Mobile Learning Applications

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Abstract
Last decade, mobile technologies have grown from a minor research to significant projects prevailed most of various lifestyles. Beside m-commerce, m-learning was one of the most interesting projects. Each project has illustrated how this technology can offer a new opportunity for learning that extends within and beyond the traditional teacher-led classroom. In fact, many higher education institutes have developed their own applications or adopted some commercial versions, yet they are successful only when developers understand the strengths and weaknesses of the technology beforehand, and integrate technology into appropriate pedagogical practices. This paper aimed to discuss the conceptual frameworks and the prerequisites of designing m-learning applications and resources giving a view of how to design a useful mobile application with limited-capabilities technology in education field. Experienced examples of a good practice in m-learning application are presented also in this paper.

Introduction

Today, the world is witnessing a significant growth of informatics technologies. People have to access information; over the past, they have had to obtain information from scientists, clergy, libraries and universities. From commerce, business, industry and medicals to every aspects in our life, and the education is one of the most important of those, whereas the conventional learning hasn't been able to fully adapt the growth (Ferioli & Van der Zwaan, 2009) with consideration about printed study resources and written assignments submitted manually to tutors who provide feedback. However, recently, students can access information and do their studying activities through the on-line learning (e-learning) environment without the need for such efforts (Gregson & Jordaan, 2009).

The need remains, because of the nature of PC, and internet has restricted the ubiquitous potential of e-learning to those moments when a learner is at home or at work in front of their PC. On the move, the learner cannot access the learning resources nor complete their course work (Motiwalla, 2007). Nowadays, the advancement of mobile devices and technologies presented during 2009 and 2010 especially with the introduction of new iPhone 3Gs and 4Gs, then iPad tablet, the mobile learning (m-learning) opportunities have increased highly (Fetaji & Fetaji, 2011); it is seen as an evolution of e-learning emerging the mobile device as a single integrated point of communication, and a useful access to information, applications and users (students/teachers) (Boja et al., 2009) (see figure 1).

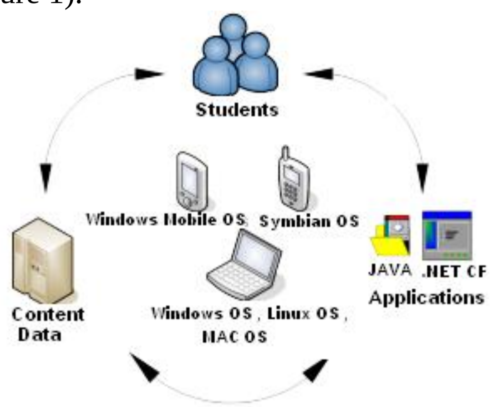

Figure 1: General architecture of m-learnin (Boja et al., 2009)

Harris, (2001) stated: “m-learning is the point at which mobile computing and e-learning intersect to produce an anytime, anywhere learning experience” (Pieri & Diamantini, 2009). In other words, m-learning overcomes the limitations of e-learning and meets the needs; it allows learners to access information and complete other course work even when they are away from their hard-wired internet connection.

M-learning theories and conceptual frameworks

Interest in mobile learning is growing in higher education as signified by the number of projects, conferences, scholarly journals, technical reports and books (Crow, Santos, LeBaron, McFadden, & Osborne, 2010). Many reviewed researched studies (Kennedy, 2003; Kukulska-Hulme & Pettit, 2009; Yordanova, 2007) have given encouraging results for using mobile technologies to support educational users in the teaching and learning process (Fetaji & Fetaji, 2011).

On the other hand, the communities cohering around mobile learning may still feel the need for standard and obvious theory of mobile learning as well as a definition (Traxler, 2009). Furthermore, theoretical justification is arguably even more important, when there is inadequate empirical evidence of effective learning with mobile technologies, guidelines for use should be theory-informed (Herrington & Herrington, 2007). Fishman, Soloway, Krajcik, Marx, & Blumenfeld, (2001) contended to set theoretically grounded guidelines represent "a major impediment to the successful use of new technologies". Many research studies and projects have examined mobile learning from an identified theoretical perspective (Herrington & Herrington, 2007), Herrington and Herrington, (2007) introduced theories that are useful for guiding the design of technology-supported learning environments for higher order learning and were as a ground of foundation for some studies (J. Herrington, Herrington, Mantei, Olney, & Ferry, 2009).

- Behaviourist theory: Activities that promote learning as a change in observable actions.
- Constructivist theory: Activities in which learners actively construct new ideas or concepts based on previous and current knowledge.
- Situated learning: Activities that promote learning within an authentic context and culture.
- Collaborative learning: Activities that promote learning through social interaction.
- Informal & lifelong learning: Activities that promote learning outside a dedicated learning environment and formal curriculum.
- Learning and teaching support: Activities that assist in the coordination of learners and resources for learning activities.

Recently, Siemens, (2005) came out with a theory called Connectivism, it has been described as 'a learning theory for the digital age', and its characteristics include:

- Learning and knowledge rests in diversity of opinions.
- Learning may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Nevertheless, in their conclusion, Cobcroft, Towers, Smith, & Bruns, (2006) indicated that also there was little attention being paid to developing specific frameworks to support the design of mobile learning. An initial attempt offered by (Sharples, Taylor, & Vavoula, 2005) suggested that a theory of mobile learning should be measured under the following criteria :

- Is it significantly different from current theories of classroom, workplace or lifelong learning?
- Does it account for the mobility of learners?

- Does it cover both formal and informal learning?
- Does it theorize learning as a constructive and social process?
- Does it analyze learning as a personal and situated activity mediated by technology?

M-Learning Application Issues

Mobile devices can be more easily integrated across the curriculum than desktop computers (Yordanova, 2007) and in a classroom environment without any extended requirements because of the environment infrastructures and the context of use. But, the success of m-learning is also limited to the hardware and software constraints of mobile devices. The lack of data input capability, limitation of processor speed, performance and memory storage, compatibility issues, limitation of file types supported, screen size and battery life (Maniar, Bennett, Hand, & Allan, 2008), directly influence the usability of mobile devices in the learning process.

However, technological capacity of all mobile devices has increased dramatically in the last few years. Nowadays, Screens are bigger and better, systems have more memory, and have more multimedia capabilities; as well as there are more convenient methods for data input (Chiu, Hung, & Street, 2009). Moreover, continuous advancing in mobile hardware technology, communication, the evolution of functionalities, ubiquitous availability of wireless networks and mobile devices are getting increasingly more powerful in terms of computing power and memory storage. Ongoing development of broadband wireless networks and the quick increase of power and capacity of cellular phones have enhanced the potential of mobile technologies in education (Boggs, 2002).

On the other hand, despite these advances of mobile technology, some obstacles exist which is still limited (Fetaji & Fetaji, 2011):

- Small screen size and low screen resolution.
- Low storage capacity and network bandwidth.
- Limited processor performance.
- Short battery life.
- Compatibility issues.
- Lack of data input capability.
- High - cost browsing through GPRS and 3G and 4G technologies.

Consequently, these limitations have shown some usability problems. The mobile screen is not equal to desktop screen. It has no sufficient space to display greater amount of information; the information may not appear properly. Therefore, a vast amount of information in a small screen might affect the users' recognition. Small screen also restricts displaying lot of graphics. Due to the low graphic resolution and limited number of colors, the interface objects and multimedia information may appear despoiled and not obvious.

With the limited display quality, users need to focus on the environment rather than the application, so output is limited (Cavus & Ibrahim, 2009). The mobile application interface shouldn't become a scaled desktop application interface. This degraded in visual appearance of interface elements in mobile screens will negatively affect the quality and efficiency of user acceptance and understandability of the learning resources.

In other side, desktop applications cannot be accessed via mobile devices and be displayed same in a mobile screen. "What works well on a large screen does not necessarily work well on a small screen" (Kukulsha-Hulme & Traxler, 2007). Most existing computer based learning management systems still do not have access support for mobile devices, and there are deficiencies in cross-platform solutions of LMS (Fetaji & Fetaji, 2011). Moreover, many mobile browsers do not support scripting or plug-ins, and do not have available memory to display desktop pages and graphics. This directly influences the usability of mobile learning systems. Web content that is mostly the format of electronic learning content is poorly suited for mobile devices (Cavus & Ibrahim, 2009). So, this limitation will decrease the ability to display information in various multimedia formats.

These usability issues of mobile devices and learning must be considered and carefully examined during the usability testing of a mobile application in order to select an appropriate research methodology and reduce the effect of contextual factors in the outcomes of usability testing (Kukulska-Hulme & Pettit, 2009).

For the evaluation of m-learning activity, in their commercial study, Gregson & Jordaan, (2009) put some important questions introduced to the learners:

- What kind of learning objectives, and pedagogical approach is the activity suitable for?
- Are there specific technical pre-requisites that need to be met in order to make use of the activity, e.g. file types, network services?
- Were any relevant constraints identified when testing the activity in the community?
- How is the activity best delivered to the learner?
- How was the activity designed, and what resources were required?
- How was the activity evaluated?
- What were the learner and tutor reactions to this activity when it was tested?

Prerequisite concepts of designing mobile learning application and resources

Mobile devices such as mobile phones, PDAs and iPods can have more processing power, slicker displays, and more interesting applications than were commonly available on desktop machines one decade ago, and educators are quickly realizing their potential to be used as powerful learning tools.

However, to provide learners and teachers with better opportunities and enhanced learning outcomes, it is important to consider mobile issues discussed above before implementing application and designing the learning environment and resources (Park, 2011). This section (adapted from (Dochev & Hristov, 2006; Low & O'Connell, 2006)) suggested prerequisite concepts of good practice in mobile learning that should be a guidance for application developers and learning resources designer with a strong pedagogical basis depending on characteristics of mobile technology.

1. Compatibility and developing environment features

Mobile operating systems offer fewer application programming interfaces (APIs) than PCs do; developers need to be aware that not all PC functionality is supported in mobile systems. The various OSs available each have different advantages, but in all cases the functionality of mobile systems is more limited than that of PCs. Moreover, designers have to be educated and aware of various platforms; learning resources must be deployed as a wide range of devices as possible in same quality even that delivered on non-mobile platforms and test the resources across platforms. In this case, designers have to apply the most appropriate standards for usable, accessible and exchangeable format.

2. Performance and device resources

Limited system resources with narrow bandwidth have to be taken in consideration. Learning resources and contents have to be designed and provided as quickly with few processing as it possible. Developers have to determine where the processing will take place either in the local device or in the network server. Applications limited by processing rather than by bandwidth, is clearly better to be performed on the server, where decoding files such as (MP3) is more appropriate for local device processing. If the constraint is in the bandwidth, the goal will be to reduce the amount of data that has to be transmitted.

For processing, in real time processing, if the application has a lot of dada, developer has to reduce the need of processing during data transfer, such as compression. On the opposite side, if the application is computation-intensive but doesn't have much data, the goal will be to offload as much processing to the network as possible.

3. Memory available

A very important issue for the developer is working with limited size memory, where it is shared between stored data and active processing. Developer has to optimize the application software by removing unnecessary features, minimize program and reduce using recursive functions until it is absolutely necessary, this function would maximize memory stack. Moreover, to prevent memory leaks, the application should eliminate unnecessary memory allocation and free all allocations on exiting processes. Resources designers have to split the content into smaller objects or resources so that users can choose to store and/or download just the bits they need.

4. Small screen interface design

With up to 240 X 320 pixel and 3.75 inches (Maniar, Bennett, Hand, & Allan, 2008), the small and limited display size and resolution of these devices and interaction styles impose new interface designs. In this context, the interface has many constraints, needs to be simpler and might contain less number of components and objects. Developers must take care to eliminate unnecessary data from the screen. Often the appeal of an application in a PC lies in taking advantage of the display capabilities and system graphics. In a handheld system, with its small, low-resolution screen and simple graphics, the application will have to be more limited in its video output. Here the challenge for the software developer is to take less and make the most of it to create a satisfactory interface for the user; Developer has to carefully layout pages and prevent scrolling into either dimensions, he has to chose more appropriate fonts to maximize readability and create graphics that are easy to view.

5. Saving power (battery life)

In mobile application, the power consumption is one of overriding issues, so developers should be aware of and use as low-power system features as they can. Mobile OSs typically provides power management features that allow for the partial shutdown when the system is in idle cycles. Therefore, it is important for the application to return control to the OS when it is waiting for a system resource. For instance, if the application needs input from a button on the keyboard, it should send an event, and then wait for system responce to inform it that the event has occurred. Doing so eliminates so-called "busy waiting" when the application does not return control to the OS while it is idling, that will save the power and enable longer use of the system between battery charges.

Examples of m-learning application

Mobile Interactive Learning Objects (MILO)

In their study, Holzinger, Nischelwitzer, & Meisenberger, (2005) presented a practical approach to m-learning for medical staff and students and call it "Mobile Interactive Learning Objects (MILOs)" which is used within a Mobile Learning Engine (MLE) that runs on mobile phones. MILOs can offer manifold possibilities for new kinds of communication and explorative learning. MILOs was structured the same way as Learning Objects for e-learning with taking into account some issues regarding to the limitation of the screen size and memory size. Different kinds of media were applied: figures and pictures, videos, audio and the most important, the possibility of the output of spoken text. Nevertheless, a MILO doesn't contain as much information as a traditional learning object (LO). Therefore, it splits up a topic into separate MILOs, which are related but independent of each other. That will enhance video and audio streaming as well as in playback (see figure 2).

Moreover, through m-Learning, MILO can be primarily used during idle periods that may end abruptly. For example: a medical student, waiting for a bus, can decide to use this spare time for learning on a mobile phone until arrival at the training hospital.

Figure 2: Example screenshots for a MILO: Media-bar for the playback of the video

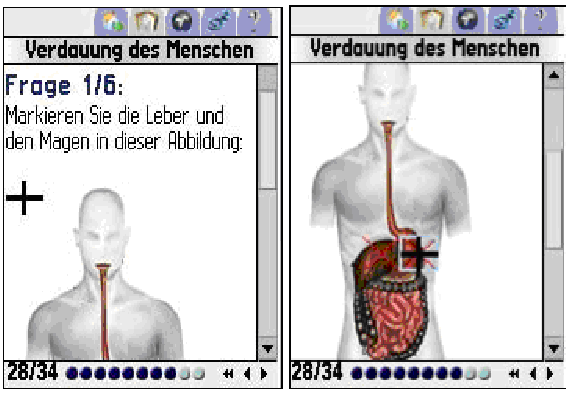

Figure 3: Example screenshots for a MILO: Interactive questions

Within MILOs, the system can define interactive questions (see figure 3). The answer to these questions will be analyzed and corrected by the application itself . The system can also define hints for question that if the users' solution to the questions are incorrect, the application provides a hint, which assists them to rethink about the problem and help them to find the correct solution. Punishment in the form of a WRONG message is replaced by encouragement and assistance . By solving the question, independently, the users get a feeling of success and increase their knowledge.

Mobile moodle (Moodbile)

Moodle is an open source Course Management System (CMS). It is also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It has become very popular among educators around the world. Moodle can provide a unique opportunity for students to enroll in social negotiation and mediation in the form of synchronous and asynchronous communication technology. Online communications are allowed for social negotiation and mediation to occur across both time and distance (Wood, 2010).

Nevertheless, what happens if a student wants to read the forum posts while he/she is on the underground without wireless access?. Does the student need to pay to read a document in the virtual campus every time she/he wants to read it?, And what if she/he has a wifi access in the cell phone and wants to get all the data while she /he has free connection and review these data while she/he is on the go?

The point is that the students might want to access the data from the LMS when they are offline, and this is not possible in a web based scenario, too. One possible way to overcome this problem would be the use of web caching tools or RSS feed readers . But the data in the LMS is password protected, and many issues can appear even if we do not consider the security problems .

For the previous reasons, some institutes have utilized the open source of Moodle and create their own mobile extension for a LMS system (Forment, Guerrero, & S‹ˆnchez, 2008) and called it as (Moodbile) , where Moodle organization has designed a standard version of mobile Moodle. Figure 4 shows snapshots of different moodbile designs.

Figure 4: Screenshots of Moodbile

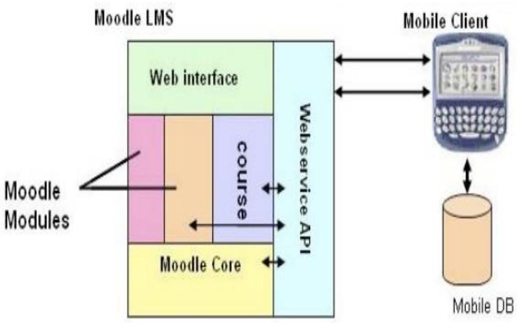

Figure 5: General system architecture of Moodbile (Forment, Guerrero, & S‹nchez, 2008)

The design of a mobile extension for an LMS system takes two software design, server and client sides. The general system architecture is shown in figure 5 consists of the following parts:

• Moodle LMS that runs on the server, this part is implemented in PHP and supports databases like MySql, Postgreql, Oracle or Microsoft's SQL server.

• Webservices layer, which is a Moodle plug-in our group has developed. This part also runs on the same server as Moodle. These web services implement both the XML-RPC and SOAP standards. However the mobile client uses only the XML-RPC protocol because -theoretically- will be more efficient in this kind of scenario. The analysis of this issue is a material for another eventual research.

• Mobile Client, through the web services layer, Moodlbile synchronizes the data with the Moodle server.

In working online, the mobile client application uses the webservice layer to access the new information from the Moodle server. This new information is sent to the mobile client and stored temporarily for offline access. When the student updates an activity, the changes are stored locally on the mobile device database, and synchronously sent to the Moodle server database (Guerrero, Forment, Gonzalez, & Penalvo, 2009).

On the other hand, the Moodbile client can work offline as well as online. In working online, the user will be able to access the information stored on the mobile device in the last synchronization. The mobile user will also be able to do some update information from the mobile device. This now updates is stored in the mobile's database, and it is ready to be sent on first synchronization (Forment, Guerrero, & Snchez, 2008).

Considering online status, the student can use the mobile device to access very specific information about recent events in short connections or extend the learning process on the move, while he/she can work with: forums, wiki contents, glossary, entries, internal mail messages and calendar.

However, regarding to mobile capabilities, the developers didn't design a full Moodle client that is able to perform all the tasks performed from the web interface. Instead, they considered that the mobile device could be useful to do short connections to the Moodle system accessing specific information with limited updates (Forment, Guerrero, & Snchez, 2008; Guerrero, Forment, Gonzalez, & Penalvo, 2009).

Conclusion

When implementing a mobile learning application, it doesn't matter to adopt a specific theory of learning design, but useful application must be kept under the general frameworks of the pedagogical concepts. Mobile technology is growing dramatically. Near future will overcome the most of its limitation with some exceptions such as screen size and battery life which the developers have to adapt with. Examples presented in this paper give a good practice, and it is represented as a guidance for both application developer and learning resources designers that show how to overcome device limitations with pedagogical consideration.

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