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Empirical investigation to explore factors that achieve high quality of mobile learning system based on students' perspectives

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ABSTRACT

This study presents three frameworks for mobile learning system based on quality factors derived from the updated DeLone and McLean information system success model. This study used the questionnaire as a quantitative method to explore quality factors for mobile learning system based on perspectives of 392 students. This study opens future work for using the identified quality factors as guidelines for researchers and designers to design and develop mobile learning applications.

1. Introduction

In the recent years, the great development of mobile technologies has generated a new way for learning in university environments called mobile learning (m-learning). Mobile learning is now the newest technology to achieve optimum learning advantages [1], by providing the opportunity for teachers as well as learners to access educational materials and services through mobile devices at any time and any place. The new and advanced features in smart phones such as streaming video, color display screen, and internet browser makes mobile learning not only possible but also practical. Furthermore, many researchers presented strong arguments for the benefits of mobile learning such as mobility, freedom and self study, facilitation of student–teacher communication and interaction and information sharing [15,20]. Since then, the interest in the development and use of mobile learning system in the university environment has been continuously increasing [14]. However, mobile learning is still in the beginning stage of implementation in the university environment [5,17]. To implement the mobile learning system successfully, the universities are responsible for understanding how to best exploit themobile learning system for learning purposes and to know what services should be offered by the mobile learning system for students. In order to understand how to best exploit and use the mobile learning system for learning in student universities, the first step is to understand the students' perspectives and perceptions of the mobile learning system. Additionally, students do not want just mobile devices; they want a high quality of mobile learning system which satisfies and meets their needs and requirements in order to accept and use this technology. Students' perspectives and perceptions of quality factors for mobile learning systems could provide information needed for universities and designers to make better decisions regarding mobile learning implementation. Therefore, this study contributes to the literature through achieving two objectives:

1. To present three proposed frameworks for the mobile learning system based on quality factors.
2. To analyze and evaluate the factors that achieve high quality of the mobile learning system based on students' perspectives and perceptions.

The structure of this paper is organized as follows: Section 2 summarizes the previous studies and frameworks that developed for mobile learning system components. Section 3 presents the contribution of the study to the literature in the area of mobile learning. Section 4 describes the theoretical background. The three proposed frameworks are presented in Section 5. Sections 6 and 7 present the methodology of research and data analysis. Finally, Section 8 summarizes this paper and future works.

2. Related works

There are several frameworks that have been developed for determining the components of the mobile learning system. A recent study by Ng and Nicholas [16] suggested a framework for

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Table 1
Comparison between previous studies and frameworks for mobile learning system components.

Literature	Frameworks/studies	Components/factors
Ng and Nicholas [16]	A framework for sustainable mobile learning	Economic sustainability Social sustainability Political sustainability Technological sustainability Pedagogical sustainability
Koole [11]	The framework for the rational analysis of mobile education (FRAME) model: an evaluation of mobile devices for distance education	Device usability Learner Social aspects
Motiwalla [15]	Mobile learning: a framework and evaluation	E-learning characteristics Mobile connectivity
Liu et al. [14]	Factors driving the adoption of m-learning: an empirical study	Self efficacy Learning autonomy Teacher readiness Student readiness Subjective norm Behavioral control

sustainable mobile learning based on five components: economic sustainability, social sustainability, political sustainability, and technological sustainability, pedagogical sustainability. Koole [11] in his study focused on three criteria: device usability, learner, and social aspects to describe mobile learning in higher education. Another study entitled mobile learning: a framework and evaluation focused on extension of e-learning characteristics and mobile connectivity to propose a framework for mobile learning applications [15]. A study was conducted by Liu et al. [14] to explore what are the factors that influence the acceptance of mobile learning in China. The researchers proposed a model based on six factors: self efficacy, learning autonomy, teacher readiness, student readiness, subjective norm, and behavioral control. Based on the previous studies and frameworks above, these studies and frameworks ignored the quality factors as components in phases of design and development for mobile learning system implementation. Table 1 shows the comparison between previous studies and frameworks of mobile learning system components.

3. The proposed contribution of research

Based on Table 1 which presents the comparison between different studies and frameworks for mobile learning components, the researcher found that these frameworks were incomplete and do not cover all components. These frameworks ignored some components that could contribute to enhance the system quality, design and implementation, and how these components could be used as guidelines to develop high quality mobile learning systems that meet students' requirements. These studies ignored the quality factors that may contribute to a successful implementation of mobile learning systems. Based on these facts, this study proposes three frameworks for mobile learning systems based on three types of quality factors and eleven sub-quality factors:

1. Information quality (content usefulness, and content adequacy).
2. System quality (functionality, accessibility, interactivity, interface design, and ease of use).
3. Service quality (availability, personalization, trust and responsiveness).

4. Theoretical background

4.1. The updated DeLone and McLean information system success model (DL&ML)

A successful implementation of new systems and technology has become an important issue as reported in information system (IS) research. Many scholars had earlier made great efforts to identify the IS success factors. For this purpose, there are several models used to identify the success factors of the information system [19]. One of these models is known as the updated DeLone and McLean IS success model (DL&ML), as was described in detail in chapter two. Many researchers have found that the DL&ML is the robust model for measuring the IS success [18]. In addition, DL&ML is the most appropriate model to study the success of IS. It is considered as a powerful model for measuring the success factors of IS [8]. Over the researches, DL&ML model has been applied in a number of information systems such as e-government system [21], e-learning system [13] and m-banking [12]. The main idea of DL&ML model is to provide an extensive review for formulating the measures of information system success. The DL&ML model consists of three types of quality factors of information system which are: service quality, information quality and system quality [8]. These quality factors may be considered as the critical aspects of information system success. Also, many researchers noted that factors relating to quality played a vital role in the success of many types of information systems [2,4]. Therefore, the quality factors from DL&ML model are used as a foundation for constructing the three proposed frameworks for this study, which will be presented in the following section.

5. The three proposed research frameworks

This study provides three proposed frameworks based on quality factors for mobile learning systems. These frameworks are focused on different components and criteria such as system quality, information and services. The next sections will present the detailed description for the three frameworks.

5.1. Mobile learning system quality framework

System quality depends on the quality of measures which are determined during the phases of system analysis, design and development in creating a worthwhile system. Practically, system quality depends on the users' perceptions, and thereby high levels of system quality may generate easy to use, comfortable, and effective of mobile learning applications. The system quality divided into five sub-criteria is functionality, accessibility, interactivity, ease of use and interface design [7]. Also, each of these sub-criteria is also divided into a number of sub-sub criteria as shown in Fig. 1. Therefore, system quality measures are included in the framework of this study which may be used to develop high quality mobile learning systems.

5.2. Mobile learning information quality framework

Information quality refers to the quality and accuracy of content which is provided by the information system [7]. In the mobile learning context, information quality refers to the learning content such as lectures, courses, assignments, images and quizzes. The learning content is the primary component that plays a central role in the success of mobile learning applications because it

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