to the implementation of ubiquitous laptop initiatives, where every teacher and student would have a laptop for their personal and professional use. Elliot Soloway has been one of the leading advocates for schools to consider using handheld computers, referring to the over $1,000 cost of most laptops versus the under $500 cost of most handhelds (Soloway et al., 2001). This distinction is beginning to blur, however, as greater numbers of laptops become available in the $500 - $999 range, and the cost of fully configured handheld computers approaches $800.

In the future, the choice of handheld or laptop may be driven more by the expected usage, with handhelds becoming the ultraportable device of choice for fieldwork in math and science (using probes or GPS attachments), and laptops being the technology of choice for general applicability between school or home (Garofalo, 2003).

Laptop Initiatives

Large school districts (e.g., Henrico County, VA) and even whole states (e.g. Maine) are adopting initiatives involving laptops using wireless networks connected to the Internet. Many vendors are supporting these efforts. The quoted information in the following sections is taken from the vendor literature.

One-to-One (Apple)

The Apple iBook laptop computer is at the heart of a number of K-12 initiatives being supported by Apple Computer, Inc. "Now iBook provides even more choice. Still small, lightweight, and durable with long battery life, the iBook allows you to choose a 12.1-inch or 14.1-inch (diagonal) TFT XGA display, depending on your needs. Every iBook comes with iMovie 2, iPhoto, 10/100BASE-T Ethernet, 56K modem, VGA video output, S-video and composite video output (requires Apple Video Adapter), FireWire port, two USB ports, AirPort optional."

Anytime-Anywhere (Microsoft)

"Access is a key component to Microsoft's vision of a Connected Learning Community. To help bring that vision to reality, Microsoft has created the Anytime Anywhere Learning program which helps schools provide 1:1 access to technology through the use of notebook computers".

Notebooks for Schools (Toshiba)

"Toshiba America Information Systems, Inc., in partnership with Microsoft Corporation's "Anytime, Anywhere" learning, introduced Notebooks for Schools in April,

1997 in support of data that demonstrates that the educational experience can be significantly enhanced by using computers as an integral part of the educational process—to collect, assimilate, refine, and communicate knowledge. This goal can be accomplished with individual student ownership of mobile personal computers."

Reinventing Education (IBM)

In 1998, the Center for Children and Technology (CCT) at the Education Development Center began a long-term study of the IBM Reinventing Education grant program sites. Three years later, CCT has found that "IBM's Reinventing Education program produced successful solutions that are dismantling long-standing barriers to public school reform -- barriers like how teachers are trained, how information is shared and used, and how learning is measured."

"Without easy access to computers, teachers are unable to take advantage of technology to present new concepts with rich media, interactivity and 3-D animation. Mobile computing allows students to analyze, explore and discover on their own. Anytime, anywhere access facilitates collaborative learning and fosters open communication between students and teachers. IBM has implemented more than 60 ThinkPad at School programs."

Handheld Initiatives

The current world of the handhelds is divided by the operating system used to control the devices.

The Palm Operating System (Palm OS) was originally developed to support the Personal Digital Assistant (PDA) application, a combination of calendar, note taking, phone-email directory and to-do list. The current trend is to de-emphasize the PDA applications and build support for these devices as handheld computers, which have a built-in PDA capability, but can also connect to a desktop computer and download other applications, news, e-books, etc. More recently, support for digital camera functions and cellular telephone functions are available for these systems. Handheld devices with wireless Internet connectivity are available at prices that approach the bottom end of the laptop market. Manufacturers supporting the Palm OS include Palm, Handspring Visor, Sony CLIE, and AlphaSmart Dana.

The alternative software platform was introduced by Microsoft in 1999 as the Windows CE operating system. Hewlett-Packard and some of the other laptop manufacturers chose this platform to deliver more general-purpose computing functions. The Windows CE operating system is now called the Pocket PC operating system to emphasize its suitability for handheld applications. Manufacturers supporting the Pocket PC (Windows CE) include Compaq, HP Jordana, Casio, NEC, and Toshiba.

Other

A few other portable computer-like devices can be found in K12 schools. These devices tend to be lower cost hybrids, offering a larger keyboard and display than the handhelds, but less function and cost than a laptop.

EMate. The EMate 300 was introduced in 1996 as a 4-pound portable device that sports a stylish and rugged outer casing with a built-in handle. Based on Version 2.0 of

the Newton operating system, EMate 300 includes a Web browser, E-mail program, spreadsheet, word processor, drawing program, graphing calculator, address book, notepad and calendar. The product is no longer available from Apple Computer, Inc.

AlphaSmart. The AlphaSmart is an under $200 word processor with a rugged case and a four line display. The new Dana has an 8 line display and supports the Palm OS.

DreamWriter. The DreamWriter is available in several configurations including one that is a word processor similar to the AlphaSmart, and another that is more like a laptop and is specifically marketed for science education. The DreamMax is an under $800 computer in a package very much like the Apple eMate. A 16-unit package in a mobile cart is priced at $13,200. The Science Branium Web site offers a number of classroom applications.

http://www.brainium.com/content.asp?pid=2030&param=noheading&solution=142

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