



Exploring Major Challenges and Benefits of M-learning Adoption

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Authors' contributions

This work was carried out in collaboration between all authors. Author MS designed the study. Author HA reviewed the existing literature and MS placed the research objectives of the paper in perspective. Authors MS and OMHR analysed the data, discussed the results and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Recently, E-learning tools have proven to be potential platforms for management and progress in the education sector. The usage of mobile learning (M-learning) tools in the field of Learning Management Systems (LMS) is an interesting area of research that worth to be investigated. M-learning can offer higher learning and teaching autonomy for the education sectors and individual learners alike. M-learning can support ubiquitous learning hence portraying it as a potential candidate for future distance education. Various research works have been performed in M-learning related to its design needs and application development challenges. This paper highlights the trends of traditional learning systems and establishes a relation between modern mobile technologies and current learning paradigm. It discusses the major benefits that can reflect on the education sector, whereas the major challenges are also put into consideration while adopting M-learning services. The potential economic impact of M-learning adoption is also considered while taking into account the students, staffs and the concerned organizations. Three case studies were used to achieve and complement the research objectives in exploring major challenges

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and benefits of M-learning adoption.

Keywords: Learning management systems (LMS); m-learning; m-learning adoption; m-learning benefits; m-learning challenges.

1. INTRODUCTION

In the knowledge age, the use of information Technology (IT) tools especially in the field of Learning Management Systems (LMS) has gained a lot of popularity. Several international reports from the World Bank (2003) and the World Summit on the Information Society (2005) emphasized that the use of information communication technology (ICT) to build human resources is a vital prerequisite for the development of knowledge-based economy especially for developing countries. Recently, the adoption of e-learning systems has been growing in academia. In 2004, the e-learning market was worth more than US \$18 billion worldwide [1]. In the Middle East, e-learning projects were expected to exceed a compound average growth rate of 32% by 2008, based on the Madar research group [1].

During the last decade, mobile devices have developed so rapidly both in hardware and software especially in terms of processing power, memory and mobile operating systems. That makes mobile devices capable of performing many intensive tasks that only powerful desktops could perform few years ago. Current mobile devices have many advanced capabilities such as rich text processing, ability to process high quality pictures, high definition (HD) videos and voices. In addition, Broadband Wireless Access (BWA) networks have provided high speed connections with low costs. This technology increases the opportunities to apply mobile devices and wireless network technologies in the learning environment, particularly for accessing pedagogical applications on hand-held devices in different locations. The integration between these two technologies (mobile devices and wireless network) represents a huge opportunity to improve and facilitate of the education process.

Electronic learning (E-learning) offers two facilities (anywhere and anytime) to improve the flexibility of our education system. The term E-learning refers to more than online learning, distributed learning, virtual learning or web-based learning. E-learning combines all learning and educational activities that are carried out by individuals or groups working online or offline, and synchronously or asynchronously via networked or standalone computers and other electronic devices [2]. Educators and learners are discovering that computers and other educational tools can facilitate learning and improve social interaction. The use of mobile devices and network technology of the learning process has changed from E-learning to mobile learning (M-learning). This paper provides an overview of the traditional learning systems and reviews the relationship between modern mobile technology and learning systems. It also discusses the benefits and challenges of M-learning adoption. In addition, the paper presents the potential economic impact of M-learning adoption. The paper is based on an argumentative and philosophical approach. The paper uses personal knowledge, literature review and three supportive case studies: M-Learning Adoption: A Perspective from a Developing Country, Mobile Learning Adoption in Saudi Arabia and Mobile Learning In Saudi Arabia - Prospects and Challenges to complement and maintain the authors statement about the major challenges and benefits of M-learning adoption.

2. GENERAL OVERVIEW

M-learning combines E-learning and mobile computing. E-learning supports classic learning approaches by integrating modern technologies in schoolrooms. Mobile computing refers to the services and applications that individuals can use during their movement using their mobile devices, such as smart phones, pocket PCs, tablet PCs, PDAs (Personal Digital Assistants), and laptops. Mobile computing extends E-learning leading to mobile learning (M-learning) which has great capabilities to improve the learning process. M-learning can offer educators and learners with the maximum learning and teaching autonomy. The education administrators and instructors are provided with more flexible managing and teaching methods. Using mobile devices and wireless networks, learning is no longer restricted to physical school rooms with specific time slots. In which, M-learning can support ubiquitous learning and can make the education process more comfortable and flexible. With this, the proliferation of the mobile device and network technologies M-learning can be used to solve the traditional learning system problems. Both teachers and students need a proper and handy system to interact with each other and facilitate the teaching system. The establishment of M-learning system should include the use of advanced learning and education process such as the M-learning applications in the university to complement and improve traditional learning system. Therefore, it can be said that M-learning is the future of distance education [2].

3. RELATED WORK

Educators are forced to incorporate modern ICT tools as students become more IT savvy through what is called a Learning Management System (LMS). LMS is viewed differently among different players depending on how many features and tools are opted to be incorporated. LMS is relatively a new concept which is often confused with other concepts like e-learning, digital learning, virtual learning and distance learning. All of these represent modern advancements to the education process which in most cases involve the utilization of ICT tools and technologies [3]. LMS is a software application that uses the internet as a medium to support education and learning process. LMS can be utilized by different organizations such as schools, colleges, universities and corporations. The emphasis in LMS is more into managing the education process rather than merely delivering course and training materials electronically. LMS is also synonymous to e-learning in terms of using the web inside classrooms to enhance the learning process [1,8]. LMS may also overlap broadly with the concept of virtual learning where the ultimate aim is to support learning inside classrooms through systemized tools and technologies [4].

In the Middle East, E-learning is seen to be very promising both to corporations and educational institutions [5]. Based on the Madar research group report [1], E-learning projects were expected to exceed a compound average growth rate of 32% by 2008. According to Robinson and Ally [6], the Gulf Cooperation Council (GCC) countries have introduced several modernizing plans in the education sector. They [5] states that in Qatar, a Blackboard Learning System has been introduced as part of the Carnegie Mellon University (Qatar Branch) website in 2006. ElTartoussi [7] looked at the status of e-education readiness in UAE and found that investment in e-learning in UAE forms about 45% of the market share and the country has done vital steps towards embracing technology in all sectors including education. In Saudi Arabia, Al-Khalifa [8] describes an LMS called JUSUR made in Saudi Arabia by the National Center of E-learning and Distance Learning in the kingdom. This system incorporated many features like site management, and course and users management such as announcements, forums, quizzes and assignments [8]. In Oman, a

revamped educational portal was launched in December 2007 by the Ministry of Education to provide communication channel and a one stop shop for major educational services between the ministry and its clients Ministry of Education [9]. According to the same source, the education portal enables parents to keep track of their children grades and absence records. It also has an LMS dedicated service where digital content and e-books along with audio, visual aids and files are shared with students electronically.

Several researches have been done on M-learning environment including requirements design [10], architecture [11], M-learning model [12,13] and current trend [14]. Also there are some applications in the market that enable teachers to manage their online quizzes and monitor their students' progress online, such as Alykko [15]. Alykko is an intelligent mobile tutoring tool for teachers that support interaction and educating dialogue using mobile technologies. It helps teachers in managing their tutors' activities using web and mobile technologies. It also supports communication between students and their teachers using either the system on mobile devices or personal computers. Alykko uses open source technologies such as PHP, MySQL database and SMS gateway. Black and Hawkers [16] provided prototype implementation to determine an optimum interface layout for mobile interaction between users via PDAs for the domain of reading comprehension using Question Answer Relationship (QAR). Their proposed prototype uses client server approach for wireless communication. The project is designed to have the advantage of mobility, where learners can be located in different location in the classroom and still participate in collaborating mobile learning activities.

POODLE [17] is a course management system for mobile phones which is a redesigning of MOODLE [18], for being suitable for hand-held devices and compatible with wireless networks. This course manager provides many features such as online and offline text assignment, designing quizzes, course files, survey tools, chats, online question in class and library. Saipunidzam et al. [19] provided a new approach of M-learning environment with mobile graph for tracking the students' progress and performance. They argue that the purpose of this system is not to replace traditional classrooms but to complement the learning process in Malaysian schools. Damien et al. [20] provided an approach of mobile phones as learning instruments: M-learning Service provision within an Info Station-based Multi-agent environment. The system is seeking to incorporate mobile devices into the learning spheres where they presented a global view of the Info Station-based network architecture.

There has been considerable amount of study and research that are conducted by several organizations to address the technical issues of mobile application development. Whereas, a collaboration between experts from industry and technology has been done to improve web content production and access for mobile users such as: Mobile Web Best Practices 1.0 [21], this publication specifies the best practices and standards for delivering mobile web based content, W3C mobile OK Scheme 1.0 [22]. This publication defines machine readable content labels that might be applied to content to indicate that the content and its delivery pass a suite of tests based on the Mobile Web Best Practices document.

Brusilovsky [23] has divided the virtual university needs into four main components. Presentation which refers to any functions related to new material, activities refers to student's activities; communications refers to students and teacher's interaction and administration functions which are related to enrolment, registration and payment etc. Also, some research has been done on establishing guidelines for the development of mobile

application such as Häkkinen et al. [24]. They discussed the design challenges of the context-aware applications and proposed 10 guidelines to address these challenges as follows:

- Personalization: Mobile devices are personal in nature, thus could be configured according to individuals needs or preferences.
- Avoid information overflow: The information size and device size has to be considered.
- Uncertainty in decision making situations: The level of uncertainty must be considered by the designer and user should be informed before executing any actions.
- Interruptions prevention: Designer must consider the actions priorities for any possibility of interruptions during execution such as calendar alert or email notification.
- Usefulness: Application usefulness in terms of reliability, usability, context adaptability in different circumstances or environments.
- Secure the user control: The device should be always controlled by the user.
- Secure the user's privacy: Sharing information with other devices or the webs may cause unwanted actions.
- Remember mobility: During the user movement fast and simple interaction must be favored, such as location detection application.
- System status visibility: It is very important to know the executed actions system feedback.
- Access to context: Sometimes it may be appropriate to provide the user the chance to edit context attributes and their measures like allowing the user to rename locations or other context attributes which will increase the understandability of the application.

Since the development of mobile application is not yet as matured as desktop or personal computer application development. It may take some time to establish and provide a well-accepted standards [25]. Unfortunately, there is no standard developed for M-learning yet. But the existing E-learning standards and models can be used to develop M-learning applications. Moreover, there are no mobile learning management systems that uses some of the new affordances of mobile devices such as location. However, there is a significant example of mobile learning management systems called mEKP mobile learning management system from Net Dimensions. That proposed solution using USB stick where it delivers a full featured learning management system on a USB stick. That enables students to do their work off-line, and have it tracked without a connection to the Internet. Then simply care their USB stick and plug it into any computer connected to Internet [26].

4. TRADITIONAL LEARNING SYSTEMS

The traditional learning systems have major drawbacks in which they are restricted to desks, whiteboards, classrooms, lecture theatre and other equipment. Where they may provide uncomfortable and inflexible learning facilities. E-learning is the use of technology to allow people to get knowledge and learn about any subject at any time and in many different locations. However, the main drawback of E-learning approach is that it bounds itself to the location of personal computers or laptops which has a negative impact of the E-learning usability.

Many studies have been conducted so far about the use of mobile and modern technologies in learning systems which provided very encouraging results. Pocket Eijiro is a Japanese project that was conducted in 2002 has shown that mobile learners have quite smaller dropout rate than electronic learners [27]. Learning2Go is British ongoing project in Wolverhampton (since 2003), has indicated that the use of the mobile devices in schools have positive impact on students' performance compared to the rest of the students with an increase in class average of 3 points [28]. Tomorrow is a project conducted in the United States in 2007 with 74,000 teachers and 1.1 million students. Whereas, around 41% of students believe that online classes and study materials will have the greatest positive impact on their learning, and around 26% of teachers chose online learning as their first choice for learning [29]. Scientists and researchers have suggested that M-learning improves the autonomous learning and it can be applied to a wide range of learners without any age boundaries. However, there are many difficulties and obstacles exist in applying and implementing any significant M-learning applications. E-learning is a well matured concept where there are a huge number of standard applications in use today. But clear copy or transfer of E-learning applications to M-learning will not satisfy students or learners in terms of usability or continuous learning. Using traditional teaching systems students can read books or listen to lectures where in using E-learning, students can learn at any time and in many different locations where personal computers are provided. However, what about getting knowledge and learning while sitting in a garden, coffee shop, waiting for a bus or even in a restaurant? Therefore, using modern methods and techniques, that is integrated in M-learning, help to make learning more interesting, widely available, more interactive and flexible.

5. LEARNING SYSTEMS AND MOBILE TECHNOLOGY

Mobile technologies could provide unprecedented opportunities to improve national economies and are seen as an enabler for sustainable development. One of the mobile technologies strongest arguments is their availability, where mobile devices can be accessed much easier than desktops. Somewhat surprisingly, despite a large amount of installed desktop computers, students are enjoying a little access to those desktop computers. For example, universities provide many computer facilities, and indeed they have many labs densely packed with desktop computers. But, most of these computer labs are located for undergraduate students in a remote corner of the campus. They are usually unavailable for self-access due to the fact that they are almost constantly reserved for teaching classes.

In the future, students should regularly be allowed to utilize some of this time, and enable the use of mobile technology outside the classroom. Nowadays, students are very rarely asked to use their mobile devices for school work. Some students may use their mobile devices in foreign language classes to look up words in bilingual dictionaries either built in or web based dictionaries. Other students may use their mobile cameras to photograph blackboards, PowerPoint displays or any other important documents.

Naturally, M-learning is a form of existing distance and E-learning. The main characteristic of distance education is the distance and time separation between teacher and students. The E-learning offers new methods for distance education based on computer and net technologies. It is apparent that E-learning and LMS development is gaining momentum in the region but most of the emphasis is placed on how to facilitate and smooth students' acceptance to LMS initiatives.

Mobile devices can be an effective learning platform. Using modern methods and techniques integrated in M-learning system, help in making the learning of our student more interesting and flexible comparing to the traditional learning system. Furthermore, the possibility to integrate M-learning systems into existing E-learning systems [30] makes it easy to stay in touch with the newest advances made in teaching research. One of the key characteristics of M-learning application is it goal directed using its small screen. M-learning application has some the benefits over LMS's such as, mobility and its supporting platform. Where learning content is personalized for the individual learner and is easily accessed from any location. Thus, M-learning is different form LMS's because of M-learning is more personal, More fun, More interactive, Networked, Spontaneous, Shorter duration, More connected, Directly to the point, Just-on-time learning, Engaging users to contribute and share.

M-learning environment using personal pocket devices (PDAs, smartphones and mobile phones) has the power to make learning even more widely available and accessible, in which its considered to be a natural extension of E-learning environments using desk or laptop computers. Compared to E-learning, M-learning has some distinguishing features such as more varied and changing locations, more immediate interaction, smaller and often wireless devices. Moreover, M-learning environment using personal pocket devices might use SMS rather than only emails to send text messages. Education provides have always faced constraints in acquiring IT resources like computer devices and internet for learning contents access, but using M-learning; the resources are already available as most learners already have their own mobile devices. In addition, the learning environment can be enhanced with the interaction among students and with their tutors via telephony integration.

However, one of the main pedagogical issues to consider is the suitability of a course to the mobile learning environment using personal pocket devices that, is not all courses can be delivered using mobile learning environment. Where, short courses such as information or theory type courses are suitable to be delivered through mobile learning environment but personal pocket devices are not suitable to deliver technical or practical courses. Using different ICT platform is another issue in education system e.g. Windows, Mac, or Linux. There are many different platforms in mobile devices and are more complex. There are a lot of mobile device manufacturers each with its specific internal architecture design, functionality and features. Also, there are mobile devices and smart phones again based on the Apple iPhone, Windows 7 Phone, and Android Phone platforms. Thus, different mobile devices platforms are another issue in delivering learning material through mobile devices [13,14].

6. CASE STUDIES

6.1 M-Learning Adoption: A Perspective from a Developing Country

To complement and maintain the authors statements about the challenges and benefits of M-learning adoption, a case study conducted by Shakeel et al. [31] has been used as support experiment. Their study is a survey-based study conducted through a structured questionnaire. Their target population for survey was the students of chartered universities operating in the twin cities of Rawalpindi and Islamabad in Pakistan. A total of 300 questionnaires were distributed. The questionnaire was divided into two parts: demographic information of the participants and responses regarding the five predictors, that is perceived usefulness (PU), perceived ease of use (PEOU), social influence (SI), perceived playfulness (PP), and facilitating conditions (FC), and one dependent variable, the intention to adopt m-

learning (IML). The purpose of their study was primarily to extend the understanding of student's m-learning adoption. Perceived ease of use positively and Perceived usefulness had a significant impact on behavioral intention where that is consistent with other studies conducted on acceptance of technology Teresa et al. [32]. The researchers concluded that M-learning has the potential to become an effective partner for providing education along with traditional methods. Their research adds to the existing literature on student acceptance and intention to adopt m-learning. Understanding the factors affecting mobile learning adoption will help the stakeholders (educators, software developers and technicians) to incorporate these factors in their design and implementation of m-learning initiatives. The key is to understand students' needs, concerns and the factors affecting M-learning adoption [31].

6.2 Mobile Learning Adoption in Saudi Arabia

The research in this study investigates the use of mobile phones and tablets for learning purposes among university students in Saudi Arabia [33]. Their study is a survey-based study conducted through a questionnaire. The scales used in their questionnaire were adopted from previous studies [34]. The questionnaire constructs were measured based on five-point Likert-scales ranging from strongly disagree (1) to strongly agree (5). The questionnaire was administered to 60 male students from a college computer science and information technology. For this purpose, an extended Technology Acceptance Model (TAM) is proposed to analyze the use of mobile devices and smart phones by Saudi university students for accessing course materials, searching the web for information related to their discipline, sharing knowledge, conducting assignments. Findings from preliminary analysis indicate that perceived innovativeness does not show high positive correlation with perceived usefulness of m-learning [33].

6.3 Mobile Learning In Saudi Arabia - Prospects and Challenges

The researchers review the prospects and technological challenges of mobile-learning in Saudi Arabia. They created a dataset using a questionnaire survey to measure two groups of students attitudes and perceptions towards the effectiveness of mobile learning adoption. A total of 131 students participated in this study. First group consists of 31 female students and second group consists of one 100 male students. In fact, the new technology has been adopted in Saudi Arabia which could be considered as the backbone of M-learning implementation. Where the network conditions and new technology supported devices affirms the implementation of m-learning in the country. Their study shows that the student's attitude to this new learning environment is welcoming. Because they like the capability to access learning materials immediately, flexibility of this approach, and its improved method of communication between learners and teachers. However, their study also show that, a huge number of students still have no idea what m-learning is? and how it can help and facilitate their study. So there is lot more challenges in M-learning adoption still need to overcome [35].

7. DISCUSSION

The results of the first case study indicate that perceived usefulness, ease of use, and facilitating conditions significantly affect the students' intention to adopt m-learning, whereas perceived playfulness is found to have less influence. The study have shown that facilitating conditions, such as Internet connection speed, software and other hardware equipment

support, are very important for M-learning adoption and students and teachers are not tend to towards M-learning adoption in the absence of these facilitating conditions. Students' perceptions about M-learning ease of use and usefulness as well as facilitating conditions to support M-learning are the main driving forces; whereas, perceived playfulness and social influence will play their part in motivating students once the smart phones as well as 3G technology become easily accessible to the vast majority. Students' interest in using M-learning as learning tool is clear from the findings of this study; the educationists and software developers can attract more users by providing content and information on resources formatted for mobile devices and by educating students on its benefits. From this case study the researchers concluded that in Pakistan as developing country the M-learning is still in an embryonic stage the influence of students, teachers, and schools on M-learning adoption is insignificant. The main impediments could be the high cost of smart phones and unavailability of supporting technology [31,32].

The second case study has proposed six hypotheses: H1: Perceived innovativeness positively relates to perceived ease of use of m-learning, H2: Perceived innovativeness positively relates to perceived usefulness of m-learning, H3: Perceived innovativeness positively relates to behavioral intention to use m-learning, H4: Perceived ICT anxiety positively relates to ease of use of m-learning, H5: Perceived ICT anxiety positively relates to perceived usefulness of m-learning, H6: Perceived ICT anxiety positively relates to behavioral intention to use m-learning. From the result of factors mean and standard deviation that used in this study, the perceived innovativeness has the highest average which indicates that surveyed students like exploring new features of mobile devices that helps them in their study. The second and third highest average are perceived ease of use and perceived usefulness respectively indicating that students are familiar with using mobile devices phones and students find out the usefulness of mobile devices as learning tools in terms of students collaboration and portability mobile devices [33,34].

The third study used set of statements that considers the positive features for m-learning method. In this set students opted flexibility and better communication facility. In which flexibility refers to the freedom of learning irrespective of any fixed time or place whereas improved communication between teachers and students gives the opportunity to have better understanding of the teaching materials. Which indicate the positive impact of M-learning on the performance, collaboration and portability, Students also chose new opportunities of learning methods as their second choice which indicates that students like M-learning as a new learning method. This study also considers the percentage of students supporting effectiveness of M-learning. Where, the result shows that 54% of the surveyed students identified lack of clear visibility due to smaller screen of cell phones. Which indicate that some of the students are aware of mobile device user visibility issues such as small screen, multi-touch interfaces and image recognition. 38% of the students have considered the poor adoption with the use of cell phone due to the differences of mobile as important M-learning adoption factor indicating that students are concerned about the differentiation between mobile platforms such as iOS, Android, Windows 7 ... etc. Some students selected high cost involved in using cell phones in M-learning and unavailability of M-learning supported cell phones are their concerns in using M-learning as a new learning method [35].

These case studies have shown that the use of M-learning will have positive impact on the motivation, collaboration and portability, as well as resulting in benefits for students, teachers and schools performance. In which M-learning supports anytime and anywhere access to learning material, motivate students and teachers for better performance and enhance interaction and discussion between students and learners. However, these studies

highlighted some challenges of M-learning adoption such as different mobile platforms e.g. iOS, Android, Windows 7, etc..., mobile device users visibility issues e.g. small screen, multi-touch interfaces and image recognition

8. BENEFIT OF M-LEARNING ADOPTION

The mobile and communication devices such as smart phones, laptops and PDAs with the connection to networks facilitate M-Learning adoption and make our learning system more flexible. M-Learning enables educators, learners and teachers to extend beyond the traditional schoolrooms. Modern mobile technology devices provide instructors and learners with new flexible interaction opportunities. The benefits of M-Learning are as follows:

- Anytime access to learning material.
- Anywhere access to learning material.
- Support distance learning.
- Enhance student-centered learning.
- Support just-in-time learning or review of content.
- It can be used more effectively for the differently-abled.
- Support differentiation of student learning needs and personalized learning.
- Can enhance interaction between and among students, learners and instructors.
- Reduce cultural and communication barriers between faculty and students using communication channels that students like.

M-learning has the potential to additionally extend when, where and how students learn and perform in all aspects of their life. One of the main benefits of M-learning technology is its possibilities to improve students' productivity by making knowledge and learning material available anytime and anywhere. It enables learners to participate in learning activities without the traditional place and time restrictions. Mobile technologies support accessible and widely available learning than the learning that used in the existing E-learning environments. M-learning is self-motivated, self-disciplined that supports studying with on time waste, studying anywhere and at any time. M-learning supports performance with easy access to information, which can immediately impact students' performance in a learning environment, facilitating their education [13].

9. CHALLENGES OF M-LEARNING ADOPTION

The previous section 8 has reviewed the M-learning benefits, but these benefits do not come without challenges. The rapid increase of mobile applications has outpaced the traditional software applications. However, these traditional software engineering applications cannot be applied directly in mobile devices due to the following issues:

- Different mobile platforms such as iOS, Android, Windows 7, etc...
- Different hardware makers for platforms such as HTC, Google, Samsung, Apple, etc...
- Mobile device user interfaces (UI) which provide a new mechanism for human computer interaction sequences such as multi-touch interfaces, image recognition, code scanning, etc... that have not been previously explored in research and there is not any established user interface guidelines exist [2,28].

The main future concerns and challenges of M-learning adoption are as follows:

- M-learning may make it easier to cheat.
- Finding the best infrastructures.
- Creating universal M-learning system user interface.
- Design an effective context aware M-learning application.
- The wireless network trust ability.
- Disclosing of the learner information via network.
- Across platform.
- Feeling of isolation, separation or of being out-of-the-loop [13].

10. POTENTIAL ECONOMIC IMPACT OF M-LEARNING

M-learning systems have many economic advantages for the education providers such as schools, colleges, institutions and universities. Education providers expect that there will be no more relying on only having dedicated computer labs, specific computer desks, chairs and computer lab space, which leads to no IT staff needed, no IT support required, no servicing, repairing and maintenance of computers are required. Many other associated costs will be saved such as networking equipment, ISP connections, air conditioning, huge power bills and other related equipment's [36]. Besides that, mobile devices, now available in abundance, are cheaper and simpler to use. Thus, using mobile devices with interactive and flexible M-learning system in education seems like education providers savior. Nalder [37] states that education providers using ICT in Education have struggled to find the time to provide basic computer technology skills training to staff or get past the time intensive operating systems and user interface lessons or keep technology repaired. Nalder [37] argues that using mobile devices by education providers may now be able to:

- Spend staff training time on improving pedagogy.
- Spend valuable student lesson time on using technology instead of wasting time learning to use technology first and then the lessons.
- Spend less money on supporting existing technology and more on supporting its use in classrooms.

However, the infrastructure in M-learning environment should to be properly addressed for successful M-learning implementation. Whereas, other than mobile devices and protocols that connects different tools, networks, and technologies to provide a common user interface. M-learning applications extremely depend on networking support such as coverage and transmission rate which are the two most important factors of the networking support. Moreover, multicasting is another important factor in network supporting in which it addresses the communications among a selected group of learners that is necessary for some applications features such as interaction or discussion. Overall, M-learning application requires wireless quality for good services that affects the M-learning application performance in terms of loss, delay and other quality attributes [38].

In spite of that, it is time to move to full requirements analysis and comprehensive design of M-learning system for our colleges, institutes and universities in Oman.

11. CONCLUSION

The use of mobile technologies in education is growing and it facilitates students learning process. Using mobile technologies as a learning tool will have positive impact on the motivation, collaboration and portability, as well as resulting in benefits for students, tutors and administrators performance. A few challenges might be encountered when integrating mobile technologies in education as a learning tool. This paper explored current available literature and expands on the M-learning concept, in order to get a good background on the benefits and challenges of the M-learning adoption. The current use and the impact of wireless technologies on the traditional learning systems were discussed and the relationship between modern mobile technologies and learning systems were reviewed. The benefits and challenges of M-learning adoption were provided based on the discussion and review of modern mobile technologies and traditional learning systems. In addition, the paper discussed the potential economic impact of M-learning adoption. Future research may lie in identifying the main concerns and requirements of students, tutors and administrators with respect to M-learning system, and on analyzing the factors that influence M-learning adoption and the use of mobile devices in the learning environment. Other future research may focus on the guidelines and policies that need to be in place to ensure the successful adoption of M-learning.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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