An M-Learning Maturity Model for the Educational Sector

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Abstract
Educational institutions are increasingly becoming interested in adopting alternative technologies as a mode for imparting education. Mobile technologies are considered to be the next frontier as they have the capability to provide high-quality learning experiences, and satisfy the increasing demand for mobility and flexibility. In view of the ubiquitous presence of mobile technology and the immense opportunities, there are favorable indications that the technology would be introduced as the next generation of learning platforms. The adoption of M-learning also has its challenges. A lack of a comprehensive assessment and evaluation methodology is seen as one of the major roadblocks in implementing the technology. The present paper has used the framework of the Capability Maturity Model (CMM) to design a model for M-learning within educational institutions. The objective is to identify key processes and maturity levels that would make the transition of learning processes from old to new, smooth and viable.

1. Introduction

The contemporary education process is expected to change because of the far reaching impact of mobile telephone technologies. Researchers such as Valk et al. [1] have pointed out that mobile technologies must be used in the educational sector, in view of their massive growth and acceptance within all levels of the society. However, the actual design of a learning platform based on mobile technology is still in the development phase, exploring and assessing several methodologies that can be used. Kukulska-Hulme and Traxler [2] and Chan et al. [3] have explored the notion of M-Learning within a one-on-one setting (i.e., each student has one independent mobile device during the learning sessions). Also researchers, such as Kukulska-Hulme et al. [2] and Engel et al. [4], have explored M-learning in a different context. In addition, there have been several other experimental studies to understand the ways in which mobile technology can be used to impart education [5][6].

Some of the institutions offering higher education have also implemented experimental initiatives for M-learning that have been successful [7] moreover, a recent case study by De Waard et al. [8] demonstrate the merger of the Massively Open Online Course (MOOC) format with M-Learning. In fact M-learning systems have already been developed in the US as well as in several countries in Europe. The technology has also been proven as an effective channel for providing inexpensive distance education for varied purposes in Asian countries like South Korea, Bangladesh, Malaysia, and Japan [9].

A common conclusion from these studies is an agreement that the process would be challenging, especially when the traditional background of the educational institutions are taken into consideration. Wishart and Green [10] consider that the most prominent challenge in the M-Learning process is the insufficient evaluation of implementation of the mobile technologies on a

non-experimental basis. Further, while educational institutions are still prioritizing their strategy and operation in terms of adopting M-learning principles, the technology itself is changing rapidly. The main advantages of adopting an M-learning platform for educational purposes would be an increase in the number of students having access to education as well as a reduction of set-up costs for the educational institutions involved [11]. One of the objectives of this paper is to address the benefits that educational institutions will get at various stages of adopting the M-learning platform for imparting education.

The primary research question addressed in this study is: Can we creatively apply the CMM concept to the M-learning domain for the educational sector? The objective is to evaluate the progress of educational institutions in an objective manner and to provide a clear roadmap for achieving a complete integration of M-learning within educational institutions so that they achieve the maximum benefits from introduced the technology as part of their education program

It has been observed that educators find it difficult to learn and apply the principles of new technology to their teaching of students. The problem is even more acute when the case of technical teaching is considered [4]. Educators have often been skeptical of applying new technologies in the teaching program. However, several studies have demonstrated that technologies, such as E-learning, M-learning, and other advanced methods, could be equal to the traditional lecture format [11].

In the absence of an overall framework of assessment that ensures the successful adoption of M-learning and, consequently, improves the educational process, the techniques are bound to be viewed with suspicion. The CMM model was initially suggested to assess the improvement of organizational processes during the process of software implementation [12].

The paper is structured as follows: Section II enumerates the research objectives. A review of the existing and relevant literature is presented in Section III. Section IV presents an analysis of the existing models that have been used as a basis for the design of the current framework. The actual model has been depicted and described in Section V. Section VI presents the conclusion from the study comprising an analysis and discussion on the proposed model and possible directions for future research.

2. Goals, Objectives and Limitations of this Research

This paper assesses the validity of the process of applying CMM to the M-learning platform. The CMM has been utilized for two purposes in the paper – to provide clear guidance that would enhance the process of adopting the M-learning platform and to integrate the platform with the presently used E-learning program. The possible advantages of using the modified version of CMM for M-learning will also be discussed at the end of the section. Thus, the objective of the paper is to answer the question: How can we creatively apply CMM to the process of M-learning? The intention is to effectively use the model to evaluate the performance of the M-learning platform and consequent stages of development. The research is limited to the evaluation of CMM as it applies to M-learning and mapping it precisely to define the process to make it comprehensive. The development of a working M-learning platform would involve knowledge of several aspects of pedagogy, such as learning and cognitive theories, that are not a part of the present study.

3. Literature review

The concept of M-learning has been a part of several debates. The main question to be asked here is: Does the concept of mobile learning refer to the mobility of the student (as considered by Kukulska-Hulme [2]) or does the term reflect the mobile device itself (as articulated by Traxler [13])? Both points of view are equally relevant and powerful and choosing either would have a significant impact on the implementation process. One aspect common to both is that the concept of M-learning encompasses learning within the traditional classroom setting as well as the possibility of formal/informal education outside the traditional classroom set up using any of the possible mobile devices. It is also clear that interaction with mobile devices is just one part of M-learning; the most important part is characterizing these interactions so that they support the education process.

In this context, M-learning can be defined in the words of Schofield et al. [14] as the process where both personal and public understanding of a concept occurs only through technology-supported conversations and interactions between individuals. Looking above at the two debated views of M-learning, it is clear that this definition is more in line with the point of view supported by Kukulska-Hulme et al. [2]. This because it can be argued that, in this case, the location of the people was vital, in the sense that they were separated enough so that interaction between them was possible only through the mobile devices. Also, people were free to move without affecting the overall learning process.

Choosing one definition of mobile learning from the many proposed is a challenging concept because the mobile-platform is undergoing rapid transformations with new technologies being developed every few months. The newer versions are getting more sophisticated but the older phones are still popular. The platform is not limited to mobile-phones, as the name suggests, but includes a host of other devices including notebook computers, digital cameras, music players, and even gaming consoles. However, unlike the E-learning platform, the m-learning platform is device-dependent and is restricted to the use of devices with mobility features. El-Hussein and Cronje [15] have emphasized this aspect clearly while defining M-learning in their paper, when they note that the devices used for M-learning must be noticeably mobile. However, the architects of M-learning models must not consider the process as merely the extension of E-learning using mobile devices. The focus of designing M-learning applications must be specific to the usage of mobile technology, using all the advantages the technology offers to facilitate the process of learning. Figure 1 below shows the different ways in which M-learning can be utilized in an education setting.

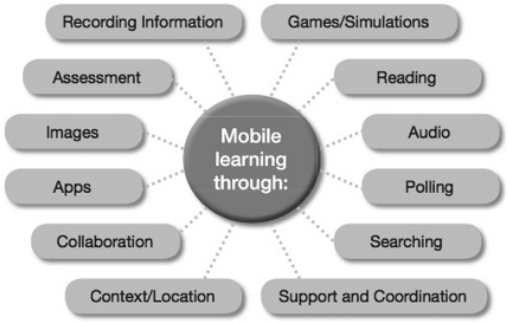

Figure 1. Utilities of M-learning in an educational setting [14]

3.1 Advantages of M-Learning

The process of M-learning offers advantages such as simplifying the learning process as well as the offering the possibility of anytime-anywhere learning. In addition, using this mode to impart education can save the time and efforts of teachers while making the entire experience enjoyable for students [11]. In order to achieve the maximum educational benefits from the M-learning platform, one must be aware of its specific features. Figure 2 below shows the characteristics of M-learning. Figure 2 shows the characteristics of M-learning.

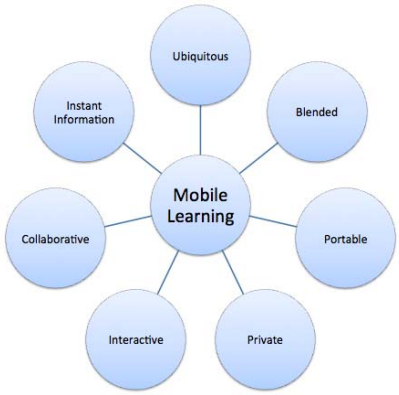

Figure 2. The characteristics of M-learning [16]

From figure 2 above, the characteristics of M-learning, as enumerated by Ozdamli and Cavus [16], are as follows: (i) ubiquitous, i.e., present everywhere, (ii) blended, i.e., unified, (iii) portable, i.e., can be conveniently moved from place to place, (iv) private, i.e., maintains the confidentiality of the learners, (v) interactive, i.e., offers two-way communication, (vi) collaborative, i.e., encourages shared learning, and (vii) instant, i.e., real time information exchange is possible.

3.2 Disadvantages of M-Learning

In order to better understand and effectively use M-learning, it is also essential to understand the limitations of the platform. For a start, there are set up costs involved in equipment acquisition, in addition to the training costs for instructing the teachers and students on how to efficiently use the platform [17]. A major concern for the educational arena has always been copyright and security issues regarding the learning material. Internet and mobile platforms are notorious for flouting the rules, leading to frequent accusations of infringement. Using the platform will inevitably expose the training matter to individuals who are unauthorized to view/use the information, if sufficient security measures are not used However, the creative advantages M-learning offers to enhance the learning experience, for both workplace and institutional education, goes a long way towards balancing out these disadvantages [18][19].

3.3 Challenges in M-Learning

The process of evaluating the M-learning platform is fraught with challenges on the part of both students and educational institutions, especially in regards to the perceived benefits. This section will concentrate on discussing the theme.

Review of Current Evaluation Frameworks

As the field of M-learning is still in its infancy, few frameworks and models have been advanced and evaluated by researchers. A review of the relevant literature shows that Vavoula and Sharples [20][21] have proposed six complications in the assessment of M-learning: evaluating the current learning settings and analyzing the possibility of meaning in different settings (setting includes physical and social environment, learning objectives, tools, and methods); deciding the assessment methods and outcomes for mobile-learning (existing learning assessment methods have been validated by long-term research); evaluating and presenting ethical guidelines for mobile-learning platform; understanding the impact of the high technical nature of the mobile-platform in an educational setting; evaluating the process of mobile learning platform on a long-term basis to understand the change process between the traditional and the new learning context (as a result of M-learning); and assessing and presenting the best mix of formal/informal settings for M-learning in an educational setting.

Vavoula and Sharples [21] also present the theoretical framework given by a previous researcher, Meek, for assessing M-learning in an educational setting. The framework known as M3 assesses the mobile learning platform at three levels: micro at which only user experiences are assessed; meso at which the overall learning environment is assessed; and macro, which assesses how the new platform blends into the established set ups of the educational institutions. Several suggestions have also been proposed to modify the framework for future researchers.

In this context, the six challenges specified by Vavoula and Sharples [20] in evaluating the M-learning process need to be addressed methodically. The challenges can be enumerated as: analyzing and capturing learning in or across context, measuring the processes and outputs from the M-learning platform, respecting the privacy of the learner/participant, assessing the utility and/or usability of mobile devices, considering the wider context of an organization or the socio-culture of learning, and, finally, evaluating the resulting informality. The authors have acknowledged that these challenges are a result of the social implications arising from the multifarious effects of using mobile devices, rather than being due to technical aspects [20].

Review of E-learning Maturity Models

Even though the educational institutions rapidly adopted the E-learning platform, the process of inducting a new albeit similar platform is challenging. Success cannot be taken for granted and the implementation process must be tailored to individual educational institutions taking into account their individual geographical and cultural aspects. Thus would ensure that the platform is adopted universally and efficiently within an institution. A review of literature shows several cases where similar implementations were handled with due care and were, hence, successful [4][6].

According to Zhou [22], the currently existing maturity models for E-learning platforms clearly delineate the performance at different maturity levels (even color them differently) This makes it easier to view the process improvement stages, but quantifying the process is still difficult as is the usage of auto-evaluation tools to measure improvement. For this reason, he has proposed a quantitative model that measures the progress of an educational institution operating E-learning programs, in terms of the CMM concepts of capability and maturity. His model is named E-learning Process Capability Maturity Model ePCMM [22].

4. Related Work

The use of the CMM in the educational context is not a new idea as clearly detailed by Lutteroth et al. [23]. Jalot [24] asserts that the CMM can be used as a tool to overcome any deficit in the quality standards of a process in any area, including the educational sector. While the author suggested that he would address the specific requirements that would tailor CMM to be used in the educational sector in future works, there was no attempt to do so. However, while presenting their E-Learning Maturity Model (EMM), Marshall and Mitchell [25][26][27] focused on the enhancement of the process in terms of the software involved as well as the ability of the model determination using SPICE ISO/IEC [28]. SPICE is considered to be the answer to ISO, in line with the five maturity levels given by the Software Engineering Institute for the CMM. In case of SPICE there is an additional level zero, which specifies the condition where the process could not be accomplished or was performed incompletely.

The basic objectives of EMM in the context of the educational sector are similar to that of CMM, while the domain appears to be different. This means that the model cannot be used for the purpose of M-learning. Another model that could be applied effectively is the OCDMM (Online Course Design Maturity model) proposed by Neuhauser [29]. The model is essentially an E-learning's maturity model based on CMM and describes the various stages of E-learning technologies' adoption in an educational institution. The maturity levels in the CMM-based E-learning model differ in the extent to which the technology of E-learning and M-learning can be employed successfully [30] [[31], respectively.

Some of the best practices from EMM and OCDMM can be taken while attempting to fit the levels into the 5-level-framework of the CMM model. One must consider that the model is essentially tailored to the context of the industry. However, aspects such as clear communication practices and approaches for employee motivation should be a part of the educational arena as well. One must admit that an important goal of an educational program is to motivate the students. In addition it is also important to improve the communication between students, student and tutors, as well as students and management. While applying the CMM model to education, these aspects must not be neglected as being parts of the industry that must be pared to fit the model to the educational sector. Developing such a 'culture of excellence' should be one of the targets of educational programs, one that educators are still in the process of figuring out.

In summary, it can be seen that CMM has not yet been applied critically in the educational domain, except by the above mentioned researchers. As discussed later, other maturity models appear to rely on developing a culture of professionalism among students as the onus of the industry. The process of E-learning is considered as a special domain and the culture promoted by the domain is not viewed to be an inherent part of the educational sector but as a consequence of technology. In any case, it can be argued that the E-learning approach cannot be applied directly to the M-learning platform. In fact, the study has shown that M-Learning modules, coupled with certain structural enhancements, have the potential to improve the educational experience as whole.

5. Proposed Architecture for M-Learning Maturity Model

The primary objective of the present study is to develop a process model, which is flexible as well as offering the users a guiding framework for enhancing the process of M-learning. From the literature review conducted in the previous sections, it was found that such a model could be developed on the lines of the existing CMM. CMM is a 5-level model that helps to judge the maturity of the software used in the institutions or organizations. In addition, the model also identifies critical steps and other validated practices necessary to improve the efficiency, effectiveness, and capability of the current process. The five levels of this model, in terms of Paulk [12], are as follows:

1. *Initial: The existing process during this stage can be characterized as ad-hoc. Smaller process steps are not defined at all and the success of any project usually depends on heroics and efforts by an individual or a team.*
2. *Repeatable: The process has matured from the previous stage and includes practices to track schedule, expenditures, and objectives/goals of the projects.*
3. *Define: The process at this stage includes process improvement activities and the corresponding management actions. All the actions are integrated and documented to make them consistent and repeatable across different projects.*
4. *Managed: At this stage, the company has progressed to include detailed and quantifiable measures for process activities as well as for quality of products. Both the processes and products quality are controlled using quantifiable measurements.*
5. *Optimizing: At this stage, the company is capable of facilitating continued process enhancement based on feedback from the process involved, pilot processes, and other innovative ideas.*

As discussed earlier, CMM was originally designed to offer benefits, such as road maps, for enhancing the software development process within an institute or organization. In this section, the focus will be on adapting the CMM model to build it into an M-learning maturity model. Table 1 below shows the five basic stages of the proposed model.

Table 1: High-level view of M- Learning Maturity Model

Level	Stage	Description
Level 1	Preliminary	Characteristics of the Level ▫ Reactive and experimental stage. ▫ Educational institutes recognize the need to improve education process with M-learning platform. ▫ Primary motivations for institutions to adopt the platform are external pressures like adoption by other institutes to provide flexibility and convenience to their students. Key Processes ▪ At this level, the institution has the pilot program for implementation but there is a lack of a vision to guide the implementation. ▪ The institution develops measures to facilitate implementation of prototypes. ▪ This is done experimentally but is hampered for a number of reasons. For instance, the mobile device coverage might be limited or students might not understand the value of the mobile learning environment. ▪ Another limitation in the implementation of the prototype might be the fact that the learning institution might not have the ability to facilitate effective implementation. ▪ In the preliminary stage, most of the universities and institutions do not have clear mobile learning policies and defined objectives to guide mobile learning.

Level 2	Established	Characteristics of the Level ▫ Based on the recognition of the opportunity provided by mobile devices in the education system. ▫ Results in the investment of M-Learning technologies to realize the opportunities provided. Key Processes ▪ In this stage, learning institutions formulate clear objectives to guide M-Learning implementation. ▪ Institutions do not have M-Learning mechanisms to evaluate their systems. ▪ There is a need for improvements in the existing and implemented pilot prototypes. ▪ Programmers develop tailored systems to facilitate the use of mobile learning, such as the Android App Education, iOS App Education, and other platforms.
Level 3	Defined	Characteristics of the Level ▫ The model of mobile learning environment has been developed to measure the quality of mobile learning systems. ▫ The focus on learning mobile systems by institutions features to offer the most mobile platforms. Key Processes ▪ The mobile device is considered as a critical tool in the interaction between students or among students, instructors and administrative staff. ▪ Institutions link their mobile learning strategies with core and technical visions. ▪ Institutions invest heavily in this type of systems to achieve success. In addition to financial investment, institutions must also develop clear guidelines, in order to achieve success.
Level 4	Structured	Characteristics of the Level ▫ M-Learning is characterized by optimization and innovation. ▫ The optimization results in a rich, dynamic, and flawless experience for students and tutors in the use of the system. ▫ The best practices have been defined and implemented by this stage. Key Processes ▪ To solidify their systems, institutions borrow and integrate the best practices from other institutions. ▪ Institutions develop and measure to ensure a real time student engagement and context awareness. ▪ Institutions also develop systems to be used in different mobile devices such as tablets and mobile phones. ▪ The use of mobile device applications allows students to provide feedback, give comments, and share information. ▪ Institutions learn to refine and improve procedures and policies to control any changes experienced in mobile changes.
Level 5	Continuous improvement	Characteristics of the Level ▫ In this stage mobile offering has already been accepted as the best approach to provide knowledge and exchange of information between students and instructors. Key Processes ▪ Institutions are constantly evaluating themselves to ensure continuous improvement and optimization. This helps identify any changes that occur that might limit or change the manner in which mobile learning is used.

6. Conclusions

The use of mobile phones for the purpose of receiving/imparting education is increasingly becoming a practical possibility. The context has been utilized as the underlying basis of this paper to formulate the initial maturity evaluation framework of mobile learning. The paper started with a literature review of the use of M-learning in the education sector, highlighting its

opportunities and challenges. Following this, the M-learning maturity model outlined the facilities offered by the mobile learning platform as a mode of providing education, charting its potential growth curve through various stages.

The core idea of the paper is to demonstrate the possibility of adapting the famous Capability Maturity Model, CMM, to sketch the road map of the progress of the usage of mobile technology in education. Both students and educational institutions can be regarded as beneficiaries of the scheme especially if such a scheme is conducted in collaboration with the central education department. It is obvious that the model is far from perfect; however, it serves to show the many benefits of the platform. Real-time implementation of the platform will be necessary to fine-tune the model further.

In summary, it can be said that the primary purpose of the framework is to provide an indicative list of stages and processes within each stage. The framework is by no means complete and might even lack certain key processes that would become evident only after comparing it with a similar project or after implementing the model on a small experimental scale. While not an exhaustive study, the framework still provides key understanding of the process and potential stages for the complete integration of M-learning within an educational institute. Further revision of the model would definitely help in understanding and overcoming potential problems.

As part of future research in this area, we hope to conduct an exhaustive study of the existing M-learning frameworks developed by researchers from different countries and prepare a comparative analysis. Such a study would provide the key points of similarity as well as differences due to geographical/cultural/political/socio-economic conditions in these countries. Based on the study, we expect to formulate an empirical model tailored to the Saudi Arabia education system with a further possibility of statistically evaluating and simplifying the model.

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