

The Impact Model: Teachers' Mobile Learning Adoption in Higher Education

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ABSTRACT

Mobile technology-based education is referred to as mobile learning and has great demand due to the prevailing contemporary socio-economic culture. Better mobile learning experiences require stakeholder satisfaction. This research aims to observe teachers' influencing factors for an applicable and sustainable mobile learning framework. The impact model with six observed variables, namely, Usefulness, Interactivity, Motivation, Attitude, Facilitating Conditions, Ease of Use and also the latent variable Teacher Adoption on Mobile Learning were proposed. This model was implemented and tested using the Moodle mobile application while introducing new features. Pre and post-usage questionnaires were used to identify the impact of observed variables on the latent variable. The sample was comprised of 60 university lecturers in different academic disciplines. Initially, the lecturers were asked to complete the pre-usage questionnaire and then they were allowed to use the implemented Moodle mobile application and finally, they were asked to complete the post-usage questionnaire. Results revealed that the most significant influencing factor for teacher's mobile learning adoption is "Usefulness". It was concluded that, incorporating other factors with the most significant factor "Usefulness" into mobile learning adoption, can better explain teachers' perspective of an applicable and sustainable mobile learning framework.

Keywords— *Mobile learning, teacher perspectives, influencing factors, higher education risk*

INTRODUCTION

The latest innovations and improvements in information communication and mobile telecommunication technologies, motivate teachers and other stakeholders of the academic institutions in higher education to shift from the traditional academic environment to the latest technology enabled modern learning environment (Somekh, 2008). On the other hand, teachers have to consider various factors when developing learning content, such as employed students, technology skilled smart generation, and learners located in different geographical places (Papanikolaou & Mavromoustakos, 2006). At present, time is the most valuable factor for people who may be wasting time in a traditional classroom to acquire an education. Conversely, it is a mispending of resources if the teacher has to function in a traditional classroom with a small number of learners. Both learners and teachers utilize time effectively with technology-enabled pedagogy. Given the availability and use of various smart devices on different operating platforms, educators need to design their electronic learning content in the distance mode of education for device independent and platform independent environments (Khaddage & Gerald, 2011). The teacher's role in technology-based education is very crucial, and to have sustainable mobile device based education, researchers need to do more studies related to teachers adopting mobile learning.

The teacher

Cambridge Advanced Learner's Dictionary & Thesaurus of Cambridge University Press define a "teacher" as someone whose job is to teach in a school or college (Cambridge University Press, 2018). Tamblyn (2000) notes that the teacher should have qualities related to skills and competence in teaching such as subject competence, creativity and motivation through positive reinforcement, and thus able to compose curriculum fit for the learner. In addition, Tamblyn notes the importance of the teachers' personality and attitudes such as handling risks and mistakes, respecting the learner, attractive presentation and over-work. Furthermore, a teacher should have the necessary capabilities for adopting technology and it is essential to have a positive attitude about the advantages of teaching with technology (Ertmer, et al., 2012).

Teacher and mobile learning

Due to the massive developments in technology, every area of the world is dominated by it. When considering the education sector, both Internet technologies and computer technologies affect it. These technologies have given rise to the birth of electronic learning (e-Learning). At present, e-learning controls education and it changes the method of delivering education (Allen & Seaman, 2015). Owing to the mobile technology revolution, mobile learning has emerged as a subset of e-learning. On the other hand, globally, people are very busy with their economic life. As with other activities, people struggle to find time for their educational activities. People choose mobile learning to have an education and save time to do many other activities, by not consuming time for classroom based education. In accordance with this situation, educational institutions and educators require the use of mobile technology to provide educational services. Teachers need the capability to use mobile technology in order to provide learning content attractively, creatively and in a perceivable manner (Georgina & Hosford, 2009). Mobile learning is a platform for the learner to pursue studies outside the classroom on the go. Hence, teachers of mobile learning are able to provide better academic services to their service receivers, such as integrating curriculum and developing a variety of learning and training content professionally. In addition, teachers need to be aware of the latest trends and issues in mobile technology with mobile learning tools, strategies, and approaches (Mohamed, 2009).

LITERATURE REVIEW

In mobile learning, the teacher's role is very important for pursuing academic activities effectively via mobile devices. The literature shows that different categories of teachers in Korea prefer to use mobile learning as a communication method as well as a teaching method (Baek, et al., 2017). Shams et al., (2014) noted that Pakistani teachers require the development of positive attitude towards mobile learning to use mobile devices as an effective teaching medium. In the music domain, teachers are required to improve their practical awareness to use a music learning application such as 'Auralbook' (Chen, 2014). Kearney et al., (2015) noted that authenticity is more important for educators working with mobile learning activities in the high speed connected mobile network environment. In addition, Al-Emran et al., (2016) noted that educators at the university of UAE have a positive attitude toward the use of mobile technology for academic activities irrespective of their experience and positions. Attitude toward usage, perceived usefulness and perceived ease of use were found to be the most influencing factors for pre-service teachers' intention to use mobile learning (Timothy, 2010). Studies have also found that mobile pedagogies are adopted by teachers due to device ownership and they have higher attitude scores on authenticity while relatively low attitude scores were noted for online collaboration, networking and student agency on mobile technologies (Kearney, et al., 2015). Pre-service teachers prefer to adopt mobile learning by satisfying the associated mobile learning features, and consider less the obstacles in mobile learning than in-service teachers (Thomas & O'Bannon, 2015). Teachers of Northern Cyprus schools were found to have a positive attitude toward using mobile learning, but they still needed

much more improvement in usage of mobile technology for learning (Ozdamli & Uzunboylu, 2015). Ayoub (2014) revealed that educators of Dar es Salaam University College of Education (DUCE) were conducting awareness programs for teachers to improve their positive attitude towards mobile learning, however other studies found that mobile game playing experience and ease of use were not reasons for educators to accept gamification for their learners (Bourgonjon, et al., 2013).

Teachers of rural school districts in Virginia indicated perceived usability as more influential for acceptance of the use of mobile technologies in education (Holden & Rada, 2011). Primary educators in Spain have realized that mobile learning is facilitating access to information and increasing engagement to learning (Domingo & Garganté, 2016). When implementing mobile learning Mac Callum et al., (2014) noted that the critical factors that affect behavioral intention of lecturers were digital literacy, ICT anxiety, teaching self-efficacy, and perceived ease of use and usefulness. On the other hand, a few barriers for teachers to adopt mobile learning are also noted. Alfarani (2015) identified resistance to change as a barrier for female lecturers to accept and adopt mobile learning in a Saudi Arabian university and a lessening of resistance with their increasing age and professional experience. Moreover, social culture negatively impacted accepting and adopting mobile learning in the same domain but it did not change based on age or experience. Teachers' perception regarding the adoption of mobile learning was found to be questionable in public schools in the State of Malaysia, because teachers' mobile learning readiness was at a very low level (Ismail, et al., 2013).

Studies have also been conducted that show teachers believe that they require further training and support to familiarize themselves with a mobile device to carry them through educational activities and therefore teachers are hesitant to accept mobile learning. However, teachers have identified learning possibilities through integration with mobile devices for enhancing the learning achievements of learners using mobile learning (Messinger, 2011). Further, negative attitudes and beliefs are major barriers for teachers when using technology. Therefore, professional development is required to change their pessimistic ideas towards successful mobile learning integration in student learning (Ertmer, et al., 2012). A majority of older teachers in certain parts of the world use smart phones with features unsupported for classroom learning due to their beliefs about the use of mobile features in classroom education (O'Bannon & Thomas, 2014). Assistance to facilitate change in their beliefs could lead to proper technological integration (Kim, et al., 2013), as it is very important to train teachers to deliver knowledge through the latest mobile technologies and devices. Additionally, existing teacher training programmes need to be modified to use new mobile technologies (Ally, et al., 2014). Furthermore, the literature shows that creating awareness among teachers about the meaning of mobile learning and the importance of a mobile device as a learning tool in mobile learning is needed. This is because teachers have a more positive attitude toward use of a laptop than a mobile phone as a mobile learning tool (Ad & Gökta, 2013). Pre-service teachers use mobile learning for self-learning, producing mathematical concepts, taking notes anytime and for doing mathematical assessments, in addition to narrow collaborative activities especially in the use of social networks based data sharing and subject matter discussions (Kearney & Maher, 2013).

Major issues for adopting mobile learning in the Nigerian higher education system and for use by teachers were security problems while using mobile devices for educational activities as well as privacy issues for the mobile users. To enhance mobile learning in Nigeria, teachers recommended reducing security threats associated with the use of mobile devices (Shonola & Joy, 2014). Some teachers have a level of uncertainty in using mobile learning as a teaching method. Thomas et al., (2014) found that Kentucky and Tennessee school teachers were uncertain about classroom usage of mobile devices. Teachers identified certain benefits as well as barriers associated with the use of mobile devices as an educational tool in schools and a majority of them believed that mobile devices do not support the activities in classrooms. Blackwell (2014) noted that teachers require

training and support to integrate mobile devices that suit student focused education systems according to their teaching methods. Further, according to the investigations carried out by Yusof et al., (2014), Malaysian special needs educators believe that they need further facilities to adopt mobile learning to provide better services to students with special needs. Edutainment technologies for instance, augmented reality, game-based educational software and animation projects were suggested to integrate with mobile learning (Yusof, et al., 2014). Moreover, technology self-efficacy was found to be more advantageous than computer self-efficacy for teachers to accept mobile technology in schools (Holden & Rada, 2011).

IMPACT MODEL AND HYPOTHESIS

The authors identified more than 30 impact factors for teachers to adopt mobile learning by studying more than 40 recently published teacher related mobile learning research papers, and developed the impact model for teacher's mobile learning adoption.

These impact factors are grouped into six observed variables, that is, usefulness, interactivity, motivation, attitude, facilitating conditions and ease of use (see Table 1 below).

Table 1: Impact factors found in the literature for teachers' adoption of mobile learning

Observed Variable	Impact factors found from literature
Usefulness	Usefulness, Access to information, Self-learning, Teaching Method
Interactivity	Interactivity, Engagement to learning, Communication, Collaboration
Motivation	Motivation, Social Culture, ICT self-efficacy, ICT teaching self-efficacy, ICT anxiety, Digital literacy
Attitude	Attitude, Subjective norm, Resistance to Change, Mobile Learning uncertainty, Teachers' attitudes and beliefs
Facilitating Conditions	Facilitating conditions, Mobile learning facilities, Device ownership, Training, Support, Readiness, Awareness, Authenticity, Security and Privacy
Ease of use	Ease-of-use, Usability

The proposed impact model for a teacher to adopt mobile learning, is defined using the above-mentioned six observed variables and the latent variable called "teacher adoption on mobile learning" (see Figure 1 below).

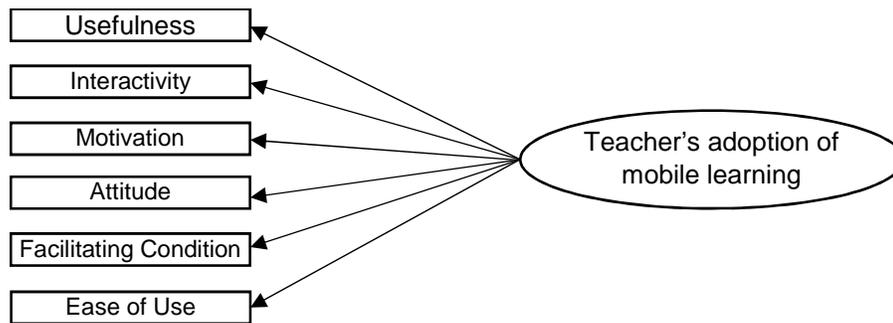


Figure 1: The proposed model for teacher adoption of mobile learning

Teacher's Adoption in Mobile Learning

For a particular user to use or accept a new technology or a system, depends on a number of factors such as availability of technology required, availability of infrastructure, suitability, sustainability, affordability, productivity and security among other variables. There have been a number of theories and models that discuss technology adoption for users such as the Theory of Diffusion of Innovations (Rogers, 1995), Theory of Task-Technology Fit (Goodhue & Thompson, 1995), Theory of Reasonable Action (Ajzen & Fishbein, 1975), Theory of Planned Behavior (Ajzen, 1991), Technology Acceptance Model (Davis, et al., 1989) and Unified Theory of Acceptance and Use of Technology (Venkatesh, et al., 2003). Therefore, in order to develop an applicable and sustainable mobile learning system, the teacher's individual impact factors should be considered.

Impact factors for teachers to adopt an applicable and sustainable mobile learning system

By studying previous published definitions the authors defined each of the impact factors in the proposed impact model for the teacher to adopt in mobile learning.

Usefulness

Usefulness is defined as the individual satisfaction for a system about heightening his or her activities' accomplishment through the system (Davis, 1989). Educators who carry out mobile-based education have different levels of satisfaction which changes based on individual factors such as gender, teaching level in the school, teaching experience and the subject taught. Some Asian subcontinent teachers (especially female teachers) were found to be satisfied with use of a mobile medium as a teaching method (Baek, et al., 2017). The possibility of quick access to information from various sources was a reason for some teachers in European countries to opt to mobile-based teaching (Domingo & Garganté, 2016). Perceived usefulness is one of the most influencing factors for pre-service teachers' intention to use mobile learning (Timothy, 2010). Furthermore, usefulness is one of the most critical factors to behaviour intention of lecturers when implementing mobile learning. Moreover, usefulness significantly influences teachers' adoption of mobile learning (Mac Callum, et al., 2014). Self-learning opportunities were identified by the educators as a condition for being satisfied with mobile-based teaching (Kearney & Maher, 2013).

In this study we defined usefulness for teachers in mobile learning in the context of satisfaction of the teacher with the mobile learning system in heightening the accomplishment of teaching activities through the system. System qualities such as usefulness, different teaching methods, access to information and self-learning were important, while also demanding applicability and sustainability of the particular system.

The hypothesis for usefulness (H1) is as follows: *Usefulness will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

Interactivity

Interactivity is defined by Muirhead (2000) as an allusion to communication, involvement and reaction, and interactivity pertains to a learner's online collaboration with the rest of the learners and with their respective educators. Newhagen and Rafaeli (1996) presented a definition for interactivity, which relates to web communication as a degree of reflections on a particular communication, and associated feedbacks. Educators prefer to use mobile devices for educational communication among colleagues and pupils with positive perspectives on mobile-based teaching (Baek, et al., 2017). Moreover, collaboration is viewed as one of the interactive utilization features for the educator in mobile based teaching (Kearney, et al., 2015). Increasing engagement with learning is also viewed as an interactive facility in this education medium (Domingo & Garganté, 2016).

In this study we defined interactivity for the teacher in mobile learning in the context of allusion to communication, involvement, and reaction pertaining to the teacher's online collaboration with all stakeholders on a mobile learning system with facilities such as engagement to learning, communication and collaboration while demanding that the particular system is applicable and sustainable.

The hypothesis for interactivity (H2) is as follows: *Interactivity will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

Motivation

Schunk et al., (2008) defined motivation as starting and giving strength to a procedure by which purposive action takes place. Also, motivation can be defined as personal psychological aspects to a particular task with purposive behaviour (MacIntyre, et al., 2001). Teaching self-efficacy and digital literacy motivate educators to adopt mobile learning with behaviour intention. Sometimes, teachers may not be comfortable with the latest technology. This emotional response of teachers leads to ICT anxiety thereby influencing teachers' adoption of mobile learning (Mac Callum, et al., 2014). Alfarani (2015) revealed that female educators were not motivated to carry out mobile based teaching with their social culture and this remained unchanged with maturity. However, teachers who represented rural areas were motivated to technology self-efficacy work on mobile-based teaching in their schools (Holden & Rada, 2011).

In this study we defined motivation for the teacher in mobile learning in the context of influencing the teacher to reach a high level of performance and disabling obstacles in teaching activities using mobile learning systems, with characteristics such as teaching self-efficacy, digital literacy, less ICT anxiety, encouraging social culture, technology self-efficacy while demanding that the particular system is applicable and sustainable.

The hypothesis for motivation (H3) is as follows: *Motivation will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

Attitude

Attitude can be defined as a cognitive judgment conveyed through assessing an item with some amount of biased belief (Eagly & Chaiken, 2007). Developing positive attitudes was found to be the main influencing factor for a teacher to adopt mobile-based teaching (Shams, et al., 2014; Timothy, 2010). Moreover, educators have positive attitudes towards using smart devices, the latest mobile technologies for academic activities but their experience, academic rank, and the device owned

were not changing their attitude (Al-Emran, et al., 2016). Educators can use different mobile devices, enabling tools and applications to provide academic services. One such tool is mobile games. Educators are able to integrate mobile games in learning content intelligently to enhance the learning activities of their learners. Even though educators' perceptions were positive regarding the use of mobile game applications, they did not accept commercial game applications (Bourgonjon, et al., 2013). It is reported that certain educational institutions need to conduct awareness programmes to uplift their teachers' mobile base teaching knowledge. Due to this, a considerable portion of their teachers' attitude to adopting smart devices for teaching has been curtailed compared to other teachers (Ayoub, 2014; Ozdamli & Uzunboylu, 2015). Teachers were found to have fewer perceptions of the obstacles in mobile learning but preferred to adopt mobile learning expressing satisfaction with associated mobile learning features (Thomas & O'Bannon, 2015). Mobile Learning uncertainty is another negative attitude towards teachers adopting mobile devices in teaching. Some school teachers have experienced uncertainty in classroom usage of mobile devices. Teachers identified certain benefits as well as barriers to mobile devices when using them as educational tools in schools and a majority of them believed that mobile devices do not support teaching in classrooms (Thomas & O'Bannon, 2015). Some mature teachers were reluctant to use mobile devices with smart features and held lower beliefs about using smart features in classroom education and their instructional barriers (O'Bannon & Thomas, 2014). Successful mobile technology integration in education depends on educators' positive attitudes, beliefs, some internal factors and the support from others. Therefore, professional development is required to change their pessimistic ideas towards successful mobile learning adoption (Ertmer, et al., 2012; Kim, et al., 2013).

In this study we defined attitude of teacher toward mobile learning in the context of cognitive judgment conveyed through assessing the mobile learning system and its features with teachers' personal beliefs and characteristics such as subjective norm, resistance to change, ICT anxiety, mobile learning uncertainty, teachers' attitudes and beliefs, and perception, while demanding that the particular system is applicable and sustainable.

The hypothesis for attitude (H4) is as follows: *Attitude will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

Facilitating Conditions

Facilitating conditions is defined by Venkatesh et al., (2003) in the context of objective factors found in the environment that observers agree make an act easy to accomplish, provision of support for users in the case of need or in the case of difficulties and also an easily controllable environment according to one's own mind. The smooth use of technology in mobile based teaching is very important in order to ensure a productive service. Hence, facilitating conditions and infrastructure surrounding the teaching medium assume importance for the sustainable use of mobile devices. Facilitating conditions significantly affect behavioral intention of teachers when using technology in academic activities (Timothy, 2010). When conducting mobile-based teaching in application areas such as music, educators need more practical awareness of mobile learning applications (Chen, 2014). Also creating awareness about what is meant by mobile learning and the importance of a mobile device as a learning tool in mobile learning is needed in order to prevent misunderstandings about mobile learning (Ad & Gökta, 2013). Teachers require further training and support to have better knowledge about the latest mobile technologies and devices (Messinger, 2011; Ally, et al., 2014; Blackwell, 2014). Authenticity is one mobile learning feature that enables teachers and learners to include academic activities for collaborative work, and authenticity was considered an important feature for a teacher to adopt mobile-based teaching (Kearney, et al., 2015). Device ownership is a characteristic of the teacher preference for authenticity and signature pedagogies in mobile learning (Kearney, et al., 2015). Teachers involved in special needs education suggested

integrating edutainment technologies such as, augmented reality, game-based educational software and animation projects with mobile learning (Yusof, et al., 2014). Low levels of readiness in mobile learning among teachers was found to be a questionable situation in mobile learning (Ismail, et al., 2013). Devices used in mobile learning connected through the Internet always face the possibility of security issues such as hacking, virus/malware attacks, and denial of service among other issues. To establish proper mobile environments, teachers recommended reducing security and privacy threats when using mobile devices (Shonola & Joy, 2014).

In this study we defined facilitating conditions for the teacher in mobile learning in the context of the degree to which an individual believes that organizational and technical infrastructure such as mobile learning facilities, security and privacy, authenticity, device ownership, training, support, readiness, and awareness exist to support the use of the mobile learning system while demanding that the particular system is applicable and sustainable.

The hypothesis for facilitating conditions (H5) is as follows: *Facilitating conditions will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

Ease of Use

In the technology acceptance model, Davis (1989) defined perceived ease of use in the context of the degree to which an individual believes that using a particular technology would be free of cognitive effort. Perceived ease of use was found to be one of the most influencing factors for teachers' intention to use mobile learning (Timothy, 2010). Moreover, lecturers' perceived ease of use as critically affecting the behavior intention of mobile learning adaption (Mac Callum, et al., 2014). In the Cambridge Dictionary, usability is defined as the fact of something being easy to use, or the degree to which it is easy to use. Usability significantly influenced teachers in rural areas when selecting mobile technologies as a medium for providing academic services (Holden & Rada, 2011).

In this study we defined ease of use for teachers in mobile learning in the context of the degree to which a teacher believes that using a particular mobile learning system with usability and other ease of use facilities, would be free of cognitive effort while demanding that the particular system is applicable and sustainable.

The hypothesis for ease of use (H6) is as follows: *Ease of use will have a significant influence on the teacher for adopting an applicable and sustainable mobile learning system.*

SYSTEM FUNCTION AND ARCHITECTURE

Moodle

The Modular Object Oriented Dynamic Learning Environment (Moodle) is a popular, fully open source learning management system with a single robust, secure and integrated platform, which enables creating a custom-made learning environment for teachers, administrators and learners. There were around 143 million users in 228 countries all over the world at November 19, 2018 (Dougiamas, 2018). Moodle has considerably supported the paradigm shift from typical classroom based learning to modern online learning.

Moodle Mobile App

Moodle Mobile App (MMA) is the official app of Moodle, which can be freely downloaded via the Google Play Store. MMA uses HTML, PHP, JavaScript and ionic with the Cordova/PhoneGap

mobile application development framework. It shifted Moodle eLearning to mobile learning (Dougiamas, 2002).

Moodle Architecture

Moodle has been developed according to the Social Constructivist theory (Gergen & Davis, 1985) which enables administrators, teachers, learners and stakeholders to share, develop and feel invested in the product through integrated wikis, forums, glossaries, databases and messaging. Moodle has three main parts, that is, the Moodle code executing in a PHP-capable web server; a database managed by MySQL, PostgreSQL, Microsoft SQL Server, MariaDB, or Oracle; and a file store for uploaded and generated files. These can be run on one server or a separate server. Moodle is an extensible and customizable system and the Moodle core is surrounded by plugins with various functionalities. Adding or changing functionalities can be done through changing existing plugins or developing new plugins. Each plugin can be developed using sub plugins to minimise the complexity of the main functionality (Dougiamas, 2002). Figure 2 below, describes the three-tier architecture of the Moodle environment.

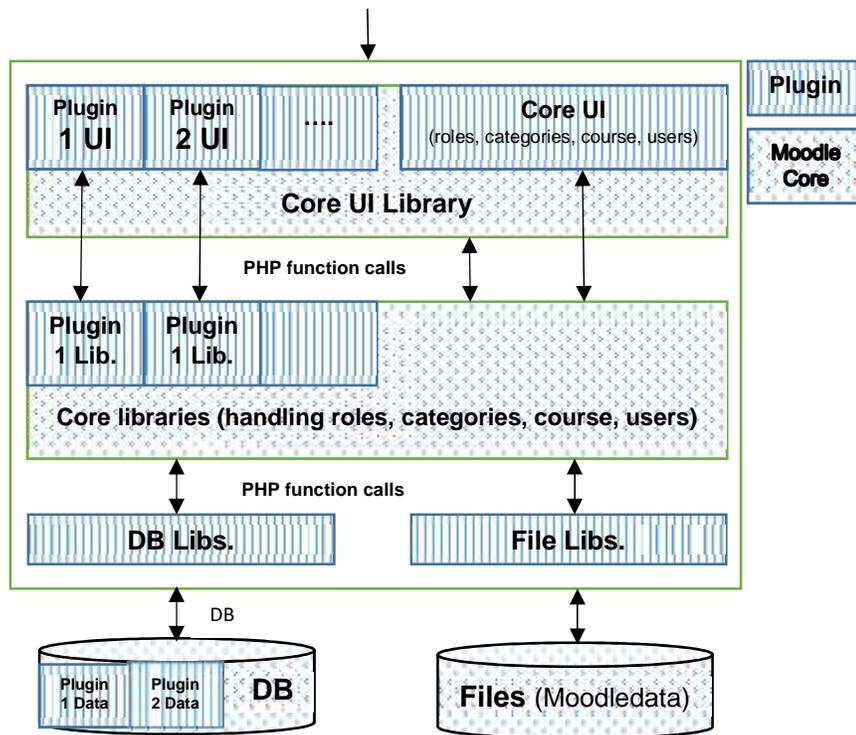


Figure 2: Moodle three tier architecture

Moodle Web Services Architecture

The presentation tier of the Moodle three-tier architecture consists of the business logic while the domain tier implements the atomic function of the Moodle facilities. The external tier is restructured for access methods in Moodle core and itself. This tier is accountable for managing Moodle services required to interact with outside clients or apps. In addition, it reproduces some logical functionalities in the presentation tier. The connector tier supports protocols such as REST, SOAP,

XML-RPC and AMF. This tier is responsible for authentication and session management. The connector tier integrates the components that adapt according to the service's specification of the external tier to the above-mentioned protocols (Dougiamas, 2002). Figure 3 describes the Moodle web services architecture.

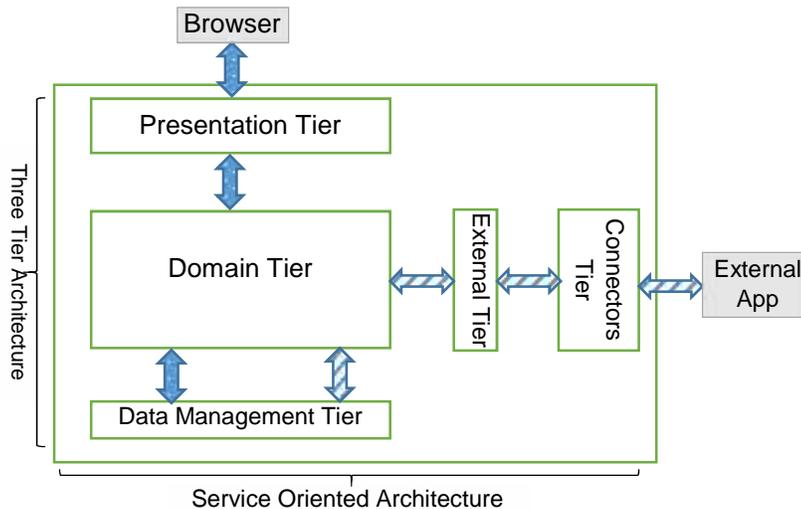


Figure 3: Moodle Web Service Architecture

New Functionalities Implemented to the Moodle Mobile App

In this research, the Moodle mobile app enabled the new functionalities through plugins. In order for this to be effective, the required support files were developed using PHP and ionic. These functionalities were developed with a view to increase the teacher's adoption in mobile based teaching. Originally, these functionalities could be accessed via the Moodle LMS. However, they did not support mobile devices through the Moodle mobile app. The functionalities are shown in Tables 2 and 3 below.

Table 2: Mobile Enabled Plugins in Moodle

Plugin	Relevant factor in teacher's impact model	Functionalities
Annotate PDF	Usefulness, Facilitating Conditions, Ease of use	Teachers can underline and highlight PDF documents using different colours and notations in online and offline modes
Checklist	Usefulness	Techers can see a learner's progress in study using content access. Learners can check items and teachers can view the checklist.

Hot Question	Usefulness	Teachers can collect questions or comments from students in or out of the classroom. Teachers and students can add, view, set priority on questions or comments. Teachers also can add, view, and set prioritized questions in online and offline modes.
Game	Interactivity, Motivation	Teacher can use game based learning activities for learners in both online and offline modes. Games are, 1 Millionaire 2 Hangman 3 Quizventure

Table 3: Training Courses in the Modified Moodle Mobile App

Service or facility provided	Relevant factor in teacher's impact model	Description and Functionalities
Teacher awareness and training	Facilitating Conditions, Attitude, Motivation	Teachers are provided two courses: Moodle Training Course, Citation and Bibliography for teacher to create awareness and train for Moodle mobile based academic activities.

Enabling New Functionalities in Moodle Mobile App

To enable mobile support for the above plugins, the following files were developed for each plugin. The sample/template files described here are to annotate PDF plugins and they can be developed for other plugins in a similar way.

Db/Mobile.php: This file is stored in the db sub folder of the plugin root folder. In this file the plugin identifier, handlers, display data, delegate, method, offline functions and language strings are specified.

mod/pdfannotate/classes/output/mobile.php: The main function of pdf annotation is developed in this php file. It displays current pdf submissions for annotation and previous annotated pdf submissions. Possible grading and comments are also generated.

mod/certificate/templates/mobile_view_page.mustache: This is the template used for Ionic, custom directives, and components integrated in the Mobile app to render the mobile app.

mod/certificate/db/services.php: This file creates and enables web services for mobile support to the plugin.

Moodle in Mobile Learning Framework

The above plugins were enabled for Moodle mobile app and a customised mobile app was built with PhoneGap mobile application development framework. Figure 4 represents a few interfaces of new facilities of the Moodle mobile app.



Figure 4: Interfaces of New Moodle Mobile Functionalities

METHODOLOGY

Pre and post usage tests were conducted among 60 selected university lecturers who work at The Faculty of Sciences, Faculty of Social Sciences, Faculty of Humanities and Faculty of Commerce and Management at the University of Kelaniya, Sri Lanka. In this survey, a questionnaire was used with 24 questions. These questions were categorised into six categories including four questions for each category, namely usefulness, interactivity, motivate, attitude, facilitating conditions, and ease of use. The five-point Likert scale ranging from minus10 – strongly disagree, minus 5 – disagree, 0 – neutral, 5 – agree and 10 – strongly agree was used in the questionnaires. Firstly, teachers were asked to fill the pre-test questionnaire according to their knowledge of the Moodle mobile app. Secondly they were asked to work with the modified Moodle mobile app that integrated the above-mentioned newly developed plugins. Finally, they were asked to fill the post-test

questionnaire. In this research, the primary data analysis was done using the mean values of bar charts. The paired sample t-test and the correlation model with Pearson correlation coefficient was developed as part of advanced data analysis.

RESULTS AND DISCUSSION

Overall, the mean value of the post usage data sample is equal to 5.3438 and according to the mean interpretation rule (see Table 4), which implies that the university teachers strongly accepted the modified Moodle mobile app (MMMA) for educational activities.

Table 4: Likert Mean Interpretation Rules

Likert Mean	Interpretation
Less than minus 5	MMMA strongly rejected by the university teacher community
Between minus 5 and 0	MMMA normally rejected by the university teacher community
0	Neutral
Between 0 and 5	MMMA normally accepted by the university teacher community
Greater than 5	MMMA strongly accepted by the university teacher community

Using the Anderson Darling Normality Test, a p-value of less than 0.005 and sample size exceeding 30 paired sample-T test (parametric) was applied for advanced analysis. The hypothesis is set as below,

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

Where, H_0 =Interactivity/Usefulness/Motivation/Attitude/Facilitating Conditions/Ease of Use has no significant influence on the teacher for adopting an applicable and sustainable mobile learning system for academic activities.

Table 5: Mean Values and P-Values of Paired Sample t Test

Factor	Mean Value	P-Value	Factor	Mean Value	P-Value
Interactivity	5.583	0.000	Attitude	5.375	0.000
Usefulness	5.313	0.000	Facilitating Conditions	5.063	0.000
Motivation	5.438	0.000	Ease of Use	5.292	0.000

As shown in Table 5 which represents the p values and means calculated through the paired sample t test, comparing the pre and post context of this research, the p-values of interactivity, usefulness, motivation, attitude, facilitating conditions and ease of use are equal to 0.000 (<0.005). This implies that H_0 is rejected and that H_1 is accepted. Hence, all factors have significantly influenced the teacher for adopting an applicable and sustainable mobile learning system.

Finally, the Pearson correlation coefficient was calculated using student response weight and counts. The following hypothesis tests were applied with the p-value. If the p-value is less than 0.05, the hypothesis is rejected at 0.05 significant levels.

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

Table 6 represents the interpretation rules of the correlation coefficients and Table 7 shows the correlation and p-values

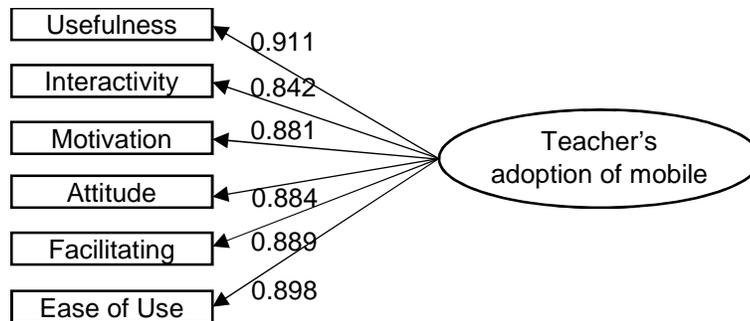
Table 6: Correlation Coefficients Interpretation Rules

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

Table 7: Correlation and p-values

Attribute	Correlation	p-value
Usefulness	0.911	0.032
Interactivity	0.842	0.074
Motivation	0.881	0.048
Attitude	0.884	0.046
Facilitating	0.889	0.044
Easiness	0.898	0.039

The results reveal that the p-values of all factors are less than 0.05. This would imply that H_0 is rejected and that H_1 is accepted. In addition, correlation of each of the observed variables is greater than 0.5 and close to 1. Therefore, each observed variable's null hypothesis (H_0) is rejected and each observed variable's original hypothesis is accepted. Hence, each observed variable is strongly connected to the latent variable mobile learning adoption. According to the correlation values, the modified Moodle mobile app and its feature model is illustrated in Figure 5 below. The results of the present study revealed that the most significant influencing factor is "Usefulness" for the teacher's mobile learning adoption.

**Figure 5:** Proposed Model for Mobile Learning Adoption with Correlations

From a review of the results, it can be assumed that new features introduced to the Moodle mobile app such as PDF annotation for assignment submission, checklist, and hot question might be useful for teachers to carry out their academic services for learners as well as other stakeholders. Mac Callum et al., (2014) obtained similar results by observing that usefulness is the most influencing factor for a teacher to adopt mobile learning. Moreover, according to the results we can see that each influencing factor has similar correlation values with slight differences and that they are all close to one (1). This result could be explained by the teacher reflecting equally high interest for each new feature introduced on the Moodle mobile app. Further, among them interactivity has the lowest correlation and this result might be due to new features introduced to the Moodle mobile app, not reflecting adequate interactivity with the teacher. Also the teacher may not experience much interactivity through game and other features introduced for Moodle mobile app, due to small

screen size, low device resolution, or other options available in the experimental mobile learning environment.

CONCLUSION AND IMPLICATIONS

This study was carried out to investigate the teachers' influencing factors for adopting an applicable and sustainable mobile learning framework. In order to do that, an impact model was proposed using six observed variables and it was implemented through the Moodle mobile application. The results indicate that teachers strongly accepted each observed variable through the modified Moodle mobile app. Moreover, each observed variable of the proposed impact model was strongly connected with its latent variable, "mobile learning adoption for teacher" and that "Usefulness" is the most significant factor for the teacher to consider when designing and developing an applicable and sustainable mobile learning framework in higher education.

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