Mobile learning technologies and educational applications

***Ozlem Ozan, Gonca Telli Yamamoto**, Yasar University, Turkey*
***Uğur Demiray**, Anadolu University, Turkey*

ABSTRACT. Mobile learning has been one of the reflections of the widespread adoption of wireless technology and Internet access from any place and anytime if requested. Technology and pedagogy are two main elements in mobile learning platform to identify in terms of educational process. Technology defines the platform and pedagogy defines the learning approach.

There are two basic factors defining mobile learning technologies: mobile devices and mobile operating systems. Typical examples of mobile devices are mobile phones smartphones, palmtops and handheld computers, Tablet PCs, laptop computers and personal media players. Mobile operating systems are Nokia's Symbian OS, Apple's IOS, RIM's BlackBerry OS, Microsoft's Windows Phone OS, Linux, Palm WebOS, Google's Android, Samsung's Bada and Nokia's Maemo.

There are various mobile learning applications in literature. According to Stead and Colley (2008) these applications can be evaluated with three main approaches: a) Supportive (Supplementary) Applications: school or teacher has to offer other activities supporting the podcast, vodcasts, and mobile games that could be considered as individual applications. b) Focused Applications: Content delivery with a focus on traditional e-learning applications for mobile. c) Indepth (deep) Applications: Social learning processes in the context of learning and retention of customers and consumers in addition to being the creator and producer is also enriched with a variety of mobile technology applications.

In this study, mobile learning applications are examined within the context above and previsions about the future of mobile learning are shared.

KEYWORDS: *Crowdsourcing, Crowdsourcing platform, University-business cooperation, Problem-solving*

Introduction

Mobile learning is a new concept that has some different connotations. It has different meanings for different communities. Although it focuses on learning with mobile and portable communications devices, it is certainly concerned with learner mobility in the sense that learners should be able to engage in educational activities without the constraints of tightly delimited physical location. Besides, the term covers learning that reflects a focus on how society and its institutions can accommodate and support an increasingly mobile population. According to Kukulska-Hulme and Traxler (2005), what is new in mobile learning comes from the possibilities opened up by portable, lightweight devices that are sometimes small enough to fit in a pocket or in the palm of one's hand. These devices can be carried around with relative ease and used for communication and collaboration, and for teaching and learning activities that are different from what is possible with other media.

In today's mobile society two main elements of mobile learning are technology and pedagogy. Technology defines the platform which learning occurs on and pedagogy defines the learning approach.

Mobile technologies

There are two basic factors defining mobile learning technologies: mobile devices and mobile operating systems. Typical examples of mobile devices are mobile phones (also called cellphones or handphones), smartphones, palmtops and handheld computers (Personal Digital Assistants or PDAs); Tablet PCs, laptop computers and personal media players can also fall within its scope (Kukulska-Hulme, Traxler, 2005). Mobile operating systems are Nokia's Symbian OS, Apple's IOS, RIM's BlackBerry OS, Microsoft's Windows Phone OS, Linux, Palm WebOS, Google's Android, Samsung's Bada and Nokia's Maemo. Entertainment and games, web browsing and search, VOIP, voice, messaging, Mobile TV, IPTV, mobile video, social networking and augmented reality applications are possible though the mobile ecosystem.

Mobile devices and mobile ecosystem

Mobile information and communication technologies are important enablers of the new social structure; we are experiencing the first generation of truly portable information and communications technology (ICT) with the relatively recent advent of small, portable mobile devices that provide telephone, Internet, and data storage and management in products (Peters, 2009). These products combine mobile telephony, removable memory chips, diaries, e-mail, Web, social networking, basic word processing and spreadsheets, data input, storage, and transfer. According to Jaokar and Gatti (2009) today mobile ecosystem covers entertainment and games, web browsing and search, VOIP, voice, messaging, mobile TV, IPTV, mobile video, social networking and augmented reality applications as shown in Figure 1.
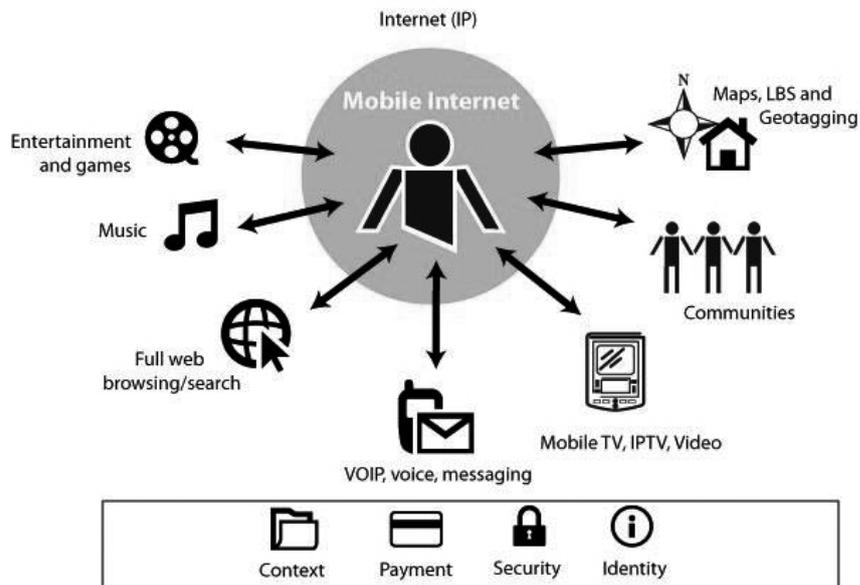
Figure 1. Mobile ecosystem

As mentioned earlier mobile learning focuses on mobility of learner rather than devices. Hence, any devices such as mobile phones, smartphones, palmtops and handheld computers (Personal Digital Assistants or PDAs); Tablet PCs, laptop computers and personal media players can be used for mobile learning to engage learner in educational activities without the constraints of tightly delimited physical location, DIDASCALIA Figure 1.

Figure 2: Mobile Devices

Mobile operating systems

A mobile operating system (Mobile OS) is a mobile platform, or a handheld operating system is the operating system that controls a mobile device – similar in principle to an operating system such as Mac OS, Linux or Windows that controls a desktop computer or laptop. However, they are currently somewhat simpler, and deal more with the wireless versions of broadband and local connectivity, mobile multimedia formats, and different input methods.

Operating systems that can be found on mobile communication devices are Nokia's Symbian OS, Apple's IOS, RIM's BlackBerry OS, Microsoft's Windows Phone OS, Palm WebOS, Google's Android, Samsung's Bada and Nokia's Maemo. Android, Bada, WebOS and Maemo are in turn built on top of Linux, and the iPhone OS is derived from Unix.

Market share of these operating systems is shown in **Errore. L'origine riferimento non è stata trovata. (Gartner, 2010**).

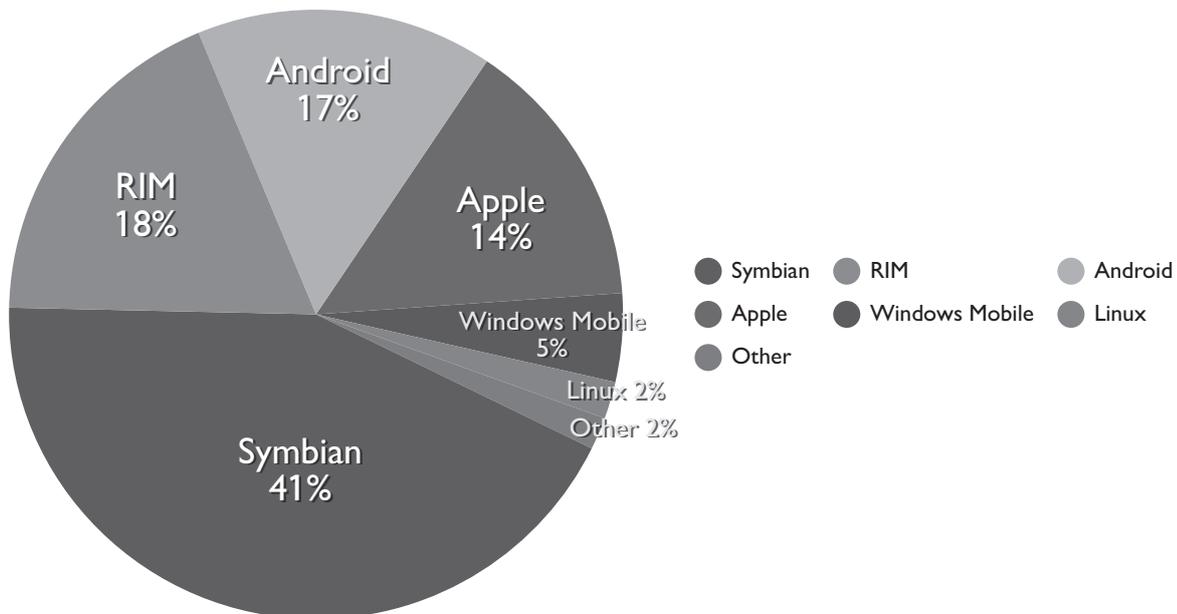Timeline of mobile operating systems (McLean, 2009) is given in Figure 4.

Figure 3. Market share of operating systems

Symbian OS: one of Nokia's mobile operating systems for mobile devices and smartphones, with associated libraries, user interface, frameworks and reference implementations of common tools, originally developed by Symbian Ltd. Current Symbian-based devices are being made by Fujitsu, Nokia, Samsung, Sharp, and Sony Ericsson.

BlackBerry OS: developed by Research In Motion for its BlackBerry line of smartphone handheld devices. This OS is focused on easy operation and was originally designed for business.

iOS (Apple): Apple's mobile operating system. It is developed originally for the iPhone; it has used on the iPod Touch and iPad as well. Apple does not permit the iOS to run on third-party hardware.

Applications can be downloaded through iTunes.

Android: an open source operating system for mobile devices such as mobile phones, tablet computers and netbooks. Android is developed by Google and is based upon the Linux kernel and GNU software. Android is along with major hardware and software developers such as Intel, HTC, ARM, and eBay that form the Open Handset Alliance
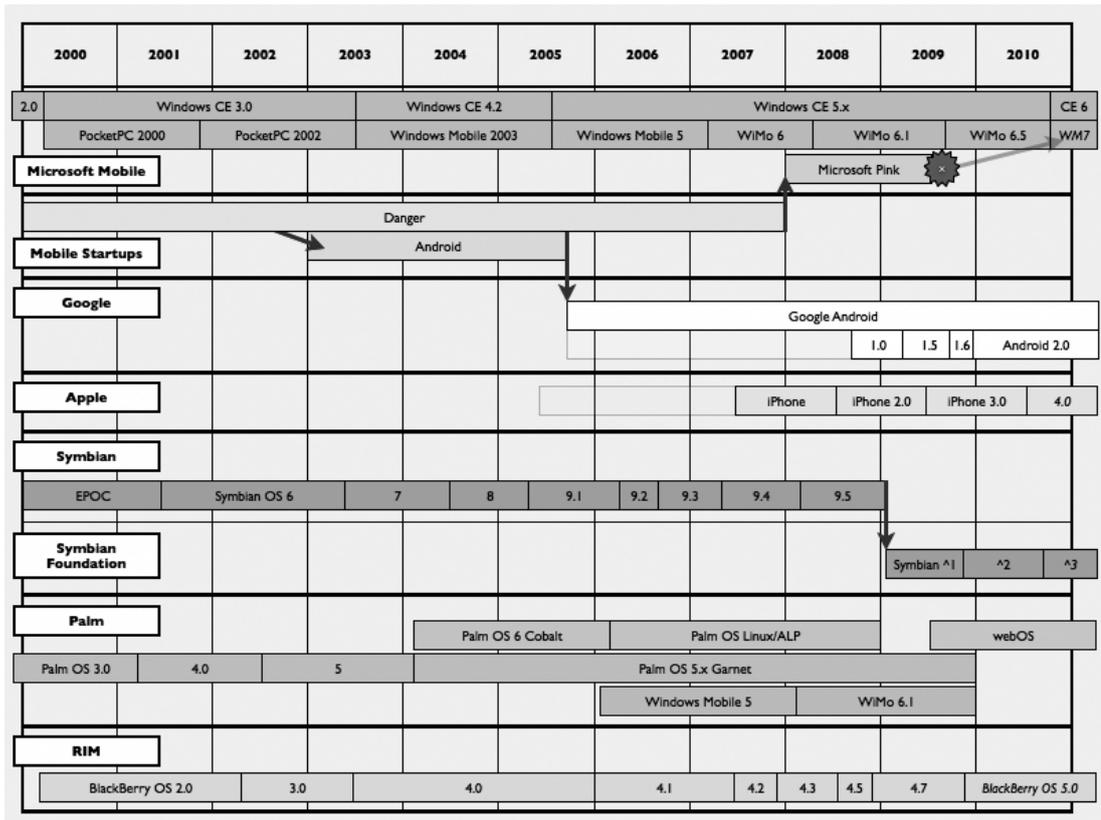

Figure 4. Timeline of mobile operating systems (McLean, 2009)

Microsoft Windows CE: mobile operating system developed by Microsoft for use in smartphones and mobile devices. It is supported by HTC, Samsung, LG, Toshiba, Sony Ericson, Dell, Acer, etc.

Palm webOS: developed by Palm Inc (closed source, proprietary). Palm webOS is Palm's next generation operating system. PalmSource traditionally used its own platform developed by Palm Inc.

Bada: Samsung Electronics' operating system. It is still in development, and Samsung expects handsets to be available in the second half of 2010. The first device to run Bada is called "Wave" and was unveiled to the public at Mobile World Congress 2010, Wave is a fully touchscreen phone running the new mobile operating system. The vision of Bada is "Smartphone for Everyone". Bada's main goal is not to compete with other existing smartphone platforms. Instead, Bada will turn Samsung's conventional customers into smartphone users by providing cost-effective smartphones (Samsung Bada, 2010)

Feature	iOS	Android	webOS	Windows Mobile	Windows Phone 7	BlackBerry OS	Symbian	MeeGo	Bada	Maemo
Company	Apple	Open Handset Alliance (Google)	HP/Palm	Microsoft	Microsoft	RIM	Symbian Foundation	Intel and Nokia	Samsung	Nokia
Current Version	4.1	2.2	1.4.5	6.5.3	Not yet released	6.0.0	9.5	1.99	1.0.2	5.0
OS Family	Mac OS X/Unix-like	Linux	Linux	Windows CE 5.2	Windows CE 7	Mobile OS	Mobile OS	Linux	Linux	Linux
Supported CPU Architecture	ARM	ARM, MIPS, Power Architecture, x86	ARM	ARM	ARM	ARM	ARM, x86	ARM, x86	ARM	ARM
Programmed in	C, C++, Objective-C	C, C++, Java	C	C++	C++	Java	C++	C++	C++	C/C++
License	Proprietary EULA except for open source components	Free and open source except closed source components	Free and open source except closed source modules	Proprietary	Proprietary	Proprietary	Eclipse Public License	Free and open source		Free and open source
Default Web Browser/Engine	Webkit	Webkit	Webkit	Internet Explorer Mobile	Internet Explorer Mobile	Webkit	Webkit	Webkit	Webkit (Dolphin Browser 2.0)	Gecko
3rd Party Application Store	App Store	Android Marketplace	App Catalog	Windows Marketplace for Mobile	Windows Phone Marketplace	App World	Symbian Horizon		Samsung App	maemo.org
Email Sync protocols supported	POP3, IMAP, MAPI,	POP3, IMAP, MAPI,	POP3, IMAP, MAPI,	POP3, IMAP, MAPI,	POP3, IMAP, MAPI	BES, BIS, Push e-mail	POP3, IMAP	POP3, IMAP	POP3, IMAP,	POP3, IMAP
Tethering	Bluetooth, USB (carrier dependent), Wifi (with 3rd party software and "jail break")	Wifi, USB, Bluetooth	Wifi	USB, Bluetooth, Wifi (with 3rd party software)		USB, Bluetooth, Wifi	USB, Bluetooth, Wifi (with 3rd party software		microUSB, Bluetooth 3.0, Wifi	microUSB, Bluetooth, Wifi
Official SDK platform(s)	Mac OS X	Multiplatform	Multiplatform	Windows	Windows	Windows	Windows	GNU/Linux	Windows	GNU/ Linux

Table 1. Feature comparison of operating systems

Mobile learning applications

Mobile learning is a new way of learning in contemporary education and it is one of the latest stages information society has reached. Mobile phones/PDA's which are start-up as the most enhanced instruments of mobile systems possess certain peculiar characteristics compared to existing computers in terms of accessing, sharing and creating information, and they become a part of life in a much faster way (Yamamoto, 2009a).

According to Sharples, Taylor, and Vavoula (2005) , there is a need to re-conceptualize learning for the mobile age, to recognize the essential role of mobility and communication in the process of learning, and also to indicate the importance of context in establishing meaning, and the transformative effect of digital networks in supporting virtual communities that transcend barriers of age and culture.

Mobile applications generally allow users to control or filter information flow and interaction through the handheld devices (Liaw, Hatala, Huang, 2010). BenMoussa (2003) identified several benefits for mobile connectivity: First, mobile devices offer personalized or individualized connectivity. Second, mobile connectivity improves collaboration via real-time or instant interactivity that may lead to better decision making. And third, mobile connectivity enhances users' orientation or direction.

These are like taking advantages of mobile devices opportunities that occur as a result of a learning format. The increase and expansion of the use of mobile devices have caused this kind of opportunities. As a result, the technical capacities of the small size but at less cost mobile devices throughout the community.

Mobile learning will be one of the main bodies for the brand new educational system. There should be an approach developing and deploying mobile learning ethically and equitably. This system supplies and enables information collection, analysis, audio-visual presentations at the same time plus flexible learning. This also impacts the way presentations form the supplier side and learning from the learners' side (Yamamoto, 2009b).

With the simplest definition, m-learning is learning offered by mobile devices and the programming of the mechanisms which activate it. According to O'Malley and colleagues (2003) mobile learning, or m-learning, has been defined as learning that takes place via such wireless devices as mobile phones, personal digital assistants (PDAs), or laptop computers. According to Ally (2009), mobile learning is a type of learning through the use of wireless mobile technology that allows anyone to access information and learning materials anywhere and at any time. O'Malley and colleagues (2003) also give a wider definition as any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies. There are various definitions of mobile learning in literature. Some of them focus on mobile devices; some of them focus on learning outside the classroom, and some of them focus on the mobility of the learner. In more general, the mobile learning can be defined as a *learning process which occurs in mobile ecosystem*. According to Kukulska-Hulme and Traxler (2005), we can see some categories of mobile learning such as:

- Technology-driven mobile learning
- Miniature but portable e-learning
- Connected classroom learning
- Informal, personalized, situated mobile learning
- Mobile training/ performance support

- Remote/rural/development mobile learning

Stead and Colley categorize approaches to mobile learning within three broad approaches (Stead, Colley, 2008):

- *Shallow* or supplementary learning: typically, these may be SMS prompts, school generated podcasts, and mobile games. They are good as a supplement to other activities.
- *Focused Learning*: typically these resemble a mobile-friendly version of classic e-learning, with targeted nuggets of learning that can be engaged with while on the move – possibly context aware.
- *Deep Learning:* Deep learners are immersed in a mix of mobile technologies, as creators or originators as well as the more common consumers of mobile media, following a constructivist model.

According to Cochrane (2010), pedagogical approaches to teaching and learning environments range from teacher-centered (instructivism) to student-centered collaboration (social constructivism). The use of Wireless Mobile Devices (WMDs) as part of the teaching and learning environment requires changes in pedagogy and integration into the teaching and learning processes. Changes in pedagogical strategies, content (reformatted for small screens and lower data bandwidths), and contexts (beyond the face-to-face classroom environment) are required.

A pedagogical framework for networked and mobile learners can be developed by using and revealing constructivism (Bruner, 1966; Piaget, 1973), social constructivism (Vygotsky, 1978), communities of practice (Wenger, 2005), a conversational model of learning (Laurillard, 2001), the social construction of technology (Bijker, 1995), connectivism (Siemens, 2005), activity theory (Leont'ev, 1981), media richness theory (Daft, Lengel, 1986). Thus a mobile (m-learning) pedagogical model will focus upon enhancing communication and collaboration within a dynamic learning environment, and will be student-centered (Cochrane, 2010).

Supplementary learning examples

The Handy project was realized by a teacher, in a Swiss private secondary school and grammar school with a specialism in sports. The mobile phone was used as learning tool as well as a topic of inquiry. Multimodal content creation (transformative; knowledge building), micro learning, m-maturity/technical literacy, archive, peer-teaching are important activities of project (MoLeaP – The mobile learning project database, 2007).

xTasks (Ketamo, 2003) is a platform for using mobile devices as a multi-user text editor. A teacher or tutor gives a task to a group of students and they can use the device for further discussion and the fulfilment of the task. The system supports them with several functions like text sharing, cooperative writing, and outline and structure support (Frohberg, Göth, Schwabe, 2009).

The Learning Lab project is conducted in Bangalore, India, at a government school (Pachler, Bachmair, Cook, 2010). The projects consisted of two assignments: "Curricular Learning Outside the Classroom" and "Exploring Locative Media". The first assignment was related to a problem-oriented and problem-solving task from Mathematics and sciences, as well as to data collection, collaborative learning and location awareness. The second assignment, "exploring locative media", was composed of different non-curricular activities.

Focused learning examples

Merrill Lynch found it was rare for employees to finish any online training they started, mostly because of time constraints. They looked to m-learning and implemented training courses via BlackBerry. The result was a 100% course completion rate (Swanson, 2008).

The project "From e-learning to m-learning" (Keegan, 2002) was initiated by Sony Ericsson and focused on the technological challenges when delivering prepared course material to a mobile phone. This was one of the first pathfinding m-learning projects. The researchers demonstrated how it is possible to provide access to e-learning content on a mobile phone (Frohberg, Göth, Schwabe, 2009).

Deep learning examples

The MOBIlearn project (Bo, 2005) developed a context awareness system that delivered content to museum visitors depending on the museum exhibit they were currently viewing (location) and the time spent in front of the exhibit (thought to reflect personal interest).

In ImagiProbe project (Vahey, Crawford 2002), a PDA with several sensors was provided, e.g. a sensor for temperature, magnetic fields, light intensity, amperage, etc. Thus, students could explore an environment by themselves and use the tool for data collection to reflect on it.

The Butterfly Watching Learning System (Chen et al., 2004) helps students to identify butterflies and learn about them. In the field the students created a picture of a butterfly with a camera and the system presented a selection of considerable butterflies. A butterfly database contained typical characteristics of the butterflies, and it was up to the students to finally identify the right one/s.

Homewood Suites (by Hilton) unveiled mobile training by providing video iPods in every location in an effort to improve performance and development in areas likes sales communications and brand messaging (CorpU, 2008). Each iPod program contains a variety of two-minute modules highlighting specific brand skills that are both essential and valuable.

Prevision about the future of mobile learning

The number of advanced mobile devices, mobile Internet access, development and diversification are expected to become more prevalent and cheaper. Because of the development of technical specifications like 3G, 4G, GSM, GPRS and satellite technologies that enter into our daily lives has also affected the mobile learning, its instructional design and application possibilities. These possibilities are rich and powerful for the societies and individuals.

Below most of the mobile applications have spread over the world and these are just the beginning applications for the learners.

- Mobile Social Media
  - Mobile blogging
  - Mobile photo blogging
  - Mobile video blogging
  - Mobile voice blogging

- Mobile Bookmarking / Social Tagging
- Mobile RSS (online or via downloadable client applications)
- Mobile Social Networking
  - SMS Messaging Networks
  - Friend/Community Networks
  - Personal Content Networks (Photos and Blogging)
  - Location-Based Social Networks
- Mobile Maps Applications
- Augmented reality applications with social interaction
- Podcasting (Student generated)

Conclusion

Mobile learning has been one of the reflections of the widespread adoption of wireless technology and Internet access as required from personal and or social. 3G, 4G, GSM, GPRS and satellite technologies that enter into our daily lives has also affected the mobile learning, its instructional design and application possibilities. Mobile devices are widely available to reach a wide audience of learners with different learning styles and individual characteristics. This means the educational environment has to be ready for this kind of learners.

On the other hand the smaller mobile devices have made mandatory the presentation of information in small groups and/or individual even small size. Therefore information processing theory and other learning theories of education issues frequently highlighted in the form of a small piles of presentations and so on. This means pedagogy and technology should work together and urgent need of the new design criteria.

In this study we stated some of the mobile applications have spread over the world and these are just the beginning applications for the learners.

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