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Designing Mobile Communication Tools: A Framework to Enhance Motivation in Online Learning Environment

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ABSTRACT

Resulting from the widespread deployment of wireless technologies and the high rates of mobile device use and ownership, online learning is evolving from desktop computers to mobile devices. Mobile communication technology is considered to be effective in promoting learner motivation and encouraging interaction between learners and instructors as well as among peers in online learning environments. This paper explores the design and development of an extension to a Learning Management System (LMS) onto mobile devices guided by a mobile communication tools framework to enhance learner motivation. This underpinning framework was based on a combination of Keller's ARCS (attention, relevance, confidence, satisfaction) motivation model and a collaboration factor. Related studies, the system design, and accompanying architectural issues are discussed in this paper, along with the results of a pilot investigation into learners' responses to its use. The results provide a better understanding of the role of mobile technology in higher education, encourage the further development of mobile communication tools, and shed light on mobile learners' motivation as compared to traditional modes of online learning.

Author Keywords

mobile communication tool, motivation, Learning Management System, Moodle, m-Learning, e-Learning, online learning

INTRODUCTION

A learner's motivation has an impact on the quality and effectiveness of any form of learning. Learners are more motivated when they have frequent contact with instructors and peers, and physical separation in online learning environments can cause loneliness, resulting in a lack of a sense of community (Bai, 2003). Existing communication tools in e-Learning systems, such as weblogs, forum discussions, and chat, can be used to support learner motivation and perceived learning; however the high dropout rate suggests that these tools cannot support the high degree of learner motivation and perceived learning required (Chaiprasurt & Esichaikul, 2010).

The benefits of m-Learning include the convenience that comes with small and lightweight devices, the availability of space and time for learning, the adaptability of content according to individual needs, and the facilitation of sustained connections between learners and instructors. Moreover, m-Learning has the

potential to increase flexibility by customizing the learning approach to deliver a more personalized and learner-centered activity. Drawing from the literature on informal learning and m-Learning, Jones et al. (2006) identified six factors of m-Learning motivation: control (over a learner's goal), ownership, continuity between contexts, learning-in-context, communication, and fun. With respect to appropriate learner interaction in the development of usable m-Learning, each of these features boosts motivation, leading us to identify which aspects of mobile device use might enhance online learners' motivation and engagement in the e-learning process.

THEORETICAL BACKGROUND AND RELATED STUDIES

The use of motivation in online learning environments plays an important role in the ongoing process of learning and interaction, not only in instructional design, but also in the use of communication tools and electronic resources (ChanLin, 2009). The model of motivation used in this study involves ARCS and the collaboration factor. The ARCS model is explored further within its realms of attention, relevance, confidence, and satisfaction.

The ARCS Model

Previous approaches to motivational design in online learning environments have mostly been based on Keller's ARCS model, researched and confirmed for validity in various learning and design environments, such as the traditional classroom; computer-assisted instruction; blended learning environments; and in online, distance and Web-based learning settings (e.g., ChanLin, 2009; Chyung, 2001; Huang et al., 2006; Visser, 2002). Termed a problem-solving approach to designing the motivational aspects of learning environments (Keller, 1987), the ARCS model is based on a synthesis of motivational concepts and theories of human motivation that focus on learners' motivation to learn, and the manipulation of instruction and learning settings to influence learner motivation (Mao & Thompson, 2007). It identifies four essential strategic components for enhancing motivation in instruction, with sub-categories for each component to facilitate the design process.

Attention

Attention is prerequisite to motivating the learning process. Strategies to gain and sustain the learner's attention and interest in the instructional content include (Keller, 1987):

- *Perception arousal* – including challenging, unexpected, or frequent communication, as well as rapid feedback following a task.
- *Inquiry arousal* – referring to stimulating information-seeking behavior. Keller (1987) postulated that this can be accomplished by asking questions or having the learner solve problems.
- *Variation* – to keep learners' interest from waning. Comprising a range of presentations, methods, media, and unexpected events, variation accommodates learners' unique needs and preferences.

Relevance

Relevance is defined as a person's perception of attraction toward desired outcomes, ideas, or other people, based upon their own goals, motives, and values—in other words, the relation of the instructional content to things that are meaningful to the learners. The relevance of the course material can be emphasized by relating the instruction or the content to the learners' personal goals, needs, interests, and motives through (Keller, 1987):

- *Goal orientation* – When learners can perceive the steps toward their desire end goal, they have developed a goal-oriented motivation helping them to recognise immediate objectives to achieve their future goals and demonstrate the utility of the instruction.
- *Motive matching* – Keller (1987) indicated that providing the learners with appropriate choices, responsibilities, and influences will help improve the effectiveness of an instructional product. Motive matching should provide opportunities for learners to perceive the instructional requirements that are consistent with their goals and compatible with their learning styles.
- *Familiarity* – The use of concrete examples and concepts should create a connection between the instruction and the learners' experience.

Confidence

Confidence is generally described as a person's expectation to do things well or deal with situations successfully. In an educational context, this refers to the learners' belief in their own abilities related to the perceived outcomes of their activities. When learners believe they have the ability to control the outcomes of their behavior, they invest more effort into the pursuit of their achievement and are more motivated to be successful. The concept of confidence can be broken down into three areas (Keller, 1987):

- *Learning requirements* – When initiating a learning task, it is important to help learners build positive expectations for success by indicating requirements in a clear manner. An additional help option should provide the learners with further understanding of the learning requirements and how to be successful.
- *Success opportunities* – Learners gain confidence in their own ability when the belief in their own confidence is supported or enhanced by the learning experience, which should provide challenging and meaningful opportunities to establish a belief in the ability to achieve successful learning.
- *Personal control* – The learners should clearly know that their success is based on their abilities and efforts. They should be provided with feedback on the quality of their performance and helped to associate their success with their abilities and efforts.

Satisfaction

Satisfaction is termed a positive feeling about what has been achieved in the learning context (Visser et al., 2002). Satisfaction serves to increase learners' motivation, which can be intrinsic or extrinsic, by providing reinforcement for the efforts given by the learners in the activities. The concept of satisfaction can be broken down into three areas (Keller, 2010):

- *Intrinsic reinforcement* – Providing meaningful opportunities for learners to use their newly acquired knowledge will give them satisfaction in learning. Such opportunities should also reinforce learners' pride of achievement and affirm the importance of the learning experience.
- *Extrinsic rewards* – Providing motivational feedback and positive reinforcement are methods of increasing satisfaction. Extrinsic rewards should include feedback about learners' performance and reinforcement of the learners' success.
- *Equity* – Equity encourages motivation and achievement through the use of consistent standards and rewards for success. A clear consistency between assignments and objectives is a helpful motivational strategy to build satisfaction in learners.

Collaborative Learning

Collaboration is defined as working together with another person or group to accomplish shared goals, and the terms cooperative and collaborative learning are often used interchangeably. While collaborative learning relies more on the quality of exchanged information or shared resources to achieve a common goal by a group of participants, cooperative structures are designed to improve performance by encouraging, increasing, and helping one another through interactions during activities (Slavin, 1995; Schunk et al., 2010). Cooperative learning as a strategy for promoting learners' motivation (Slavin, 1995) confirms the suggestions of previous research studies (Sharan & Shaulov, 1990; Johnson & Johnson, 1989) that cooperative learning enhances learners' motivation more than the traditional whole class. For collaboration, peer discussions must be made to develop the participants' sense of community within their particular group, and collaborative learning—widely acknowledged in its ability to make learners more motivated to learn (Miyake, 2007)—emphasizes activities that support learning through social interaction. Collaborative activities have been found to significantly improve the effectiveness of a learning experience, increasing both individual and group performance (Webb & Palincsar, 1996). Whereas online learning is unlike traditional face-to-face learning, where social presence and a sense of community is encouraged, it can enhance persistence and motivation in due course (Rovai, 2002) so long as online learners have sufficient opportunity to interact with each other, and continuous encouragement for their learning efforts.

A MOBILE COMMUNICATION TOOLSFRAMEWORK

Based on the analysis of motivational factors, the characteristics of mobile technologies, and the potential of such technologies to promote and increase human interactions, this study proposed the integration of mobile communication tools into an e-Learning system. Table 1 illustrates how the ARCS model and collaboration factor were utilized as a framework for developing mobile communication tools in existing e-Learning systems. This study developed the proposed framework based on Moodle (a Learning Management System or LMS), or Virtual Learning Environment, used for creating quality online courses and managing learner outcomes. Considering the ability of SMS (Short Message Service) to make learning more widely accessible than other mobile communication tools, SMS messages acted as the main supplementary tool integrated into the LMS to enhance learner motivation.

Motivational factors	Mobile Communication Tools
Attention: arousal and sustainment of learners' curiosity and interest in the instruction or learning activities.	SMS (asking questions, course notifications & announcements)
	Mobile RSS Feeds (the topic of contents, forums, news)
	Mobile Instant Messaging (MIM)
Relevance: relation of the instruction to the learner's needs, interests, and motives.	SMS (URL related instruction & course information)
	Assignment Feedback Tool
	Mobile Instant Messaging(MIM)
	Mobile Polls and Votes
Confidence: learner's expectation of a successful learning experience.	Mobile Blogging
	Performance Gradebook Tool
	Assignment Feedback Tool
Satisfaction: learner's sense of achievement regarding the learning activities or experiences.	Attendance Reporting Tool
	Mobile Blogging
	SMS (reinforcing feedback and grading results)
	Performance Gradebook Tool

Motivational factors	Mobile Communication Tools
Collaboration: working together with another learner or group to accomplish shared goals.	Mobile Blogging
	Mobile Instant Messaging (MIM)
	Mobile Polls and Votes

Table 1. A mobile communication tools framework

Short Message Service (SMS)

This study allowed the instructor to deliver bulk SMS messages from Moodle with the help of the Text Messaging System, which retrieves messages and phone numbers as they are texted from Moodle. Bulk SMS services that were provided to learners, according to motivation factors, were as follows:

- *Attention:* SMS (course notifications and announcements) allowed the instructor to text messages to learners who had not yet completed some of the activities in Moodle, such as submitting their assignment, viewing course material, and posting to a discussion forum. The instructor was able to select the learners to receive the message and write a text notification to them in Moodle. Such SMS course reminders were intended to stimulate and sustain a learner's curiosity and interest. Similarly, through SMS, the instructor could text questions to selected learners that were specifically intended to help learners think and learn about a subject. Frequently asked questions based on what learners have learned in the lesson were expected to stimulate their attitude of inquiry and naturally challenge their thinking.
- *Relevance:* SMS (URL-related instruction and course information) allowed the instructor to select learners who have neither earned a good score nor submitted the assignment. The instructor could then help them to understand through detailed explanations, or by text linked to a URL, where detailed feedback is posted, how the instruction in which they were participating could either contribute to solving their problem or enrich their performance.
- *Satisfaction:* SMS (reinforcing feedback and grading results) constituted words of affirmation, encouragement, praise, or recognition, and therefore differed in this study from general feedback. SMS reinforcement allowed the instructor to tell learners that what they were doing in the LMS was working well. Providing timely, adequate, and encouraging feedback in the form of reinforcement helped to maintain the desired performance.

Figure 1 shows the default page of the system. Once a learner has logged in and selected a desired online course, the learner was directed to the main page of the system, consisting of seven tools, described below.

Mobile RSS Feeds

Mobile RSS Feeds enabled learners to view and manage all RSS forums and news in Moodle on their mobile phone. To do so, an effective RSS reader is required on the learners' mobile device, allowing the learner to select and bookmark the RSS feeds, and synchronize with their mobile devices in a way that is suitable to their individual learning styles and needs.

- *Attention* – Mobile RSS Feeds are designed to retain the learner's interest, accommodate a variety of the learner's unique needs and learning preferences, and support attention factors leading to improvements in the learner's motivation in an e-Learning system.



Figure 1. Mobile Communication Tools Menu

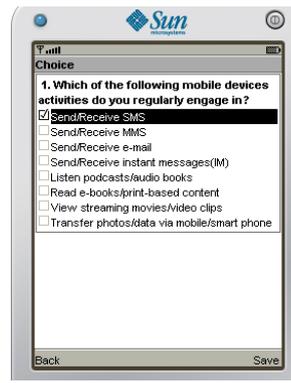


Figure 2. Mobile Polls and Votes

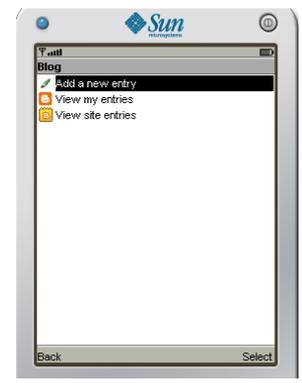


Figure 3. Mobile Blogging Menu

Attendance Reporting Tool

Learners could verify course hours attended in Moodle for each selected duration (today, yesterday, current week, previous week, current month, previous month, and all days). Besides an individual's online duration, learners could also view their percentage and average attendance for the whole session, page hits, and other attendance statistics including percentages, ranks, averages, as well as lows and highs.

- *Confidence* – By attending the e-Learning system regularly, the learner is more likely to keep up with daily course activities. It is important to let learners know that they are solely responsible for their success through their personal efforts and abilities by indicating their attendance in a definable manner, in turn helping learners to feel that they have control over the outcome of their study.

Performance Gradebook Tool

The Performance Gradebook Tool was a graded report on the quality of an individual learner's performance. This tool provided a graded element (grades for each assessment), rank (the position of each element in relation to the rest of the class), and percentage in a similar manner to the Moodle Grader Report.

- *Confidence*– Clearly informing and measuring performance by grading the learners' work helped them to believe in their potential success, making them more likely to exert the effort required to be successful.
- *Satisfaction*– The Performance Gradebook Tool provided all absolute marks and grades given for each assignment, examination, or other course activity within a Moodle course. Equity issues range from providing consistent assessment standards for all learners' activities to keeping them informed about their progress through the tool, anytime and anywhere.

Assignment Feedback Tool

The mobile feedback tool was intended to provide personal, individualized information to a particular aspect of a learner's work in Moodle for a quicker, more convenient way to access feedback. The tool allowed learners to view individual feedback on each assignment directly, and continue to learn from it at anytime and anywhere, using their mobile device.

- *Relevance* – The instructor could use the feedback tool to give learners background knowledge about what a question was asking and to give them a link to more information.

- *Confidence* – Gathering assignment feedback seems to improve the learners’ confidence. From the feedback they received, they could either try to improve or maintain a certain aspect of their competence, which could in turn increase their self-confidence.

Mobile Polls and Votes

The mobile polls allowed participants to select one choice from a variety of options provided by the instructor in Moodle (see Figure 2). The instructor could also define a time window within which participants were allowed to make a choice. This allowed participants to change their minds before the final date, making changes that were automatically displayed by Moodle.

- *Relevance* – Polling via mobile devices was potentially a way to attract and engage learners to view results and additional related activity in the e-Learning system. It was potentially useful in stimulating thinking about a topic, and articulating existing knowledge and understanding.
- *Collaboration*– The instructor created a poll on the Moodle website, and participants to the survey responded using their mobile devices. Mobile polls provided an easy way for learners to express their opinions and determine where they stood against fellow peers.

Mobile Blogging (Moblogging)

Mobile Blogging (also known as Moblogging) is a form of blogging that allows people to share online journals and discuss various topics directly on the Web from mobile devices. In this study, learners created and updated their own blogs in Moodle by simply sending images and/or text from their mobile devices. (see Figure 3).

- *Relevance* – Mobile Blogging related the instruction to learners’ experiences and offered real world relevance to daily circumstances for them.
- *Satisfaction* – Mobile Blogging enabled learners to remotely update their comments and pictures in an authentic context anytime and anywhere on the Moodle blog website. It represented an attempt to encourage and support the learners’ intrinsic enjoyment of newly acquired knowledge with the opportunity to relate their instruction to personal experiences in real settings.
- *Collaboration* – Mobile Blogging helped to establish a collaborative learning environment for learners in virtual classrooms. Learners could snap photos with the tool and then easily upload the pictures with text descriptions directly to their Moodle blog. Their peers were also able to update comments and view a list of blog entries using Mobile Blogging or Moodle blog. Learners were afforded the opportunity to share their experiences, embed them within an authentic context of use, and bring reality closer to their peers and instructor.

Mobile Instant Messaging (MIM)

MIM is a text form of communication which involves immediate correspondence between two or more people via a mobile device. MIM allowed users in this study who were enrolled in the Moodle course to send and receive messages to and from other users via Moodle Messaging System.

- *Attention* – The instructor was able to send a message to selected course participants in Moodle to notify them of events like forum posts, which learners could then read through MIM. The tool helped to make explicit the need to take into account the varying stimulation needs of learners who differ in their traits and state.
- *Relevance* – MIM supported the instructor in making instruction responsive to learners’ motives and values by accommodating different learning needs and styles.

- *Collaboration* – MIM integrated into the Moodle Messaging System gave learners a tool to share information, instantly communicate, and improve teamwork with the capability to collaborate not only synchronously, but also asynchronously, through peer discussions. Learners had the ability to keep in touch with their peers on mobile devices when they were away from Moodle’s Helpdesk.

SYSTEM ARCHITECTURE

This study mainly focused on the design and development of tools for enhancing learner motivation rather than content delivery. The basis of the proposed framework was developed by Moodle, an open source e-Learning software platform where the learner is significantly involved. Figure 4 demonstrates the systematic overview of the proposed tools integrated into existing Moodle LMS and Web Services. The architecture is divided into three components: e-Learning client, m-Learning client, and server. These three components are described in detail in the following sections.

E-Learning Client

As the presentation layer of an e-Learning system, the e-Learning client provides learning materials delivered by a web browser. This layer not only delivers HTML code to the user, combining images, static content, and layout, but also supports interaction, application, and content-specific interfaces for each registered user. The document templates, user interface views, and all users’ customized applications are developed as objects and retrieved on demand. In Moodle, with which the study was engaged, this layer is implemented using PHP. This study attempted to maintain the original presentation layer of Moodle; however, some user interfaces, along with their implementations, were added to support the proposed tools.

M-Learning Client

The m-Learning client consists mainly of two components: the mobile communication tools and the Text Messaging System. The mobile communication tools were used by learners on their mobile phones as an additional module for Moodle and were implemented by Java ME (Java Platform Micro Edition). Java ME provides a robust, flexible environment for applications running on mobile and embedded devices, such as mobile phones or personal digital assistants (PDAs).

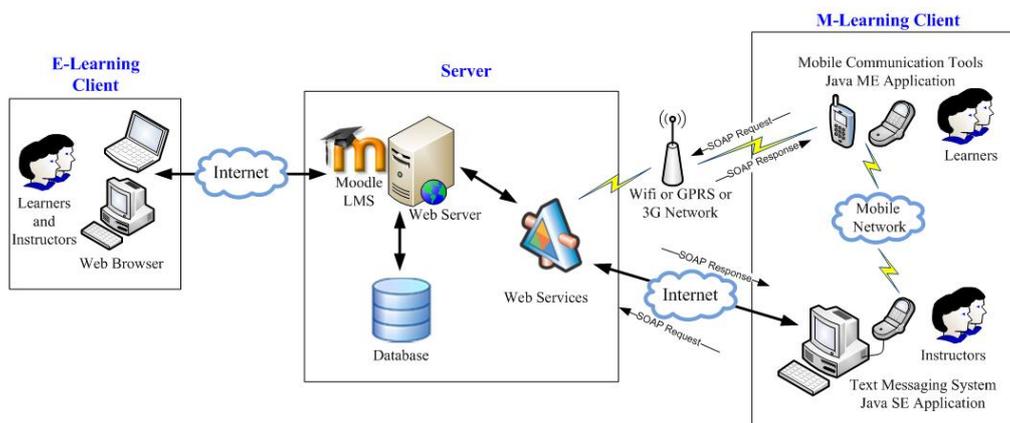


Figure 4. Architectural demonstration of the integration of the LMS with mobile communication tools and Web Services

As the second component, the Text Messaging System was used by the instructor to deliver messages to groups of learners via their mobile phones. Implemented by Java SE (Java Platform Standard Edition)

technology, the system allowed messages, learners' names, and phone numbers to be retrieved from Moodle (see Figure 5 and 6). The system worked with existing plans on GSM phones attached to SIM cards and paid local operators per SMS, as usual. As a PC/laptop-based system, it was not on servers controlled by third parties. Consequently, the instructor could easily manage outgoing messages.

Server

In this study, the server consisted of three main parts: the Moodle LMS, database, and Web Services. Based on PHP language, the Moodle LMS uses a client/server approach, and all content of operations and functions exists entirely in the server. The e-Learning client, a Web page created in HTML, acts as a gate to enable the browser to obtain user requests from the server. The course information contents are stored and managed using databases such as MySQL and SQL Server. The last component is an interface (Web Services) that maintains the communication between the LMS and the mobile communication tools, as well as between the LMS and the Text Messaging System. Web Services enable mobile client applications (mobile communication tools) and the Text Messaging System to access the LMS's contents and activities. Web Services are also responsible for translating the LMS's function requests into appropriate formats for mobile applications. An overview of Web Services is explained in the following section.

Web Services

Web Services is a software system designed to support application-to-application or machine-to-machine interactions over a network, constituting an infrastructure used for developing and deploying distributable applications. In addition, it allows software codes to be written in different languages and run on different operating systems. Other systems interact with Web Services through a URL described by SOAP (Simple Object Access Protocol) messages sent over accepted Internet protocols, such as HTTP. Clients access Web Services applications using XML (eXtensible Markup Language) messages that follow the SOAP standard through its interfaces and bindings, which are defined using XML artifacts, such as a Web Services Definition Language (WSDL) file (Singh et al., 2004).

As Web Services can run on a variety of software platforms, architectures, technologies, or devices, this study employed Web Services to provide information from the LMS to the proposed tools on mobile devices as well as to the Text Messaging System on a desktop or laptop computer. The study also used WSDL and XML-based language to describe Web Services. WSDL-based documents provide information about how to interact with the target Web Services, including a description of the Web Service, a method for accessing a Web Service, the location of a Web Service, binding information, and a way to exchange data by using a Web Service.

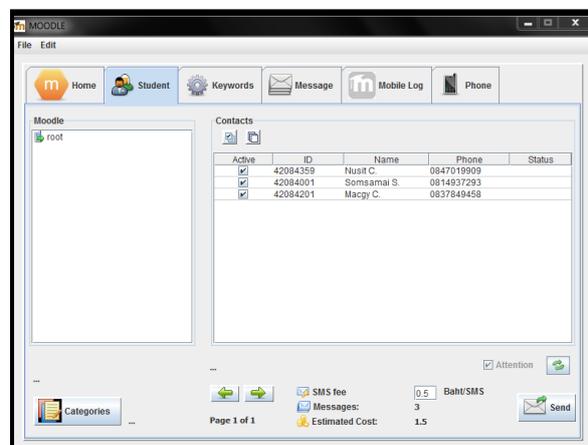
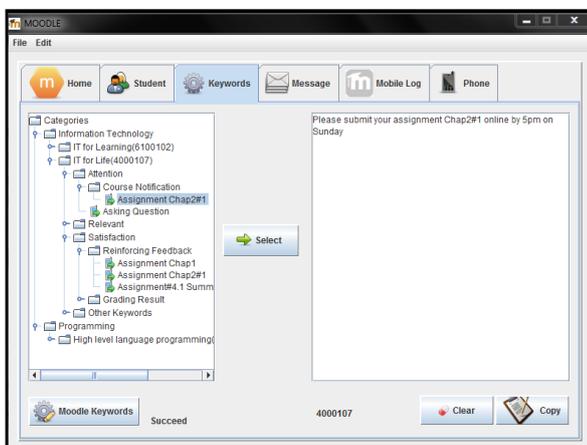


Figure 5. Selecting the course notification text message to learners

Figure 6. Retrieving the learners as they are texted from LMS

TOOLS EVALUATION

The main focus for evaluating the tools was to determine the learners’ opinions and obtain learner feedback after participating in the study. Data for the evaluation were collected from questionnaires of how successful they were in supporting learning at the end of the course, forum discussions in the e-Learning system, and access logs of the m-Learning (mobile communication tools) and e-Learning systems throughout the semester. A pilot study was conducted involving 40 first-year undergraduate students who had taken the “*IT for Learning*” course through an e-Learning system in the first semester of 2010 in the Faculty of Information Technology at one university. The course was organized using a Moodle LMS with the proposed new tools. The participants’ task was to log in to both the e-Learning and m-Learning systems to access the materials and interact with their peers and instructor. All students owned a mobile phone and could receive the text messages. However, only 15 students in this sample had a mobile phone supporting the Java platform to run and access all proposed tools,

The questionnaire was designed to gather information about the learners’ perception of their learning experience, especially as related to the tools used during the online course. Questions focusing on the importance of the proposed tools were asked using a 5-point Likert scale with a tool not used rated as a 1, a somewhat important tool rated as a 3, and a critical tool rated as a 5. The questionnaires were distributed to the students, and 29 of them were returned. The overall results indicated that the learners found the proposed tools important for accessing information and for communicating with peers and the instructor in online learning (3.21). The results from the survey are shown in Table 2.

Survey (N = 29)	Average	Std. dev.
How important is using the following tools in your mobile phone to supporting online learning? 1=not used, 3=somewhat important tool, 5=critical tool		
• SMS	3.69	0.95
• Assignment Feedback Tool	3.44	0.63
• Performance Gradebook Tool	3.44	1.15
• Mobile Blogging	3.19	1.33
• Mobile Instant Messaging (MIM)	3.13	1.06
• Attendance Reporting Tool	3.00	1.10
• Mobile RSS feeds	2.94	1.29
• Mobile Polls and Votes	2.88	1.20
<i>Background questions</i>	<i>Percent</i>	
• Do you have a mobile phone?	100%	
• Can your mobile phone access the Internet?	88.64%	
• Can you install and run mobile communication tools on your mobile phone?	51.72%	

Table 2. Result from survey of tools evaluation

Throughout the semester, the total number of SMS messages sent to an individual learner with a mean of 29 (ranging from a low of 18 to a high of 32), or approximately two messages per learner per week. 38% of respondents said that they accessed the course website (e-Learning system) twice a week, while 27.6% and 17.2% said they accessed it once a week or less, and four times per week, respectively. The actual number of learner postings on the online discussion board, including comments or questions, was approximately three postings per learner per week.

Moreover, the students were asked to provide additional comments. They felt that they gained valuable experience in using the e-Learning system and its associated mobile communication tools. The majority of students saw value to be gained from the flexibility of accessing the course, sharing of ideas, opinions, and knowledge with their peers and instructor at anytime and from anywhere. The findings show that SMS has become one of the most popular and most effective means of communication in the online course. SMS is the only method of the proposed tools that touches 100% of participants. Obviously, SMS is push media that can distribute information, and can be customized for individual preferences.

CONCLUSIONS

This paper has discussed and demonstrated how to utilize mobile devices in online learning environments, mainly considered as an additional tool by providing learners with different methods of mobile communication to encourage motivation and engage in an online learning process. After analyzing the survey data and logs of access on the server, this study found that the proposed framework can assist learners in their learning process. The usefulness of various tools developed in this study for support-perceived learning depends on which learning activities the tools can support. In other words, instructional design for learning activities is necessary for selecting the appropriate tools to improve the learners' motivation for learning. Further research would be required to explore the relationship between motivation factors (ARCS and collaboration) and overall learners' motivation in an online course that is supported and non-supported by mobile communication tools so as to better understand their interrelationship and the effectiveness of the tools.

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