Commentary: Ubiquitous Computing Revisited—A New Perspective

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In 2002 representatives from the teacher educator associations representing the core content areas (science, mathematics, language arts, and social studies) and educational technology met at the National Technology Leadership Retreat (NTLR) to discuss potential implications of ubiquitous computing for K-12 schools. The NTLR participants envisioned that students might carry inexpensive, lightweight portable devices containing educational applications and data. The representatives from these associations developed seven statements regarding ubiquitous computing, which were published in a sidebar in our article, "Grand Challenges: Preparing for the Technological Tipping Point" (Bull, Bull, Garofalo, & Harris, 2002):

1. Ubiquitous computing will be a widespread force in schools by the end of the decade or sooner.
2. Ubiquitous computing will be a disruptive cultural force with great potential for good or ill.
3. Educators at all levels have a responsibility to articulate constructive visions for ubiquitous computing.
4. Educators must be prepared to use ubiquitous computing to advance teaching and learning.
5. Educators must work with hardware and software developers to shape pedagogically sound educational tools and evaluate them before widespread implementation in schools.
6. Small-scale pilot initiatives need to be immediately undertaken to demonstrate feasibility across a demographically-representative range of schools before ubiquitous computing takes place on a larger scale.
7. Pilot initiatives should be evaluated to ascertain the effect of ubiquitous computing on teaching and learning, and these findings should be used to guide future educators. (p. 11)

We are halfway to the end of the decade, so it may be a useful time to reexamine some of the underlying assumptions and conclusions of this retreat in light of recent developments.

Ubiquity of computing outside schools is significantly changing scientific collaboration, commerce, and social interactions. The way in which leisure time is spent is very different than a few years ago. In the last half of the 20th century a typical child watched television an average of 3 to 4 hours per day. This experience essentially consisted of passively viewing materials created by others.

A recent survey by the Pew Internet and American Life Project (Lenhart & Madden, 2005) found that 87% of all teenagers report using the Internet. The majority of students interact with one another socially via the Web. They use text messaging, voice over Internet protocol (VOIP) communications, and videoconferencing to communicate with one another. They interact with and use online media – digital music, video, and news accessed through the Web.

More than half of all teens are now content creators on the Internet – creating and sharing media such as original artwork, digital photographs and videos, Web logs, and Web pages. This transformation has been accelerated by a transition to the Web as a platform (sometimes referred to as "Web 2.0 applications"). Because of this transformation, the current era has been characterized as the "age of participation."

In our original "Grand Challenges" article, we based our assumptions on future directions, in part, on the pattern of diffusion of graphing calculators developed in the 1990s. These are now used in almost all high schools. Graphing calculators are essentially inexpensive, specialized handheld computers developed for a single subject. Only a short creative leap was required to imagine extension of these devices to general-purpose lightweight handheld computers.

The pattern of diffusion has not occurred in the manner we envisioned. A general-purpose handheld device designed specifically for education has not emerged, nor has any device that combines the functionality of existing graphing calculators with productivity applications.

Instead, the focus of the technology developers has shifted to cell phones that combine multiple functions – camera, personal digital assistance (PDA), communication device, etc. Many adults are unwilling to carry both a cell phone and a separate PDA. Consequently, as adoption levels for cell phones increased, much of the research and development funding that previously had been dedicated to PDAs was diverted to development of similar capabilities in cell phones. And because of the many potential misuses of cell phones in schools, few have been willing to consider taking advantage of their capabilities in an educational capacity.

A New Perspective on Ubiquity

Although development of a multisubject, lightweight portable computer has been sidetracked by cell phones, ubiquitous computing has taken shape in other forms. The trend appears to be for students to use multiple computers in multiple locations – in the school lab, in a public library after school, at a friend's house, or at home. Students typically do not carry a single dedicated processor with them. Rather, they carry only data and documents on a flash memory drive (or an MP3 player). For these students, computing has already become ubiquitous.

Another trend is emerging: Web services. This will allow future users to access both applications and data via the Web. Because both the application and data reside on the

Web, students will be able to work from any place that an Internet connection is available. As an added bonus, most Web-based applications incorporate collaborative tools that facilitate social interactions.

This is already affecting the way in which students access academic resources. Usage patterns have shifted dramatically as students access digital resources via the Web rather than physically going to bookshelves. Teens and parents report that the Internet is vital to completing school projects and has effectively replaced the library for a large number of online youth. Seventy -one percent of students reported using the Internet at their primary source for their last major project, (Lenhart, Simon, & Graziano, 2001). Librarians have recognized that their role is changing.

A variety of form factors for accessing the Internet are continuing to proliferate. More than half of all teens now have cell phones, and newer models often support text messaging, e-mail, and Web browsing. In addition, rapid advances in projector technologies and associated decreases in cost are encouraging use of this technology for whole-class instruction.

Teaching in a Ubiquitous Environment

Some teachers are already taking advantage of the ubiquitous access that many students now have. They are distributing assignments and digital resources via the Internet, confident that most students will be able to obtain access to a terminal. In some cases teachers still provide paper copies for the decreasing number of students who do not have ready access. Interactive resources, such as online practices tests with feedback, electronic spreadsheet files in mathematics, and audio files for language class, may be available only in electronic form. Some are exploring the use of podcasts and MP3 players in school settings. This raises continuing equity issues for those students without ready access (currently estimated to be about 15% of the teenage population).

There is a need to study this changing environment to determine conditions under which positive effects on learning outcomes may be achieved. There is some evidence that teachers' planning and instruction may be positively affected by this new capacity. As best practices for this environment are identified, it will be crucial to incorporate them into teacher preparation.

Possible Futures

An affordable portable educational computing device may be available at some point in the future. MIT has just unveiled the prototype of a $100 laptop designed for schools in developing countries. Advanced Micro Devices has announced plans for a Personal Internet Communicator (PIC) with a target price of about $185, and Novatium hopes to offer a home computer for approximately $75. These efforts suggest significant interest and indicate that these entities still believe this to be a feasible goal.

Summary

To date ubiquitous computing has not emerged in the form that we originally envisioned, as a portable device designed specifically for schools.

- Students are instead accessing multiple computers from multiple locations, in another form of ubiquitous computing.

- Many students are also carrying multiple single-purpose handheld devices such as cell phones, iPods, and graphing calculators.

In the future, it may yet be possible for each student to have a portable educational computer as a result of several ongoing educational initiatives. In the meantime, the current forms of ubiquitous computing are already affecting school and schooling. Consequently, the recommendations originally developed by the interdisciplinary task force remain relevant.

References

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