Teaching and Learning with Mobile Technologies

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INTRODUCTION

For the past decade, handheld devices with mobile and wireless capabilities have emerged as the next promising generation of technology for teaching and learning. Today, handheld devices such as mobile phones, personal digital assistants (PDAs), portable gaming devices, and tablet PCs have already become pervasive in daily lives of students. With this trend, there has been increased interest as to how mobile technologies can be used to enhance teaching and learning. One of the challenges for educators is to examine how we can use the new innovations of mobile technologies to create learning experiences that are often limited in traditional classroom environments. The purpose of this article, therefore, is to provide innovative and practical applications of mobile technologies in a variety of educational contexts, including from K-12 to higher education and informal learning.

TYPES AND CHARACTERISTICS

In this section, a few types of promising mobile technologies and their characteristics are described. A mobile phone is a portable communication device. Besides a basic communication service, current mobile phones offer a variety of services, including: (a) sending and receiving text messages, (b) reading e-mails, (c) browsing the Web, and (d) taking and sending photos. In particular, a recent High Speed Downlink Packet Access (HSDPA), which delivers "peak rates of 14 Mbps and average throughput rates close to 1 Mbps" (Rysavy, 2004, p. 4), supports even more demanding services such as video conferencing calls and rich multimedia applications.

PDAs (e.g., Palm Pilot and Window Pocket PC), featured as a small-sized touch screen and stylus, are relatively small, light, and cheap compared to other mobile technologies. While PDAs have been primarily used for organizing schedules, taking quick notes, managing a list of contacts, and checking e-mails, they have also been the most popular handheld device for mobile learning. In recent years, the capabilities of PDAs have been expanded with a built-in voice recorder, camera, MP3 player, wireless connection, and increased memory. As such, people are looking for more applications of PDAs for teaching and learning than before.

A laptop computer is equivalent to a desktop computer in terms of functionalities, but is superior to a desktop computer in terms of portability (Yang, 2005). However, there are limitations to using a laptop computer for education due to its relatively high cost and relatively short battery life compared to other mobile devices.

Tablet PCs have a touch screen which is much larger than that of PDAs, and are lighter and slimmer than laptop computers. Like PDAs, people can directly write on the touch screen of a tablet PC with a stylus. Besides this basic feature, tablet PCs offer a variety of features, including "note taking facilities, text searching, document annotation, and speech recognition" (Sharples & Beale, 2003, p. 395). They are generally categorized into two types: 1) slate models which come without keyboards, and 2) convertible models which come with an attached keyboard (Van West, 2005). A keyboard and a mouse can be also used with slate models via USB cable or wireless connection. Therefore, tablet PCs can be used like laptop computers.

The commonalities of these wireless mobile technologies are portability, connectivity, and versa-

tility. They enable learning to be ubiquitous in and out of classrooms, provide potential opportunities for collaborative learning, and enrich learning experiences with the support of technologies. Figure 1 below shows a mobility continuum in terms of learning, system, and communication. As learning moves from individual to collaborative, the mobility of learning devices is increasing. Accordingly, it necessitates more decentralized technology systems supporting many to many communication. For instance, participatory simulations (Colella, 2000) as a type of collaborative learning requires mobile devices that allow communication channels and input systems among multiple learners. The next section discusses four types of applications of mobile technologies along this mobility continuum: (a) mobile individual learning, (b) classroom communication systems, (c) mobile computer-supported collaborative learning, and (d) participatory simulation.

APPLICATIONS IN EDUCATION

Mobile Individual Learning

Wireless and mobile technologies have been used to promote individual learning either by reaching individuals through mobile devices or by brining learners to the context where learning happens. Thornton and Houser (2004) explored the potential of short message service (SMS) for vocabulary learning as part of English language courses. They found that more than 90% of students acknowledged this SMS as a valuable teaching method for vocabulary learning and that students who received SMS outperformed those who learned vocabulary on paper or through the Web.

The water quality research (Crawford & Vahey, 2002; Vahey & Crawford, 2002) is one of the most cited examples about the use of handheld computers for individual inquiry-based learning. Using "the Palm handheld computers along with the ImagiProbe system and Vernier probes" (Vahey & Crawford, 2002, p. 6), high school students collected on-site and laboratory data to examine the water quality of the local stream. They also analyzed data, generated research questions based on data analysis, tested the hypotheses, and wrote their journals. Handheld computers supported learning through authentic activities in contexts in which students, acting like scientists, gathered information.

Another example of mobile individual learning is a Bird Watching Learning (BWL) system, implemented in Taiwan (Chen & Kinshuk, 2005). The purpose of the BWL system was to support outdoor birding watching activities, which provided students with opportunities to closely look at birds through a telescope and to listen to what experts said about key features of birds. The BWL system creates a wireless mobile ad-hoc networking environment with the aid of wireless or mobile devices: a Wi-Fi-based wireless laptop, a digital camera, and PDAs equipped with IEEE 802.11b wireless network card (Chen & Kinshuk, 2005). Acting as a local server, a teacher's wireless laptop broadcasts photographs and video files of birds from a massive database of the birds to students' PDAs. Using PDAs and automatically generated queries about birds (e.g., bird color, size, etc.), students could search the database for relevant information about birds.

The wireless and mobile technologies can be also used for individual learning in informal settings as well as classrooms. Mobile devices equipped with the location-aware learning system (LALS) provide unique learning opportunities to visitors in museums or planetariums (Chang, Sheu, & Chan, 2003). The LALS senses the location of the visitors so that they can get context-specific information on their PDAs. The Tate Modern Museum in London, for instance, implemented multimedia tour systems using the method described above in July 2002 for the first time (Proctor & Burton, 2003). With the help of the handhelds equipped with LALS, visitors could construct knowledge about a specific exhibit by viewing informative videos and still images, listening to expert explanations, and searching for the gallery database on a specific exhibit.

Classroom Communication Systems (CCSs)

The first product of the classroom communication system (CCS), *Classtalk,* was invented in the late 1980s by a group of NASA scientists, engineers, and physicists who wanted to realize Socratic teaching and to facilitate students' active learning in large classrooms (Abrahamson, 1998). Since then, this technology, also known as the classroom response system (CRS) or classroom performance system (CPS), has been adopted in various subject areas (to read the exemplary applications of CCS in education, refer to Abrahamson, 1999, Davis, 2003, Dufresne, Gerace, Leonard, Mestre, and