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Modelling the Influencing Factors on Mobile Learning Tools

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ABSTRACT

In this study, the authors are concerned about influencing factors on mobile learning tools for the applicable and sustainable mobile learning environment. The authors proposed an impact model with five influencing factors namely usefulness, interactivity, motivation, facilitating conditions, and ease of use. The 60 students and 60 teachers in different learning and teaching disciplines in higher education institutions were involved in this study to evaluate the model. Initially, they were asked to fill the pre-usage questionnaire with their initial mobile learning experience. Then, they were allowed to use mobile learning tools in the Moodle mobile app and allowed to fill the post-usage questionnaire. The results reveal that the most significant influencing factor is the ease of use. Hence, the study concluded that ease of use would be the most significant factor to be considered when designing mobile learning tools in the mobile learning environment.

KEYWORDS

Higher Education, Influencing Factors, Mobile Learning, Mobile Learning Tools, Moodle Mobile Apps

INTRODUCTION

In the present modern world, technology dominates to human lifestyle in every aspect. Massive development in technologies in recent decades affects directly education. Today it is difficult to think about education without the involvement of diversified kinds of technology (Ramírez-Montoya, 2018). Among these technologies, mobile telecommunication (MT) is very significant. Integration of MT with portable devices such as smartphones, tab computers, PDAs, and other portable communicative devices that have computing power with internet facilities for carrying out education emergence as mobile learning (ML) (Grant, 2019). On the other hand, the highest E-Learning growth rate of 17.3% on yearly basis is reported in Asia. While its global rate is 7.6% (Docebo, 2020), and according to Figure 1. Asian continent's digital marketing capability is growing rapidly (Statista, 2020). Hence, ML is a new phenomenon for educational stakeholders to extend their academic activities from traditional classroom activities to a new ubiquitous learning environment. Whereas, outdated obstacles for ML

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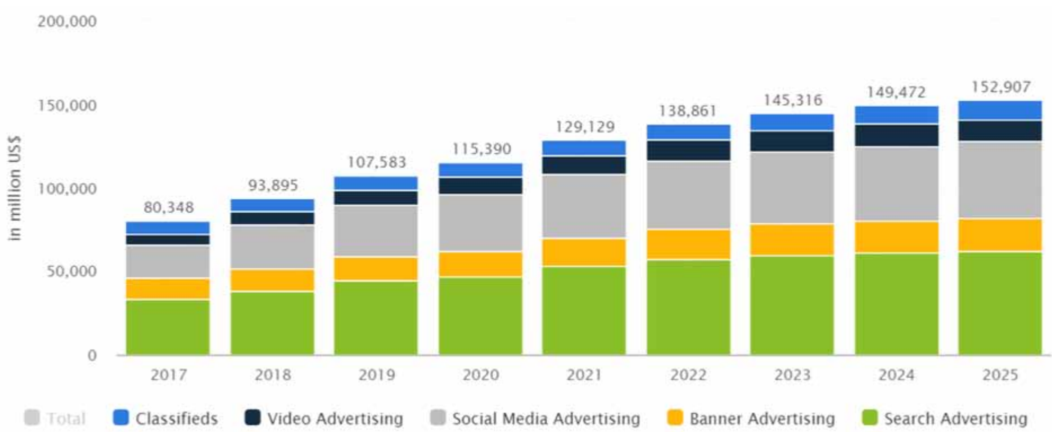
such as connectivity, accessibility, and cost are minimized with the huge advancement in mobile internet penetrations and curtail in smartphone market prices day by day (Bahia & Suardi, 2019).

Figure 1. Digital marketing capability of Asian Tertiary Education



Besides teachers and learners, today, like to use ML as a teaching and learning medium due to facilities, include such as anytime-anywhere learning, pervasive learning, etc. (Ateş-Çobanoğlu, 2020). These facilities are empowered by various ML tools and these ML tools influence both teacher and learner to use them in various academic activities. ML tools can be integrated into mobile devices in the device production stage or can be added as an add-on or third-party subroutine in customizable ML environments. For instance, Moodle is the popular open-source content management system that can add functionalities as add-ons call plugins. Teachers and learners able to add ML tools as Moodle plugins for their ML environment or can be built their plugins and added to their ML environment (Dougiamas M., 2020). The researches have conducted many studies in ML related to numerous fields such as health, management, engineering, humanities, and social sciences and identified different impact factors (Larentis, Barbosa, & Barbosa, 2020), (Klein, Junior, Silva, Barbosa, & Baldasso, 2018). But lack of researches can be found in modeling the influencing factors for learners and teachers to use ML tools in academic activities. In this study, the authors intend to find the main influencing factors for learners and teachers to use ML tools for adopting ML in higher education. Therefore, as the contribution in this study, the authors proposed an impact model for influencing factors on ML tools which can be used when developing an applicable and sustainable ML environment in higher education. This article proposed an impact model for ML adoption using ML tools makes different research output compared to the existing literature.

The paper is structured as follows: next in the ML tools section, the ML tools considered in this study are described. The literature review section describes previous research related to ML and ML associated models. Also, it accumulates the artifacts for formulating the proposed model. The next impact model and hypothesis section describe the model creation and hypothesis generation. The system used in this study is described under the section system function and architecture. The next sections are methodology, results, discussion, and conclusion and implication.

MOBILE LEARNING TOOLS

In ML, teachers and learners can use a variety of ML tools. However, we have selected six types of most popular ML tools for this study.

Mobile Application

Mobile application or mobile app is the tool developed to use on portable, lightweight, and wireless gadgets such as smartphones, and tablet computers with computing power (Chen & Kotz, 2000).

Push Notification

Push notification feature is available in smartphones and desktop devices manufactured today. It allows apps to interact with users by pushing short messages. Notifications are generated by applications or services with forms of graphical prompt, acoustic indication, or touch action generated alert. They communicate a piece of information to a user to aware of different knowledge within the present environment (Gan & Balakrishnan, 2016; Seraj & Wong, 2014).

Chat

Synchronous communication medium for online users via desktop or mobile devices in text or video forms. This facilitates two or more online users located in different geographical distances (Church & Oliveira, 2013).

Forum

Asynchronous communication medium among internet users as an instructional interaction. This is a heavily applying tool on online learning methods such as ML, e-learning, and distance learning as a collaborative consulting technique (Sun, Lin, Wu, Zhou, & Luo, 2018).

SMS/Mobile App Messages

Short message service (SMS) facilitates mobile devices, most mobile apps, and online systems to send text messages. SMS uses standard communication protocols to exchange text message size up to 160 characters among mobile devices. Some devices enable voice conversion of the SMS within the device to facilitate an audible version of the text message (Premadasa & Meegama, 2016; Church & Oliveira, 2013).

Mobile Gamification

Gamification is an interactive game integration for learning and teaching activities through a mobile application. In the present technology-based education gamify, social, and mobile are the three types of media can be used to create effective ML systems (Khaddage, Lattemann, & Acosta-Díaz, 2014).

LITERATURE REVIEW

Mobile application (MA) is a major tool in ML for both teacher and learner. The application should include properties like garb to local needs, trustworthiness, quality content, and easy remembering operating steps to adopt learners in mobile wireless technology (Gan & Balakrishnan, 2016; Seraj & Wong, 2014). User expectation is one of the critical factors to be considered when designing ML. Especially electronic material reading MAs are expected to be easy to work and worth (Hyman, Moser, & Segala, 2014; Mohamad, Lakulu, & Samsundin, 2016). Learners' acceptance for mobile learning application (MLA)s relies on the features such as security for data with integrity and privacy, usefulness as offline access, and simplicity as simple and understandable contents (Alwi, Habibah Bt., & Fatin Munirah Bt., 2016). An optimized MA architecture enables MAs to use mobile platforms and devices independently with high efficiency. Using this architecture, a MA can be operated remotely with enhanced usability, flexibility, and convenience in ML (Lan, Wang, Chen, Song, & Parsaei, 2016). When designing a MLA, learner motivation factors such as self-initiating, using self-experience technology, and flexibility with routines should be considered (Viberg & Gronlund, 2015).

Another inspiring ML tool is gamification. Gamification is the reason for learners' subject interest in botanical science learning and its game-based learning strategy is the most important factor for success. Learners prefer to self-study mobile learning environment (MLE) with educator assistance for learning with different outside study conditions (Su & Cheng, 2013). Learners prefer to learn music subjects in game-integrated MLE (Chen C. W., 2014).

Chatting is one of the important tools in MLE. This facility enables learners and teachers to synchronous communication especially in outdoor learning environments with their educators effectively. Calvo and colleagues (2014) found the best commercial chat applications for educational activities based on Universal Design for Learning (UDL) guidelines (CAST, 2018). By considering features such as user accessibility, message customization and personalization, and restricting interfaces, they identified WhatsApp, Line, and ParaChat as educationally suitable chat applications while Facebook and Hangout not best suitable for academic discussions (Calvo, Arbiol, & Iglesias, 2014). According to the WCAG 2.0 guidelines most suitable chat application is Edmodo while Moodle avoids accessibility barriers for educational chat activities in the non-commercial versions (Calvo, Iglesias, & Castaño, 2017).

One other exciting facility associates with MAs is push notification (PN). PNs appear on the mobile screen anywhere and anytime as a notification whenever the new content is generated by MA. Pham and colleagues (2016) used English learning related MLA to experiment for learners' ideas about PNs. Such as PNs increase the usage time and retention of the app, learners prefer attractive notifications. However frequent PNs are considered annoying. Also, PNs with learner-satisfied content and layout effect for accepting the ML system (Wang, et al., 2017). Mehrotra and colleagues (2015) proposed a data-driven model that resides in the operating system of the mobile device and it includes the classifier that leads the learner to have more relevant notification based on the current user activity.

A mobile learning forum is another great ML tool. It is popular for collaborative learning by developing and shaping knowledge under social constructivism (Sun, Lin, Wu, Zhou, & Luo, 2018). An African subcontinent based research reveals that mobile forums enhance the collaboration between learners and teachers (Sebbowa & Muyinda, 2018). Sometimes in online discussion forums, students discuss ideas not related to the post topic, relatively misperception ideas (Beckmann & Weber, 2016).

One of the most popular and firstborn mobile tools is SMS and a huge amount of researches was carried out so far by educators to better apply in the field of ML. Students involve SMS in their learning positively and have a great learning experience with the SMS integrated learning system (Ziden, Rosli, Gunasegaran, & Azizan, 2017). A low-cost SMS delivery system is useful for university students to receive lecture materials, assignments and submit learner assignments with higher interactivity (Kwang, Chung, & Teoh, 2015). English learning students prefer to use content and audio based mobile systems even though SMS is expensive (Fazeena, Ekanayaka, & Hewagamage, 2015).

The basis of identifying factors for the proposed model as follows. Influencing factors for learners and teachers to adopt ML in the above literature were classified and grouped by considering their similarities. As shown in Table 1. various impact factors associated with previous models and studies in ML were summarized. Finally, they were categorized into the impact factors proposed in this article.

Table 1. Impact factor summarization and categorization in previous studies and models

Influencing factors (or facilities) in previous ML related studies	Influencing factor associated with proposed impact model
Accessibility (Alwi, Habibah Bt., & Fatin Munirah Bt., 2016), Electronic document reading (Hyman, Moser, & Segala, 2014), Critical thinking abilities (Ahmed & Parsons, 2013), Social media Interactivity, Interactive automated responding (Xu, Kang, Song, & Clarke, 2015), Conducting discussions (Rekha & Venkatapathy, 2015), Distance learning (Alkasirah & Nor, 2018), Short courses engagement(Goh, Seet, & Chen, 2012), Improve learning outcome(Su & Cheng, 2013), Learn complex matters, Knowledge retention (Kiryakova, Angelova, & Yordanova, 2014)	Usefulness
Learning collaboratively, Interactive ML Tools features (Butoi, Tomai, & Mocean, 2013), Interactivity for ML acceptance (Mtebe & Raisamo, 2014), Cognitive interactions, Collaborative learning, and Composing knowledge with collaboration & sharing ideas (DeWitt, Alias, Siraj, & Zakaria, 2014),	Interactivity
Improve reading skills (Mohamad, Lakulu, & Samsundin, 2016), Self-initiating, Using technology self-experience, Flexible with routines (Viberg & Gronlund, 2015), Learner motivation for ML (Garcia-Penalvo & Conde, 2014), Learner participation, Confidence in academic activities. (Chiang, Yang, & Hwang, 2014), Carry on academic activities by enhancing understanding and outcomes (Kiryakova, Angelova, & Yordanova, 2014; Su & Cheng, 2015),	Motivate
Operate remotely, Enhanced usability, Flexibility, Platform independence (Lan, Wang, Chen, Song, & Parsaei, 2016), Behavioral intention (Timothy, 2010), Acceptance of ML (Mtebe & Raisamo, 2014), Transparent managing ML tools(Mehrotra, et al., 2016), Situated learning and device engagement (Weber, Voit, Kratzer, & Henze, 2016), Accessibility (Calvo, Iglesias, & Castaño, 2017), Features (Jana, Pande, Chan, & Mohapatra, 2013)	Facilitating Conditions
Easy to operate (Gan & Balakrishnan, 2016), Simple navigations (Seraj & Wong, 2014), User satisfaction (Hyman, Moser, & Segala, 2014), Guiding learner's success, Teacher recommendation (Sebbowa & Muyinda, 2018), Study enthusiasm (Hayati, Jalilifar, & Mashhadi, 2013)	Ease of use

In the recent past studies, researchers developed several models using mobile computing which can be applied to ubiquitous learning or ML. An agent-based model was proposed for recommending a pedagogical context for ubiquitous learning groups (Ferreira, Gluz, & Barbosa, 2020). Another model was proposed by modeling learner interaction data on the system and learning style able to predict consensus information of learners such as course dropouts (Heidrich, et al., 2018). An architectural model was proposed for adapting learning objects to the context, according to the learners' study behaviors and presenting learning objects fit to the device specifications (Abech, Costa, Barbosa, Rigo, & Righi, 2016). A different model was proposed to maintain learner profiles dynamically and generate the best-fit learning context for learners (Wagner, Barbosa, & Barbosa, 2014) (Table 2).

Table 2. Proposed model comparison for similarities and differences with previous models

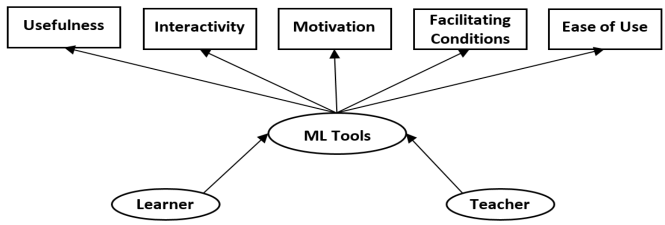
Model (or framework) Reference	Purpose	Target User	Constructing Method	Evaluation
Proposed Model	ML adoption for teacher and learner	Learner & teacher	Using previous ML researches	Prototype and End-user
(Hyman, Moser, & Segala, 2014)	Developing formal instructional content	Learners	Using previous similar researches	Device-based practice with questionnaire evaluation
(Ahmed & Parsons, 2013)	Technology-assisted inquiry-based learning environments	Teachers	Using previous researches	Mobile app with Questionnaire
(Mtebe & Raisamo, 2014)	ML adoption for learner	Learners	Models in previous studies	Questionnaire
(Mehrotra, Hendley, & Musolesi, 2016)	Notifications solution	Learner & Teacher	User preference data in the Device	Questionnaire
(Ferreira, Gluz, & Barbosa, 2020)	Educational content recommendation	Teachers	Profile data	Simulated scenarios
(Heidrich, et al., 2018).	Diagnosing learners	Teachers	Learner behavior data	Student survey
(Abech, Costa, Barbosa, Rigo, & Righi, 2016)	Content adaptation	Learner & teacher	Learner behavior data and device characteristics	Prototype evaluation
(Wagner, Barbosa, & Barbosa, 2014)	Maintain profiles dynamically	Learner & teacher	Learner behavior data and device characteristics	Prototype and simulation

Most of the past researches for model development in ML used system interaction data or user behavior data to generate models and frameworks. And also they were developed to improve functionalities. But in this article, the authors used influencing factors of ML in past researches as the impact factors of the proposed model. Also in this research, the proposed model intends to implement through the Moodle ML application and evaluate user response questionnaire whereas most of the previous model evaluations used similar evaluation approaches. The purpose of this study is to model the learners' and teachers' influence on ML in HEI.

IMPACT MODEL AND HYPOTHESES

In this article, the model was developed to describe the factors that depend on learners' and teachers' ML tools usage in the applicable and sustainable ML framework. Mainly five observed variables are identified with the ML adoption to elaborate the proposed model by literature. These observed variables (influencing factors or impact factors) are usefulness, interactivity, motivation, facilitating conditions, and ease of use (Figure 2).

Figure 2. Influencing factors on ML tools for learner and teacher in the proposed model



IMPACT FACTOR DEFINITIONS AND HYPOTHESES

Usefulness

Originally Davis (1989) defined usefulness as a core certainty to consent about information technology to understand user's intention towards embracing new technology. He defines usefulness as the extent of personal confidence for using a system to boost fulfillment. Usefulness is one of the major influencing factors for teachers and learners to use ML tools in academic activities. Accessibility (Alwi, Habibah Bt., & Fatin Munirah Bt., 2016), electronic document reading (Hyman, Moser, & Segala, 2014), and increasing performances & critical thinking abilities in the natural experimental atmosphere (Ahmed & Parsons, 2013), are useful features in MAs for learners. MAs are useful because, it helps learners to develop learning performance and advance positive attitudes regarding ML (Ahmed & Parsons, 2013; Oyelere, Suhonen, Wajiga, & Sutinen, 2018; Alqahtani & Mohammad, 2015). The chat facilities are more useful when interacting with social media and interactive automated responding functionality (Xu, Kang, Song, & Clarke, 2015). Also, online forums are very useful to experience programmers for conducting discussions and clarifying computer program code related matters (Rekha & Venkatapathy, 2015). Learners considered SMS is useful for distance mode adults for religious learning activities (Alkasirah & Nor, 2018).

H1: ML tools are useful for teacher and learner to adopt applicable and sustainable ML

Interactivity

Hillman and colleagues (1994) defined interactivity as engagement in learning. Garrison (1993) improved it further as that the interactivity facilitates learners for elaborating and debating ideas. Interactivity can be found as the interaction between students, student and teacher, student and content, and student and authority (Northrup & Rasmussen, 2000). Interactivity is a generic feature cause to popular mobile devices and allows learners for learning collaboratively in ML. ML users get more benefits with interactive features of ML tools. User interactivity is a useful requirement for ML than content presentation and graphical user interface (Butoi, Tomai, & Mocean, 2013). Interactivity is a major factor for learner's ML acceptance (Mtebe & Raisamo, 2014). Teacher's interactive participation style for academic activities via different ML tools is heavily affected by learner's engagement in ML activities. Some of the best interactive features in ML tools are cognitive interactions, collaborative learning, composing knowledge with collaboration & sharing ideas (DeWitt, Alias, Siraj, & Zakaria, 2014), interaction with social media, and interactive automated responding functionality (Xu, Kang, Song, & Clarke, 2015).

H2: ML tools are interactive for teacher and learner to adopt applicable and sustainable ML system

Motivation

Motivation is defined as the strength to get going and supervise a performance. Also, motivation is a fundamental factor for achievements in learning (Serio, Ibáñez, & Kloos, 2013). Jones and her colleagues (2006) identified factors such as autonomy, proprietorship, communication, amusement, learning-in-context, and continuity between contexts are effect stakeholders in ML to motivate in the mobile device-based academic activities. Motivation is a personal psychological aspect for learner and teacher to carry on the mobile device based learning using ML tools. MAs motivate learners to use technology to improve reading skills (Mohamad, Lakulu, & Samsundin, 2016). Learners get motivated for pursuing learning endeavors in a ubiquitous environment with self-initiating, using self-experience technology, flexible with routines. Therefore, learner motivating factors need to be considered when designing MA to the learner for learning (Viberg & Gronlund, 2015). The learner is motivated for ML in situations when the learner able to integrate their preferred ML tools (Garcia-Penalvo & Conde, 2014). Furthermore, the ML tools motivate learners for attendance and confidence in their academic activities and lead to improving learning achievements (Chiang, Yang, & Hwang, 2014). Amusement in ML environments motivates learners to carry on academic activities to enhance understanding and outcomes (Kiryakova, Angelova, & Yordanova, 2014; Su & Cheng, 2015) while less enjoyable is a reason for demotivate to use MA in education.

H3: ML tools motivate teacher and learner to adopt applicable and sustainable ML system

Facilitating Condition

Facilitating conditions(FC) can be described as the extent of personal confidence for facilities available in both institutionally and technically assisting in using the system (Venkatesh, Morris, Davis, & Davis, 2003). Facilities offered in a particular technology is very important to the learner and teacher for adopting academic activities in ML. Ability to operate ML remotely with enhanced usability, flexibility, and convenience in mobile platforms independently call an optimized mobile application architecture. (Lan, Wang, Chen, Song, & Parsaei, 2016). Teachers' behavioral intention of using mobile technology depends on the FC of ML tools (Timothy, 2010). FC influence learners and teachers to accept ML (Mtebe & Raisamo, 2014). FC for learners preferred ML tools and transparency in managing, they facilitate effective MLE (Mehrotra, Hendley, & Musolesi, 2016). The learner gets benefit and support from FC for situated learning and device engagement (Weber, Voit, Kratzer, & Henze, 2016), high level of accessibility (Calvo, Iglesias, & Castaño, 2017), and device features (Jana, Pande, Chan, & Mohapatra, 2013) in ML Tools.

H4: ML tools have supportive facilities for teacher and learner to adopt applicable and sustainable ML system

Ease of Use

Ease of use is another core certainty to consent about information technology proposed by Davis (1989). He defined ease of use as the extent of personal confidence for using a system with the least complexity (Davis, 1989). Ease of use is one of the foremost factors for the learner to use ML tools in education. Easy to operate is a great ease of use feature in MLA for learners (Gan & Balakrishnan, 2016) and MAs are believed as ease of use when they have simple navigations (Seraj & Wong, 2014). User expectations depend on the level of ease of use in MLAs and the ease of use factor should be integrated into MLA for satisfied user expectations (Hyman, Moser, & Segala, 2014). Collaborative ML tools with their ease of use nature in guiding learner's success have a great recommendation for teachers (Sebbowa & Muyinda, 2018). To be a most successful learning mode MLA need to facilitate learners to carry on studies enthusiasm with ease of use features (Hayati, Jalilifar, & Mashhadi, 2013).

H5: ML tools are ease of use for teacher and learner to adopt applicable and sustainable ML system

System functions and architecture

In this study, we modified the Moodle mobile environment by including different ML tools to analyze the proposed model.

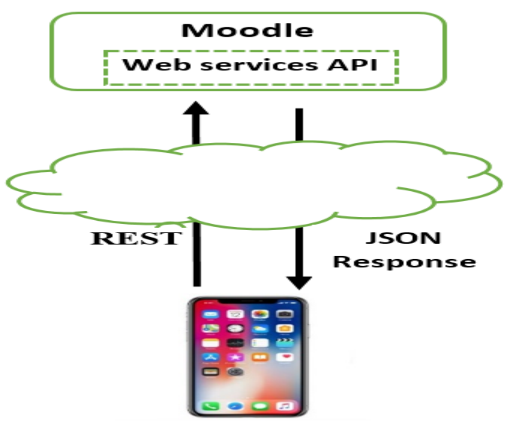
Moodle Mobile Learning Environment

Moodle mobile application (MMA) is the mobile version of the Moodle open-source learning management system, which facilitates learners and teachers to carry on academic activities anytime, anywhere. It uses open-source software development technologies such as HTML, PHP, JavaScript, ionic, and Cordova/PhoneGap mobile application development frameworks (Dougiamas M., 2018). MMA is an extensible and customizable application. It can be done through plugin or app theme modification. However, when developing a new plugin or use the existing Moodle plugin for new functionality in MMA, it is required to enable mobile support for them by developing special PHP files in each plugin (Dougiamas M., 2020).

Communication Between Moodle Mobile Environment and Moodle Desktop Environment

As shown in Figure 3 Moodle mobile communicates with the Moodle server through web service API using REST protocol and JSON response. The recommended communication protocol is HTTPS. User sessions are managed by using unique tokens. HTTP requests are used to file upload and download.

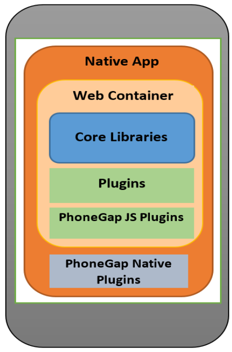
Figure 3. Communication between Moodle mobile and Moodle



Moodle Mobile Architecture Basics

MMA is a platform-specific native app that uses device features as well as mobile operating system features. Hence the MMA has separate versions for android and iOS. The web container includes in the native app consists of core libraries, plugins, and PhoneGap JS Plugins. Core libraries are Moodle mobile JavaScript files, Moodle mobile cache JavaScript files, Moodle mobile language JavaScript files, JQuery library, and other backbone libraries. Plugins are the functionalities developed for performing a transaction using the app such as upload, participations, contents, add a note, add content, chat, forum, etc. PhoneGap JavaScript files come with the mobile application framework support for web containers. Other than these two types of plugin, we can see PhoneGap native plugins allow the app to access device and platform functionalities.

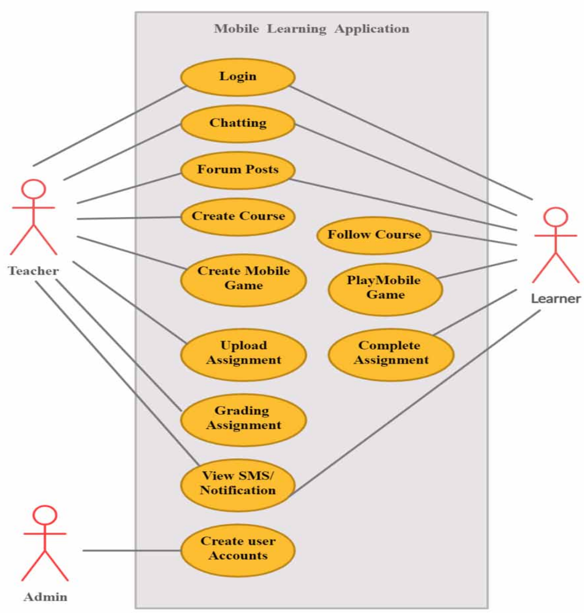
Figure 4. Moodle mobile architecture.



Use Case Diagram

Basic functionalities of the mobile application i.e. login, chatting, post a forum post, create a course, follow a course, create a mobile game, play mobile game, upload assignment, complete assignment, grading an assignment, view SMS/notification, and create user accounts of a teacher, learner, and system admin are depicted in Figure 5.

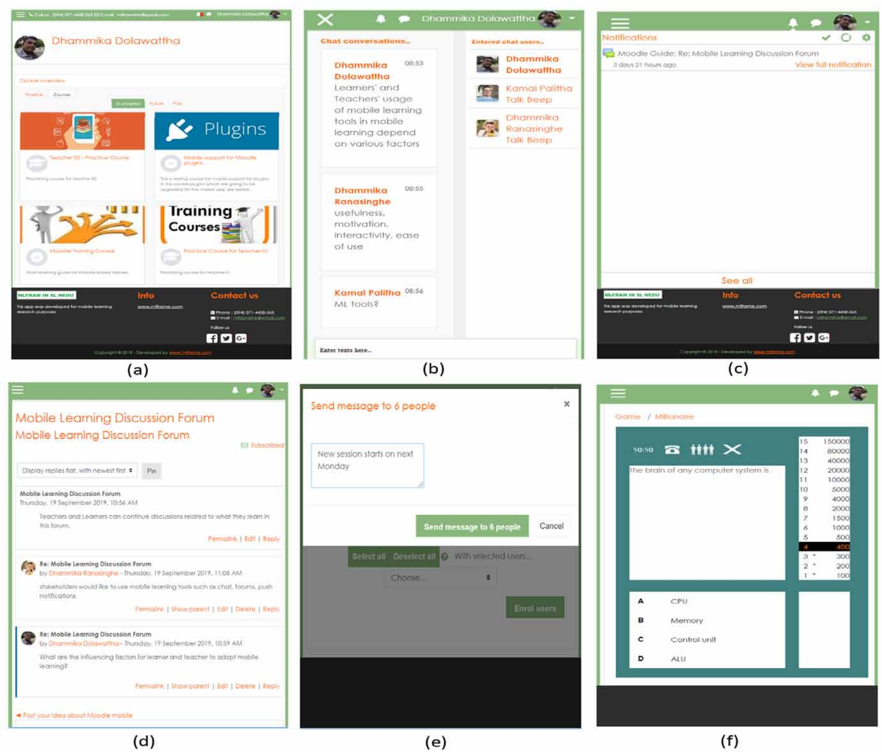
Figure 5. Use case diagram



Mobile interfaces

Some of the interfaces of functionalities implemented in the customized MMA are shown in Figure 4. In Figure 6, (a) denotes home interface of mobile application, (b) denotes interface of the chat tool, (c) denotes interface of the notification tool, (d) denotes interface of the forum tool, (e) denotes interface of message tool, (f) denotes interface of the gamification tool.

Figure 6. Interfaces of tools in modified Moodle mobile app



METHODOLOGY

The pre and post usage tests were conducted among 60 selected university lecturers who work at the faculty of science, social sciences, humanities, and commerce and management at the University of Kelaniya, Sri Lanka. Also, the pre and post usage tests were conducted using 60 selected university students who learn at the above mention faculties in the same university. In this survey, the same questionnaire was used for both teachers and learners. A questionnaire consists of 20 questions. These questions were categorized into five categories including four questions for each category namely usefulness, interactivity, motivate, facilitating conditions, and ease of use. The ðve-point Likert scale ranging from -10 – strongly disagree, -5 – disagree, 0 – neutral, 5 – agree and 10 – strongly agree was used in the questionnaire. Firstly, teachers and learners were asked to fill the pre-test questionnaire according to their knowledge of educational mobile apps. Secondly, the same set of above teachers and learners were asked to work with the modified MMA which was integrated functionalities such as push notification, chat, forum, SMS/mobile app messages, and gamification. Finally, they were asked to fill the post-test questionnaire. From the above questionnaires, 120 valid pairs of pre and post questionnaires were selected for both teachers' side and learners' side with an equal potion for each side. In this research, the primary data analysis was done using mean values of bar charts and the Anderson-Darling Normality Test. The paired sample t-test and the correlation model with the Pearson correlation coefficient were developed as advanced data analysis.

Research Instruments

Guided response type pre-test and post-test survey questionnaires with ðve-point Likert scale value responses were used in this study. The same questionnaire was used for both pre-test and post-test surveys. Mainly questionnaire has five components and each component has 4 questions. The validity of the questionnaire was done by using content validation. For content validation, a subject expert checked the questionnaire and evaluated it as the questions effectively capture the topic under investigation. Reliability of the questionnaire was done using Cronbach's Alpha test. Cronbach's Alpha test was done using MINITAB computer application for windows. The results revealed that the Cronbach Alpha value was 0.778, which is considered an acceptable level of reliability (Taherdoost, 2016).

Survey Sample

The higher education institute in which the study was carried out consists of four faculties in the same geographical area i.e. faculty of science, social sciences, humanities, and commerce and management. Each faculty has a nearly similar population of students and teachers. Therefore, second-year students of each faculty are considered in this study. Similarly, each faculty occupied with a nearly similar number of teachers. The sampling technique used in this study is Stratified sampling which can be applied to a sample population consists of subpopulations. As subpopulations nearly equal in size, a similar percentage is considered as samples in each faculty. Therefore, each faculty represent an almost similar student and teacher population (Table 3).

Table 3. Demographic profile of the participants

	Science		Social Sciences		Humanities		Com. & Mgt.		Total		
	M	F	M	F	M	F	M	F	M	F	
Students	7	8	8	7	8	7	7	8	30	30	60
Teachers	8	7	7	8	7	8	8	7	30	30	60

The authors considered a quantitative approach in this study for evaluation with the participants. The impact model for learners and teachers to use ML tools for adopting ML was done by literature. The model implementation is done by a well-established Moodle mobile application. Therefore, in model creation or implementation authors didn't wish to involve expert participants.

SCOPE OF THE STUDY

The scope of the study is ML in Sri Lankan higher education. The target group is university students, teachers, and administrators who involve in an academic transaction in various fields such as Science, Social Sciences, Humanities, Commerce and Management, and medicine. In this scope, various areas of digital marketing platform development have to be assessed. Such as content delivery or pedagogy, conducting exams, connectivity, learning assistance, etc. Digital marketing platforms need to be assessed for measuring their educational strength, cognitive capabilities, on-demand service capability, online payment facilities, and reliability, etc. (Williamson, 2020)

RESULTS AND DISCUSSION

In the primary data analysis, Anderson-Darling Normality (ADN) test was conducted to overall post-test survey responses with the following data conversion on Likert scales as shown in Table 4.

Table 4. Likert scale data conversion

Questionnaire Answers	Value
Strongly Disagreed	-10
Disagreed	-5
Neutral	0
Agree	5
Strongly Agree	10

Table 5. Likert mean interpretation

Likert Mean	Interpretation
Less than -5	The proposed system strongly rejected by the university education community
Between -5 and 0	The proposed system normally rejected by the university education community
0	Neutral
Between 0 and 5	The Proposed system normally accepted by the university education community
Greater than 5	The proposed system strongly accepted by the university education community

The overall post responses mean is equal to 6.9404, P-value <0.005, and the confidence interval is (6.7838, 7.0970). As shown in Table 5. This implies that the university teachers and learners have strongly accepted ML tools in ML. The data set is normally distributed and can apply a parametric test on the data set. Mean is within the Confident interval and mean accepted under 0.05 significant level. As shown in Table 6. Means of each attribute of post responses i.e. useful, interactivity, motivation, facilitating conditions, and ease of use were calculated.

Table 6. Means of each attribute in the post-test survey

Attribute	Mean
Usefulness	7.427
Interactivity	7.208
Motivation	6.865
Facilitating	6.760
Easiness	6.417

The results as shown in Table 6 the mean values of each attribute is greater than 5. This denotes that the university community accepted the ML tools in ML with the modified MMA. Likewise, attributes of the proposed model in ML tools for teachers and learners were accepted. As the data set is normally distributed (ADN test results) and the number of data sets exceed 30, the paired sample *t*-test (parametric test) was applied to pre-test and post-test data sets as an advance analysis. The hypothesis was set as follows in this test.

$$H_0 : \mu = 0 \text{ VS } H_0 : \mu > 0$$

Where, H_0=ML tools are not useful/interactive/motivated/Facilitated/Ease of Use for teacher and learner to adopt applicable and sustainable ML.

Table 7. Paired sample t-test results

Factor	Mean value	P-value
Usefulness	7.427	0.000
Interactivity	7.208	0.000
Motivation	6.904	0.000
Facilitating Conditions	6.760	0.000
Ease of Use	6.417	0.000

As shown in Table 7 the paired sample *t*-test results p-value of each factor equal to 0.000 (<0.005). This implies that the H_0 is rejected and H_1 is accepted. Also, the mean value greater than zero. Therefore, the result of the paired sample *t*-test denotes that the ML tools are useful, interactive, motivated, facilitated, and ease of use for teachers and learners to adopt applicable and sustainable ML.

Finally, the Pearson correlation coefficient was calculated to describe the correlation in the proposed impact model. The weight and counts are used for students' responses and the rules shown in Table 8 are used to interpret the correlation coefficients.

Table 8. Correlation coefficient interpretation rules

Correlation coefficient	Positive	Negative
0.0 – 0.3	No correlation	No correlation
0.3 – 0.5	Week positive correlation	Week negative correlation
0.5 – 1.0	Strong positive correlation	Strong negative correlation

$$H_0 : \rho = 0 \text{ VS } H_1 : \rho \neq 0$$

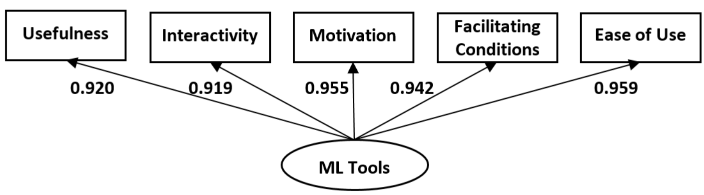
The above hypotheses tests were applied with p-values and these hypotheses were rejected at 0.05 significant levels when the test p-values are less than 0.05. The Pearson correlation coefficient test between student response weight and counts calculated using the MINITAB computer application for windows and results were summarized as shown in Table 9.

Table 9. Pearson correlation coefficient test results

Variable	Correlation	p-value
Usefulness	0.920	0.027
Interactivity	0.919	0.027
Motivation	0.955	0.011
Facilitating conditions	0.942	0.017
Ease of use	0.959	0.010

According to the test results, each p-value is less than 0.05 denotes that the H_0 is rejected and - H_1 is accepted. Therefore, it implies that ML tools are useful, interactive, motivated, facilitated, and ease of use for teachers and learners to adopt applicable and sustainable ML. Also each variable's correlation greater than 0.5 and close to 1. According to the correlation interpretation rules shown in Table 8 each observed variable of the proposed impact model is strongly correlated with ML tools used for ML. Finally proposed impact model with correlations is shown in Figure 7. The results reveal that the most significant factor for teachers and learners to use ML tools is the ease of use.

Figure 7. Influencing factors on ML tools for learner and teacher in the proposed model with correlations



Though in this study ease of use was elected as the most significant factor for learners and teachers to use ML tools in higher education. However, every factor in the impact model has very similar correlation values and they all are closed to one. Results of this study align with related results in previous studies immerged significance for ease of use in ML tools such as ease of use for operating steps in educational mobile apps (Gan & Balakrishnan, 2016), simple navigation (Seraj & Wong, 2014), easiness in electronic ML application (Hyman, Moser, & Segala, 2014), ease of use in mobile forums (Sebbowa & Muyinda, 2018), and easiness in message-based language learning (Hayati, Jalilifar, & Mashhadi, 2013). But other factors remaining in the impact model also can be considered as very effective for ML tools integration in ML. Apart from that, being all the impact factors in this model received higher correlation values denotes ML tools are very significant in ML for stakeholders in higher education. Nevertheless, few assumptions can be made as reasons for having these results in this study. The first assumption is most learners and teachers in the contemporary era experience easiness for mobile tools in using mobile devices for day-to-day activities and social collaborations. The second assumption they use similar tools considered in this study for social connectivity and mobile device related to recreational activities. On the other hand, these results also reflect their willingness to use mobile devices in academic transactions with great satisfaction. In this study, we used to integrate a few selected popular ML tools such as push notification, chat, forum, SMS, and gamification. But these results possible to change with different learning tools integration with Moodle mobile application in the post-test survey.

CONCLUSION AND IMPLICATIONS

The main objective of this study is to identify the influencing factors for teachers and learners to use mobile learning tools in the applicable and sustainable mobile learning framework. According to the past literature, an impact model with five main influencing factors were proposed. The proposed impact model was implemented using the modified Moodle mobile environment and tested using a selected group in the university community. Anderson darling test and paired sample *t*-test were used to analyze the data. According to the results, the university community strongly accepted the factors proposed in the impact model for mobile learning tools used in the proposed system. Also, each observed variable in the impact model is strongly connected with the latent variable 'mobile learning tools'. The most significant factor is 'ease of use' for considering when developing or integrating mobile learning tools in mobile learning systems. However other factors i.e., usefulness, interactivity, motivation, facilitating conditions are also equally significant for integrating mobile learning tools in mobile learning systems because in this research almost all observed variables in the impact model receive very close correlation values to each other. Authors suggest future research that explores these correlations using samples from different higher education institutes to have more generic results. Then the change in correlation can be identified for different ethnic groups as well. According to that designers able to develop a more robust mobile learning solution.

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