

“M-Learning Not an Extension of E-Learning:” Based on a Case Study of Moodle VLE

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ABSTRACT

In this paper, the authors present work that was carried out to develop an m-learning extension to a Moodle based VLE at the University of Colombo School of Computing (UCSC) and its initial evaluation. They believed this new development could bring a value added service to learners and describe how mobile browsing, mobile applications and Short Message Service (SMS) were used to access learning resources and activities to interact with other users who were facilitating or following on-line courses. However, in their investigation, the authors discovered that m-learning cannot be promoted as a value added service for the current e-Learning based framework. Learners do not receive a significant benefit compared to the cost they incur to interact with the learning service. Both pedagogy and technical infrastructure must be considered together, not as an extension of existing services but to provide a new learning service for m-learning.

Keywords: E-Learning, Learning, M-Learning, Moodle, Pedagogy, Virtual Learning Environment (VLE)

INTRODUCTION

Information Communication Technology (ICT) based techniques can be effectively used in the learning and training process as they minimize the limitations of time, location and pace. This was the main reason for e-Learning to become a popular alternative for traditional face to face (f2f) learning during the last decade. In the f2f learning environment, teachers, learners and resources are connected within a small physical

space. e-Learning enables distance learning by making use of Web/Internet based technologies to provide a more flexible and convenient learning environment.

During the last few years, with advances in mobile technologies and devices such as smart phones and pocket PCs, the e-learning trend is mixed and enhanced with m-learning alternatives. Hence, it is sometimes difficult to understand whether a particular service is based on e-Learning or m-learning. Unfortunately, some initiatives promote e-learning as m-learning when the learning takes place through mobile

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devices. For example, “Mobitel m-learning” (<http://www.mobitel.lk/training-ml>) is a highly publicized m-learning initiative in Sri Lanka (GSMA, 2010). However, when we analysed this service we found that learners are accessing an e-learning based learning management system and streaming video content of a blended course using laptops and wireless broadband dongles. The public, who are not very clear about the difference between e-learning and m-learning, believe what service providers are saying. Politically, these types of initiatives can be defended since the m-learning definition used does not consider the pedagogical requirement of m-learning and purely depends on technical features. e-learning is defined as ‘learning supported by digital electronic tools and media,’ and m-learning as ‘e-learning using mobile devices and wireless transmission’ (Milrad, 2003). On the other hand, without the technical infrastructure it is a dream to talk about m-learning, and the distinction between m-learning and e-learning must be clearly visible to all stakeholders. Whether the m-learning could deliver better service than e-learning as a value added service is an open question. This question is studied and presented in this paper:

What is the relationship between e-learning and m-learning? (Keegan, 2002) Without e-learning infrastructure can we introduce m-learning (Peters, 2007)? Technology could drive us as has happened in many other cases but we should not let the technology take us just anywhere. When e-learning was introduced, the same thing was discussed with respect to f2f learning. Online/Web based facilities were initially introduced as a supporting facility for f2f classes. Later, it was integrated to develop the blended learning environment. In the next stage, e-learning was introduced completely removing the f2f interaction. However, e-learning is not a teaching environment but a learning environment. Those who try to practice the traditional f2f learning through e-learning always find failures because of the pedagogical differences. Failures are good learning lessons that help many people to correct their mistakes. It is difficult or painful to carry out the paradigm

shift but it will bring many benefits. A similar paradigm shift is required from e-learning to m-learning. This was the main lesson learned in this case study of developing an m-learning extension to the existing e-learning framework.

Modular Object Oriented Dynamic Learning Environment (Moodle) (<http://www.moodle.org>) is the well-known open source software that has contributed significantly the paradigm shift from classroom based learning to online learning. Many educational institutes have started using Moodle to experience online learning. University of Colombo School of Computing (UCSC) also developed their online learning service platform using Moodle starting from 2005. It was initiated with blended learning courses for internal degree programmes and later was extended to a fully online degree programme called Bachelor of Information Technology (BIT). The majority of the users who take these courses have mobile devices and the number of users possessing a mobile device is usually higher than those who possess a computer with an Internet connection. Therefore, we believed that there was a significant opportunity to use mobile devices in the learning environment.

Mobile learning could be defined as an extension to the e-learning platform, blurring the temporal and geographical barriers by taking advantage of mobile technologies (GSMA, 2010). Unlike in e-learning, the learning process is not restricted to a prearranged, fixed location where the Internet connection is available, and learning could happen with the movement of the learner as long as he/she has the mobile device and an Internet connection. Hence, m-learning could be used to enhance the learning activities resulting in increased efficiency and effectiveness of the learning process.

However, designing and developing an m-learning extension as a software solution is not straightforward. Moodle is not intrinsically designed to be accessed through mobile devices, but the constructivism pedagogy supported in Moodle VLE could be applied to design the interaction in m-learning. A number of issues and challenges have to be addressed when ex-

tending the Moodle based e-learning platform to integrate with an m-learning extension. For example many of the mobile web browsers do not fully support JavaScript; this limitation makes accessing Moodle through mobile devices difficult.

The paper is organized as follows. First, we present the background for this case study. Then we follow up with a presentation on how the SMS facility was integrated with the existing learning process. Afterwards a description on how the mobile phone browser and mobile applications have been used to provide the learning activities of VLEs of UCSC. We then discuss the outcome and lessons learned in this exercise both technically and pedagogically. Finally, we conclude the paper with our suggestions to develop m-learning extensions.

BACKGROUND

When we are struggling to provide a good e-learning service with technology changes, competitors carry out marketing campaigns announcing that they are providing m-learning services (Sunday Times, 2011). In the business world, novelty is marketing to introduce new things. As academics, we should be cautious when we introduce novelty to the teaching and learning environment. It should be evaluated thoroughly, both technically and pedagogically. A few years ago, it took great courage for us to integrate e-learning in higher education programmes, although we are still not getting the best out of it. When m-learning was discussed, we understood it as a something built on top of e-learning. In real life, if the second floor (e-learning) is not strong enough, then the third floor (m-learning) will have many instability problems. On other hand, you do not want to finish everything to start a new thing. For outsiders, the development is a waterfall but it is incremental internally. At the same time, "You do not want to know everything to do something" is valid in agile software develop-

ment. After several discussions, we started our m-learning development while experimenting with software architecture and other projects related to Moodle.

We analysed the existing literature to identify the initial features to be selected for the first extension of m-learning development. Several initiatives were identified with respect to m-learning applications, namely; 1) Sending SMS block for Moodle, 2) Mobile Learning Engine (MLE), and 3) Moodle for Mobile.

Sending SMS block (Reyes, 2008) gives the basic functionality of sending an SMS using Moodle to a selected group of users. This block was used as the basis for developing SMS integration for the proposed m-learning extension since it offered the basic functionality, interfaces and easy customization. However, sending SMS block did not keep a record of the sent messages to implement a discussion among participants, unlike a forum in the VLE. Several technical drawbacks of SMS block and enhancements were identified in order to develop a SMS based m-learning extension for Moodle VLE.

MLE (Mobile Learning Engine) (<http://mle.sourceforge.net/>) is a fork of MOMO (MOoodle MOBILE) project (MOMO, 2010). MLE enables access to the Moodle virtual learning environment via a J2ME applet (MIDlet) installed on the user's mobile device. There are two main components in MLE namely, 1) Mobile Application and 2) MLE-Moodle plug-in. Mobile application allows users to access and participate in learning activities in the course pages. For example, this allows learners to attempt online quizzes, upload assignments and do other kinds of activities by using a mobile device. Hence, users can download the content from Moodle and access the content as offline content. The MLE-Moodle plug-in gives another facility to access Moodle as well as through the mobile browser. Moodle for Mobiles (MOMO, 2010) is a project for accessing Moodle through mobile browsers. It uses compact HTML (CHTML) that

could only be used with some specific mobile phone models such as DOCOMO (<http://www.nttdocomo.com/>).

After analysing features, the learning pedagogy and activities that take place in the UCSC Moodle VLEs, MLE plug-in was selected as the base to develop the m-learning extension, because of its comprehensive features and ability to operate on mobile phones used in Sri Lanka. Since the current m-learning initiatives in Moodle are an open source development, we decided to share our developments with the Moodle community. After completing the first version of the m-learning extension, we carried out an evaluation of our approach towards m-learning as an extension to e-learning based on Moodle VLE. This paper summarizes these aspects.

SMS EXTENSION TO MOODLE VLE

While investigating Moodle and its related m-learning initiatives, we conducted a survey to identify the use of mobile phones by the students of UCSC VLE. More than 85% of the students use mobile phones. Their main purpose was to communicate using SMS among the friends and relatives, which is very economical compared to voice calls. All types of mobile phones supported the SMS facility, irrespective of their generation. Therefore, we assumed there was a significant potential to use SMS based interaction to increase the student participation in learning activities (Lim, Fadzil, & Mansor, 2011). Hence, our objective was to develop an SMS based discussion forum in courses to keep the learner engaged in the learning process. At the same time, we decided to develop SMS based polls to obtain different learner opinions as a feedback mechanism. However, sending SMS Block (Reyes, 2008) was lacking in those features. Hence, we extended the SMS sending block to include those two features. These extensions for SMS Block were provided to the Moodle community (Wickramasinghe, 2009b).

Design of SMS based Communication and Forums

Apart from subjective discussions (Lim, Fadzil, & Mansor, 2011; Kukulka-Hulme, 2007), SMS messages can be used to communicate important notices to students by facilitators, such as cancellation of a lecture, or extension of a deadline, thus providing value added services to the students when they are following a particular course. However, only privileged users (facilitators) are allowed to send SMS messages since otherwise it could create unwanted disturbance to learners. At the same time, facilities were developed to select users in a course (all users, a specific group or specific individuals) when SMS messages were sent from the Moodle VLE.

To keep a record of what sort of interaction took place through SMS messaging, all the SMS messages are copied to a SMS forum in the course page. Therefore the registered learners who do not have mobile devices to access VLE or those who are not willing to access using mobile devices, would not be disadvantaged. These sent SMS messages are directly added to the respective news forums in the course page. The sent messages will appear in the “site news” forum of Moodle VLE if the message is sent by the administrator, while they will appear in the “course news” forum if sent to a particular student category by facilitators of the relevant course. By adding the sent messages to forums the users could keep a track of sent messages, as illustrated in the Figure 1.

Since SMS is a two way communication mechanism, we extended the module allowing learners to reply to SMS Forums defined in the courses. Students’ replies are listed in the SMS Forums (Figure 1). The respective forum was identified using a unique forum id which must be inserted as the first characters in a message. An example is shown in Figure 2.

Another important feature of this SMS poll module is that the received replies are shown as anonymous in the presentation layer. How-

Figure 1. Integration of SMS with Moodle forums

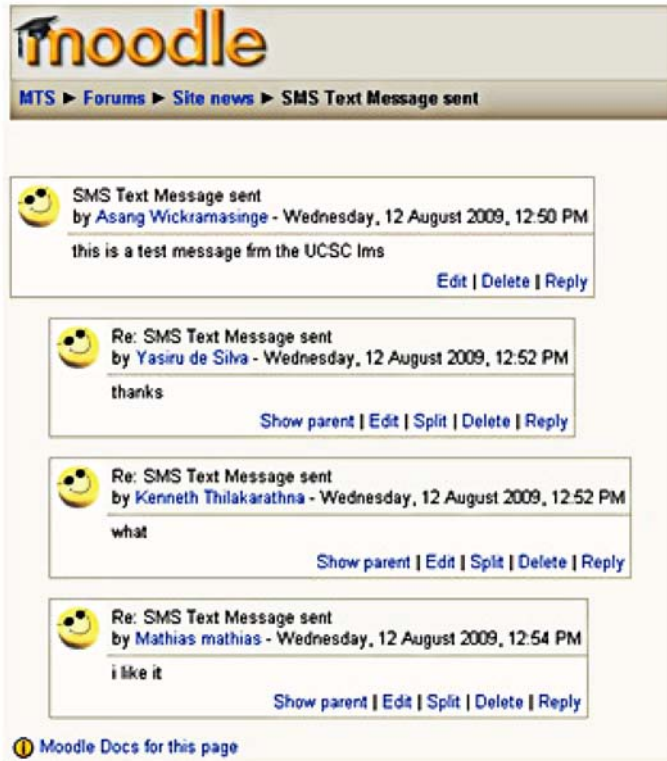


Figure 2. Reply format for the forum SMSs

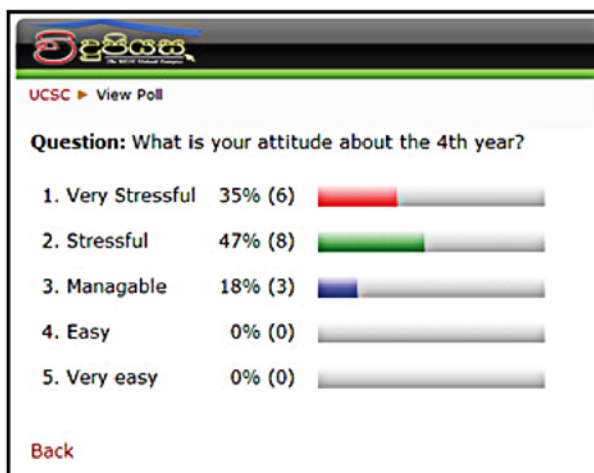
1110<space><post>

ever the received replies are correctly validated at the database level. By showing the replies as anonymous in the presentation layer, more freedom and flexibility have been given to the students to select the most appropriate choice. The replies for the poll questions are presented in graphical formats and in numerical formats as shown in the Figure 3.

MOBILE INTERFACE FOR MOODLE VLE

The main purpose of developing a mobile interface for UCSC Moodle VLE is to facilitate “learning on the go” (Alexander, 2004). Students’ primary requirement is to access learning content whenever they need to, irrespective of

Figure 3. SMS poll in Moodle



whether they have a computer and Internet connection. Mobile accessibility would allow them to go through the content many times during the day whenever they want. However, we also identified several important facilities they would like to access through a mobile interface, such as accessing quizzes, participating in forums, and uploading assignments. Submission of assignments before the given deadline is the most common requirement and many students prefer to delay the submission until the last minute.

Design of SMS Based Polls

SMS polling is an interesting feature to obtain the learners' participation. At the same time, it could be used to collect the feedback/opinions of students with respect to activities in the course. Thus this would increase the interactivity of the learners. However, we allow only privileged users of the course to create SMS polls. When a privileged user creates an SMS poll for all students or selected student groups, a message with poll questions and available voting options were sent as an SMS. Two or more suitable options/answers should be defined in the poll question as shown in the Figure 4. As in the SMS forums, the poll questions are also added to the sent messages and the reply format is appended

at the end of the message. Students can send their feedback using SMS in the given format as shown in Figure 5. Figure 6 shows the poll question displayed in a mobile phone.

Moodle (1.9 and before) was not developed to be accessed from mobile devices directly. In our technical analysis, we identified the following limitations that were negatively affecting the mobile accessibility of Moodle VLE:

- Use of JavaScript;
- Moodle layout (three column layout not suitable for the mobile devices);
- Network usage (Moodle themes and other content);
- Interaction model (Not suitable for mobile devices).

Moodle uses JavaScript for validation and other purposes. However, many mobile web browsers still do not fully support JavaScript. The three column layout in Moodle is suitable for large desktop screens. Many mobile devices have smaller screens with height greater than the width, and a three column layout is unsuitable in this context. Moodle themes also consume a lot of bandwidth when loading a page into a mobile device and users experience a time delay.

Figure 4. Creating poll interface in Moodle VLE

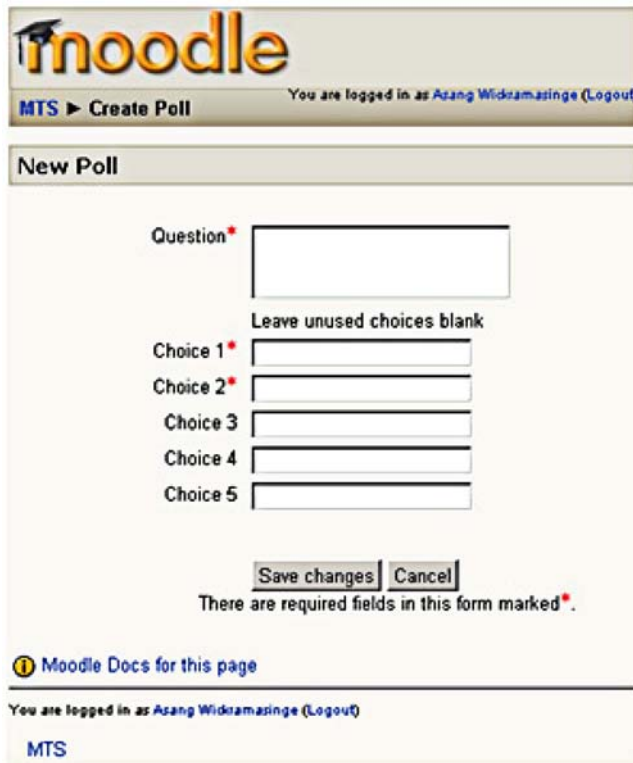


Figure 5. Reply format for the Poll SMS

p1110<space><choice>

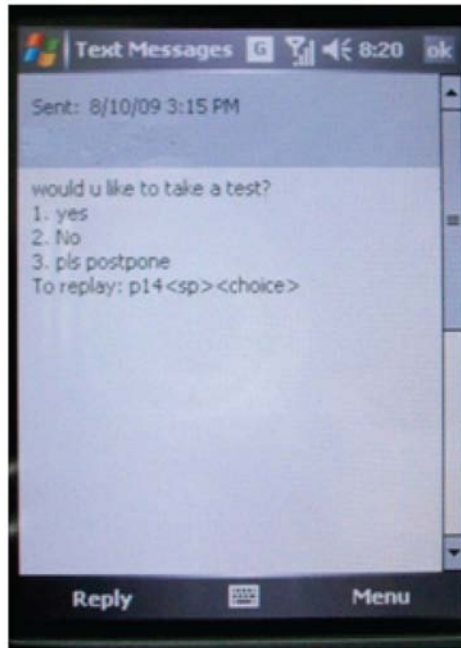
The GUI interface of Moodle is designed considering window-based components in a desktop environment and generally it requires a pointing device to access the active links and content. However, many mobile devices do not have the capability to point an object on the screen. Therefore, interaction issues need to be addressed, so that the links are accessed easily with few key presses.

When we experimented with the MLE Moodle plug-in to access Moodle content from mobile devices, we observed several bugs which prevented us from using it to complete activities. Three main bugs that we identified were:

- Assignment upload;
- File upload to Moodle forums;
- Displaying courses.

Since the assignment submission facility is a very important requirement to be supported through the mobile devices, we corrected the relevant source code. The MLE Moodle plug-in also gave errors when displaying courses on mobile devices. This was mainly due to the MLE plug-in being unable to handle “div” tags with “style” attributes. After these bugs were corrected, the module was extended to meet the requirements we identified for the mobile

Figure 6. SMS poll question in a real device



interface of Moodle. The MLE developer community was informed about these bug fixes and the development of new code (Wickramasinghe, 2009a).

Accessing Moodle through Mobile Browsers

The MLE plug-in was the main component to access Moodle through a mobile browser. It addresses the issues in accessing Moodle via mobile devices in several ways:

- **Simple Interface:** MLE enables users to access the Moodle via a simple interface. This interface allows them to access almost all the core features of the Moodle VLE;
- **Single Column Design:** Single column design allows users to access the content easily when it is viewed from a mobile

device. This design decision directly address to the screen size limitation in mobile devices;

- **Minimal Content:** Minimum amount of content is used to design the user interface. Fewer images have been used. Most of the formatting is done through CSS (Cascading Style Sheets) tags and thus requiring less network bandwidth;
- **Arrangement of URLs:** The main URLs are arranged in a list from the top to the bottom of the screen. It is convenient in accessing the links with navigation keys in a mobile device. This design decision transforms the interaction model woven around pointing in Moodle to an interaction model based on navigation keys on a mobile device.

There are two main advantages of using the mobile browser for accessing Moodle. They are: 1) no separate applications to be installed, and 2) ease of use (same as accessing a mobile web site). This method of accessing Moodle also carries two limitations: 1) the user needs to be online for accessing content, and 2) being unable to use the device specific features.

Accessing Moodle via Mobile Application

J2ME and Symbian C++ are some technologies used to develop mobile applications. The MLE application was developed using J2ME and it has many features compared to Moodle access via mobile browser:

- **Improved functionality:** Mobile application allows one to access the messages sent from Moodle and use the mobile phone capabilities such as taking snapshots or recording/uploading videos;
- **Less network bandwidth utilization:** Since the presentation is developed inside the mobile application, only the content is transferred;
- **Offline content support:** Mobile application has a feature to store local content which can be viewed without network connection;
- **Bluetooth content sharing:** Using the Bluetooth technology in J2ME (JSR-182), students could share local content with peers.

Students of Moodle VLE could gain many advantages by using the mobile application, 1) Offline content support, 2) Offline content sharing via Bluetooth and 3) Less network usage. However, there are also some limitations such as 1) Mobile application has to be installed and 2) The extent the mobile device support to J2ME has an impact on additional features of the application.

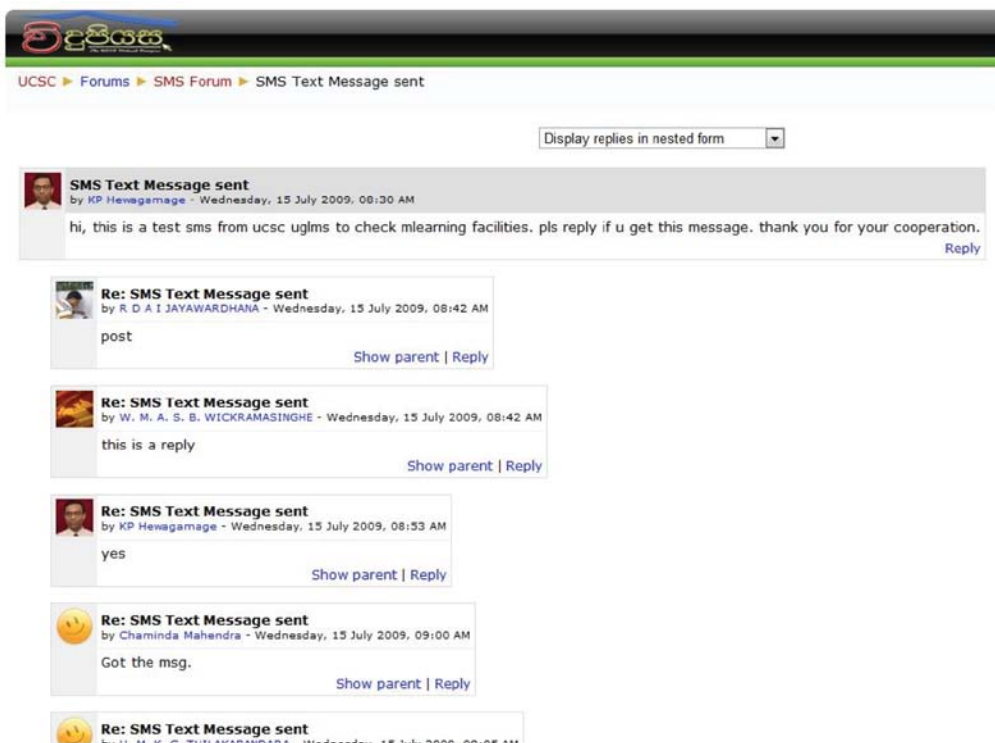
EVALUATION

After developing the first version of Moodle m-learning extension, we deployed to the active Moodle VLE instances at UCSC. We also evaluated the cost-benefit analysis of SMS gateways vs. Sending/Receiving Messages using a mobile dongle. For the initial implementation, we decided to go ahead with the latter alternative, for which we defined a unique mobile phone number for each Moodle VLE instance at UCSC. Since different instances of the institute were installed on different server machines, we were able to assign separate phone numbers. Since there was a lack of drivers for the Linux operating system, and sending/receiving SMS messages from the Moodle instance was not straightforward for Moodle 1.9 and 1.8, more experimental and technical work was required before making the service operational.

The very first task was to inform the users about the facility asking them to update their profiles with a mobile number. There were 2,943 participants in the VLE and only 321 had updated their mobile numbers. However, it was difficult to convince some teachers and students and they were unnecessarily afraid of their privacy and additional costs that could incurred when sending SMS messages. Figure 7 shows an open SMS forum to test the feature.

In our evaluation, an SMS forum message was sent to 321 users and out of that only 18 replied. This is only 5.6% of the users who received the SMS and 0.61% of the total number of users of the VLE. We found that teachers were only interested in using SMS to send urgent messages such as the cancellation of lectures. However, some teachers were not willing to use such services since the cancellation will be recorded in the VLE. Teachers did not find any pedagogically better alternatives compared to regular online forums which can be subscribed to using email. There were no restrictions on the message length in normal discussion forums but SMS forums were re-

Figure 7. SMS forum: Posting delivered as an SMS and reply SMS messages listed as a discussion forum



stricted with respect to the number of characters in a posting. Hence, the majority of teachers believed the SMS forums were not a good alternative or better mechanism for discussions since they also incur additional financial costs.

Students were very interested in the SMS facility in the VLE but they were not happy to use it extensively since they did not receive others' postings. Some students were concerned about the additional cost and they thought online discussion forums were more interactive. However, we did not want to activate the feature of redistributing messages through SMS since it is not cost effective and it may create some unnecessary disturbances.

Both teachers and students liked the SMS Polls. However, they were not interested in using them productively. Teachers did not like the restrictions in the messages and options

when creating a poll. They also did not need immediate responses for polls and preferred to keep them open. Students were more concerned about the privacy if it contained very sensitive questions and choices. Simply, the SMS polls could not add new value to the regular learning process in the Moodle VLE.

We also evaluated the mobile interface for Moodle VLE technically and pedagogically. Table 1 shows the comparison.

To support users, we defined short URLs to access the m-learning extension through their mobile phones. For example, <http://vle.bit.lk/m> is the entry point to access the m-learning extension of BIT. Some screenshots of the m-learning extension of BIT VLE are shown in Figures 8 and 9. Students were informed about the mobile application which they can install on their mobile devices.

Table 1. Comparison of mobile browser vs. mobile application in accessing content in Moodle VLE

Mobile Browser	Mobile Application
Ease of use, no separate application installations.	Application should be installed.
No off-line content support.	Supports off-line content.
Must have a mobile network to access the content.	Usable where there is no mobile network.
Same features for all the users.	Device dependent features.
More network usage.	Less network usage.
No sharing through the browser.	Share resources via Bluetooth with peers.
No support for flash animation and SCORM lessons.	No support for flash animation and SCORM lessons.

Figure 8. M-learning interface of courses in the BIT VLE



Figure 9. Learning activities through m-learning interface



Figure 8(a) shows the login page of the m-learning extension. Figure 8(b) lists the courses available when a student logs in through their mobile phone. A user can navigate using buttons on the phone. If they select the course, IT2204 Programming, Figure 8(c) shows the upper part. The student has to scroll down to see other content in the course page.

Figure 9(a) shows the starting page of a forum with links to navigate the threads. Figure 9(b) shows the learning resources when selecting a particular topic. It only shows learning resources that can be viewed, such as textual resources, discussion forums and online quizzes. Interactive SCORM learning objects developed using Flash contents are not displayed since they cannot be browsed on many mobile devices. Figure 9(c) shows a MCQ quiz screen.

Courses in the Moodle VLE were designed considering online access through desktop computers. Most of the text content that was displayed on a mobile browser/ application requires several screens for navigation. Learners with Java enabled mobile devices were able to browse PDF documents but many users failed to access them. The biggest discouragement was having no support for SCORM and Flash objects. Except for the very few users who had the latest smart phones, all other users had no option to browse interactive learning activities. Students who were used to the desktop environment did not like the interface because of the small form factor with too much content on the screen.

CONCLUSION

This paper presents the road map followed in developing an m-learning extension to the existing e-Learning framework established using a Moodle based VLE. Many people believe that learning through mobile devices creates the environment for m-learning. With the spread of mobile wireless broadband, accessing the Internet through mobile devices has become a ubiquitous activity. However, these mobile devices have their own limitations and they

cannot be used to perform all activities carried out using desktops. People tend to forget these factors due to marketing propaganda with respect to mobile technology and m-learning.

Both e-learning and m-learning are ICT enabled applications through the Internet. How are they related to each other? Using m-learning, can we do everything that we did using e-learning? If the development is incremental, can we develop m-learning extensions on top of our e-learning infrastructure? What are the problems learners face when they encounter both e-learning and m-learning? This paper described a practical path followed to explore these questions as well as to experience the reality.

After carefully investigating what is technically possible using the current technology, we selected two functionalities to develop the m-learning extension. These two functionalities were 1) SMS integration to the Moodle VLE and 2) accessing the Moodle VLE via mobile devices.

Regarding SMS integration, we developed two features, namely SMS Forums and SMS Polls. While experimenting with them, we shared developed code with the open source community. Bi-directional communication between learners and the moodle VLE using SMS could improve the interaction. SMS integration with forums allows them to have an SMS interface. The SMS poll messages are very important for gathering student feedback. Technically, this is an interesting exercise but when we evaluated these features we understood the importance of pedagogical issues in m-learning (Park, 2011).

Considering different types of mobile phone, we experimented with the access to Moodle VLE using two approaches, namely mobile browsers and a mobile application developed using the MLE Moodle plug-in. These two approaches have their own capabilities and limitations. Accessing learning content through mobile devices is not very comfortable. Both technical and pedagogical issues affect significantly when learners try to access existing e-learning content (Peters, 2007). The

e-Learning content was designed considering desktop interfaces. Both teachers and students who were very familiar with the existing e-learning infrastructure were dissatisfied with the facilities and interface of the m-learning extension.

The most important lesson that we learned in this study is to consider both technical and pedagogical aspects together. M-learning extensions cannot be developed to an existing e-learning system without changing the pedagogy and design of the learning content. What we do in a classroom environment cannot be delivered as it is in an e-learning environment. Both the pedagogy and learning content must be changed to make it suitable to deliver using an e-learning system. The same rule is applied when we want to transfer from e-learning to m-learning. When we move from one paradigm to another, we will have several new opportunities as well as having to sacrifice some good practices from the previous paradigm.

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REFERENCES

- Alexander, B. (2004). M-Learning: Emergent pedagogical and campus issues in the mobile learning environment. *EDUCAUSE Research Bulletin*, 2004(16). Retrieved May 1, 2011, from <http://www.educause.edu/ECAR/MLearningEmergentPedagogical/157524>
- GSMA. (2010). *mLearning: A platform for educational opportunities at the base of the pyramid*. Retrieved from http://www.gsmworld.com/documents/mLearning_Report_Final_Dec2010.pdf
- Keegan, D. (2002). *The future of learning: From eLearning to mLearning*. Retrieved May 1, 2011, from http://deposit.fernuni-hagen.de/1920/1/ZP_119.pdf
- Kukulska-Hulme, A. (2007). Mobile usability in educational contexts: What have we learnt? *The International Review of Research in Open and Distance Learning*, 8(2). Retrieved May 1, 2011, from <http://www.irrodl.org/index.php/irrodl/issue/view/29>
- Lim, T., Fadzil, M., & Mansor, N. (2011). Mobile learning via SMS at Open University Malaysia: Equitable, effective, and sustainable. *The International Review of Research in Open and Distance Learning*, 12(2). Retrieved May 1, 2011, from <http://www.irrodl.org/index.php/irrodl/rt/printer-Friendly/926/1738>
- Milrad, M. (2003). Mobile learning: Challenges, perspectives, and reality. In Nyiri, K. (Ed.), *Mobile learning: Essays on philosophy, psychology and education* (pp. 151–164). Vienna, Austria: Passagen Verlag.
- MOMO. (2010). *Mobile Moodle Project*. Retrieved May 1, 2011, from <http://www.mobilemoodle.org/momo18/>
- Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *The International Review of Research in Open and Distance Learning*, 12(2). Retrieved May 1, 2011, from <http://www.irrodl.org/index.php/irrodl/article/view/791/1699>
- Peters, K. (2007). m-Learning: Positioning educators for a mobile, connected future. *The International Review of Research in Open and Distance Learning*, 8(2). Retrieved May 1, 2011, from <http://www.irrodl.org/index.php/irrodl/issue/view/29>
- Reyes, B. R. (2008). *Block: Sending SMS block*. Retrieved May 1, 2011, from <http://moodle.org/mod/data/view.php?id=13&rid=1875>
- Sunday Times. (2011, May 1). *Higher education ministry using Mobitel's mLearning*. Retrieved May 1, 2011, from <http://sundaytimes.lk/110501/BusinessTimes/bt17.html>
- Wickramasinghe, W. M. A. S. B. (2009a, March 26). *MLE - Mobile learning engine forums view topic - Error in parsing the Div tag with styles* (Online forum comment). Retrieved May 1, 2011, from <http://sourceforge.net/apps/phpbb/mle/viewtopic.php?f=16&t=6>
- Wickramasinghe, W. M. A. S. B. (2009b, July 23). *Modification and improvements done for the SMS block* (Online forum comment). Retrieved May 1, 2011, from <http://moodle.org/mod/forum/discuss.php?id=109344>