Embedding Ubiquitous Technologies

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INTRODUCTION

Since the onset of technology as a tool in our personal and professional lives, we've progressed through at least two waves or stages of computing. The concept of ubiquitous computing names the third wave of computing, still in its infancy stages. The first wave consisted of mainframe computers shared by numerous people. The majority of society is presently in the second wave of the personal computing era, where people and machines interact through a predominantly iconic environment. The third phase of computing, referred to as ubiquitous computing, or the age of *calm technology,* takes place when technology recedes into the background of our daily lives. Alan Kay of Apple calls this the "third paradigm" of computing, while Weiser coins it as the "third wave" of computing (Weiser, 1996).

In Weiser's (2006) third wave of computing, we achieve a vision of multiple computers per person in which "technology recedes into the background of our lives" (p. 1). To reach this point, each individual would need a personal computing device. Studies have shown that students are increasingly gaining access to computers outside of school, whether it be in their own home, a neighbor's house, or the public library. However, schools have yet to even achieve a ratio of one computer per student (Bull & Ferster, 2005-2006).

During this time, we have experienced distinct phases of computing that include: (1) the strife for one-to-one computing, and (2) portable devices with wireless access. Each of these phases has revealed some insights into future ubiquitous technologies and research. According to America's Digital Schools (ADS) 2006 five-year forecast, "the transition to mobile computing will help facilitate the transition to ubiquitous computing, which is not practical in desktop computer environments" (Hayes Connection & Greaves Group, 2006, p.1).

The ADS 2006 forecast further defines this one-to-one ubiquitous computing environment as one in which each student and teacher has an Internet-connected wireless computing device for use both in the classroom and at home that is not shared with others. For the purposes of this article, this is how ubiquitous computing will be defined.

BACKGROUND: NEGOTIATING THE WAVES

In the next section of this article, we will take a historical look at how each of these phases has contributed to the embedded ubiquitous environment within educational settings.

One-to-One Computing: Origins and Goal-State

Throughout the 1980s and 1990s, it was common for schools to place all computers in a centrally located lab or media center (Means & Penuel, 2005). These labs were found to be somewhat effective for students (Kulik, 1994). However, limited access is one reason why the integration with technology as an instructional tool was minimal in many classrooms (Cuban, Kirkpatrick, & Peck, 2001; Sheingold & Hadley, 1990). To make technology more powerful in regards to student learning, it was and still is deemed that students must be able to use computers more than once or twice a week in a school lab setting (Kozma, 1991).

Some of the major recommendations by researchers for educators and decision makers towards effective one-to-one initiatives include distributing a few computers throughout all classrooms, providing more time for teachers to collaborate across subject areas, and providing adequate technical staff to maintain computers and high-speed Internet access (Cuban, 2001). Providing such technology access and support within a networked environment at the classroom level in the 1980s and 1990s demonstrated major shifts in the learning environment, such as whole-class to small group instruction and lecture and recitation to coaching (Collins, 1991; Dwyer, Ringstaff, & Sandholtz, 1991; Sandholtz, Ringstaff, & Dwyer, 1997).

Portables with Wireless Access

In order for teachers to be effective in providing real-world connections, they need to understand and utilize the new wave of communication tools posed to future generations of mobile users and learners. Small group instruction and coaching can easily lead to creating a community of learners (Rogoff, 1994). A more interpersonal environment in which students and teachers become learning partners and experience role-reversals in terms of knowledge experts regarding content and technology. Considering the emerging mobile learning milieu, the community of learners environment becomes more important in terms of how students view information, communication, and community. This is a very different view from prior generations (Kleiman, 2004).

According to the America's Digital Schools (ADS): A Five-Year Forecast Report (2006), schools have rarely changed as quickly as we find them today transitioning from a desktop world to a mobile world. This mobile world includes laptops, tablets, and student appliances, but not cell phones. In the 2006 ADS report, researchers found:

- Students' use of mobile technology is currently at 19.4%, while 52.1% are projected to be mobile in 2011;
- 1:1 computing is currently found to be in process in 24% of school districts, versus 4% in a 2003 report;
- Academic improvement results were tracked to show 87% of the schools with moderate to significant positive results and 13% reporting no or poor results; and
- Online learning is growing at the rate of a 26.3% compounded annual growth rate;
- Professional development to support 1:1 initiatives is seen as extremely important by 65% of superintendents, yet only 16.9% of district curriculum directors believe their current professional development is prepared for such support; and
- Student appliances (113%), tablet computers (82.7%), PC laptops (25%), and Mac laptops (23.7%) will grow significantly over the next five years (Hayes Connection & Greaves Group, 2006).

These statistics indicate rapid technological growth for today's professional educators. Mobile, ubiquitous education is imminent and will change the face of learning environments through alterations in space, different areas of life, and time (Vavoula & Sharples, 2002). Literature reveals that teachers need assistance in learning how to integrate technology into their curricular plans (Kanaya, Light, & Culp, 2005; Schwab & Foa, 2001). Ubiquitous learning also necessitates teachers' assistance in learning how to integrate such portable technologies.

CATCHING THE UBIQUITOUS TECHNOLOGY WAVE: EMERGENT UBIQUITY ISSUES

It is too early to indicate if the changes being brought about by embedding ubiquitous technologies to the curriculum will provide solutions to problems and questions posed throughout educational technology history. Therefore, more focused and inventive in research and development efforts within the field of educational technology becomes paramount.

A number of researchers have argued that ubiquitous computing with wireless connectivity has the potential to change learning environments and outcomes (Roschelle, Penuel, & Abrahamson, 2004). Yet, other researchers have found that "the No Child Left Behind legislation and the economic situation of the past few years have been slowing, and in some places, reversing, progress in these types of uses of educational technology," as well as causing educators "to focus on how technology can be used to increase test scores" (Kleiman, 2004, p. 250). More innovative, constructivist-based activities that better prepare our students for the 21st century exist and provide great learning motivation for students and educators.

In the author's opinion, further research and development is needed because of the slow or apprehensive overall migration towards progressive ubiquitous learning environments within elementary, secondary, and post-secondary educational settings. In light of what current research tells us, the following will be presented: (1) administrative guidelines for supporting ubiquitous technologies; (2) a practical ubiquitous learning design guide; and (3) suggestions towards ubiquitous technology research frameworks.