



## Full length article

## Towards a quality model of technical aspects for mobile learning services: An empirical investigation

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## ABSTRACT

Quality issues are commonly reported following the development of mobile learning applications. To evaluate and increase the chance of the successful development of new mobile learning products, the adoption of a complete and well-defined set of technical quality aspects for mobile learning development and their adoption in the education environment are proposed. This work describes a model that captures most abstract and generic technical aspects of mobile learning service quality, including availability, fast response times, flexibility, scalability, usability, maintainability, functionality, reliability, connectivity, performance, user interface and security. A set of technical quality aspects was developed following a literature study focussing on standards and guidelines for learning and mobile application software quality. The presented case studies point to a set of contextual technical quality factors that influence the choice of mobile learning application. The findings also indicate that there are causal relationships between learner satisfaction and the overall proposed model technical quality aspects. The model has a positive impact on overall learning process outcomes by evaluating the technical aspects while maintaining the quality of mobile learning delivered. The model components purportedly affect learning outcomes by assessing and improving the acceptability to stakeholders of the technical aspects of mobile learning.

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## 1. Introduction

Virtual and electronic worlds are receiving increased global attention in wide range of applications in business, government, education and social media (Zhang, Zhang, de Pablos, & Sun, 2014; Zhang, de Pablos, Zhu, 2012). In a range of educational environments, learning normally consists of students' interactions with their instructors, who are responsible for providing learners with quality learning content. The rapid diffusion of ICT and its deployment in learning processes has led to a massive improvement in the quality of learning using several learning techniques. In particular, mobile computing technologies have enhanced learning performance and provided new activities for active learning, utilising the advantages of mobility and wireless technologies. This supports the establishment of a learning environment in which knowledge may be obtained at any time irrespective of geographical location

(Alzahrani, Alalwan, &amp; Sarrab, 2014; Sarrab, 2014).

The use of mobile devices as learning tools to facilitate the learning process is often seen as a conceivable key solution to some of the challenges currently faced by students, teachers and education providers in general. The use of mobile wireless technologies as a learning tool in education is the most recently developed approach to learning in educational environments. Since mobile learning (M-learning) materials are delivered using wired or wireless Internet, they are information-oriented services and products. All service divisions should thus have service quality characteristics that specifically fit its criteria and features (Al-Mushasha & Shahizan, 2009). It is well-known in learning environments that service quality and stakeholder satisfaction are the key factors for a successful learning process. Service quality in M-learning is used to denote the general perception of how good the M-learning application in terms of software and mobile application quality, while M-learning application quality attributes are used to acknowledge that application quality comprises many different attributes, for example performance, reliability, usability and security. M-learning application service quality does not need to be

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perfect but rather needs to answer the question of “How much less than perfect is sufficient?” There is no adequate answer to such a question, whereas a specific answer needs to consider the context in which it is being asked. However, the Quper model helps in answering this question by describing a relationship between the quality level, the costs and benefits (Regnell, Berntsson, & Olsson, 2008). Researchers and developers in the field of ICT have proposed five dimensions to measure the service quality provided, including reliability, responsiveness, assurance represented in knowledge, empathy and tangibles, such as equipment, facilities and personnel appearance (Al-Mushasha & Shahizan, 2009; Khan, Al-Shihi, Al-khanjari, & Sarrab, 2015; Pitt, Watson, & Kavan, 1995). Despite extensive research into M-learning, there are no complete and well-defined technical aspects of M-learning service quality in the education environment. The set of technical aspects of M-learning service quality proposed in the model is based on a literature study, mobile application software quality standards and relevant guidelines. This study presents the results from case studies that examined the application of the proposed model in four different M-learning applications. The main objective of this study is to determine which technical quality aspects aid the development and adoption of M-learning services in the education environment. In particular, this study aims to identify the most relevant technical quality aspects for M-learning services that motivate learners, instructors, learning providers and decision-makers in developing, selecting or adopting M-learning in the education environment. This research draws on a background study and usage experience to understand all possible characteristics of technical M-learning service quality. To achieve the objective of this research, it was necessary to investigate the components of the proposed model in different M-learning applications empirically.

## 2. Software quality

The quality of M-learning products is described from the perspective of software quality characteristics. Many well-known standards and quality characteristic systems exist, such as ISO 9126 (Standards Collection, 1994) and (ISO, 2005), which outline several characteristics of software applications. Given the large amount of information available, time restrictions and the cost of the software application development process, it was decided to focus on the characteristics of high-quality mobile learning applications. This set of software quality criteria is defined by selecting the significant characteristics set for the software product analysed software and the technical and nontechnical quality characteristics of the M-learning application. Several factors can influence software quality in general. However, in the case of the M-learning software application, the situation is more complex due to the particularities of the process, particularly those derived from the information technology field. In mobile learning applications, many technical and nontechnical aspects might influence the overall quality of the final product. In multi-national and cross-cultural virtual classes, learners' cultural values have significant impacts on knowledge sharing process (Zhang, de Pablos, Xu, 2014; Zhang, Vogel, Zhou, 2012). The nontechnical aspects include pedagogical, social and economic factors. The approach to mobile learning quality should take into consideration the fact that the mobile learning process is educational as well as technical. The technical aspects thus include a range of factors that might influence the quality of mobile learning product. Ignoring technical and nontechnical aspects risks making the final results concerning the quality of mobile learning application less accurate. Furthermore, the objectives of the mobile learning application development process would be affected and significant resources would be used in less important areas. Mobile learning application producers aim

to maximise general quality levels, with a greater focus on improving the characteristics that are considered to be critical. However, the level of stakeholder satisfaction with mobile learning applications plays a major role in increasing the quality of the final product. Whilst it is entirely based on using different types of mobile technologies to deliver educational and learning materials, its evaluation means more than the evaluation of a book or other traditional resources. The quality of mobile learning application is in this sense influenced by the quality of the content and by the way in which teachers manipulate the learning material and its delivery to learners through mobile technologies (Pocatilu & Boja, 2009).

## 3. Technical quality model

Software engineering comprises many different software quality models. The most common approach to representations of software quality present a hierarchy of quality attributes, such as McCall's quality model (McCall, Richards, & Waiters, 1977), Boehm's quality model (Boehm, Brown, & Lipow, 1976; Boehm, Brown, Kaspar, 1978) and ISO 9126 (ISO9126, 2001). However, all these quality models have been criticised for containing several deficiencies. The main complaints about ISO 9126 are insufficient or absent detailed quality aspects and inadequate information about measuring the defined quality aspect. (see Fig. 1).

Dromey's quality model (Dromey, 1996) proposes the action definition that is required to achieve the desired quality level, instead of describing the quality approach itself. This approach will provide developers with concrete actions that will reach the preferred quality level. Grohmann, Hofer, and Martin (2005) argue that M-learning quality aspects can be divided into two main parts: technological and service quality aspects. M-learning technologies are concerned with limited battery life, small screen size,

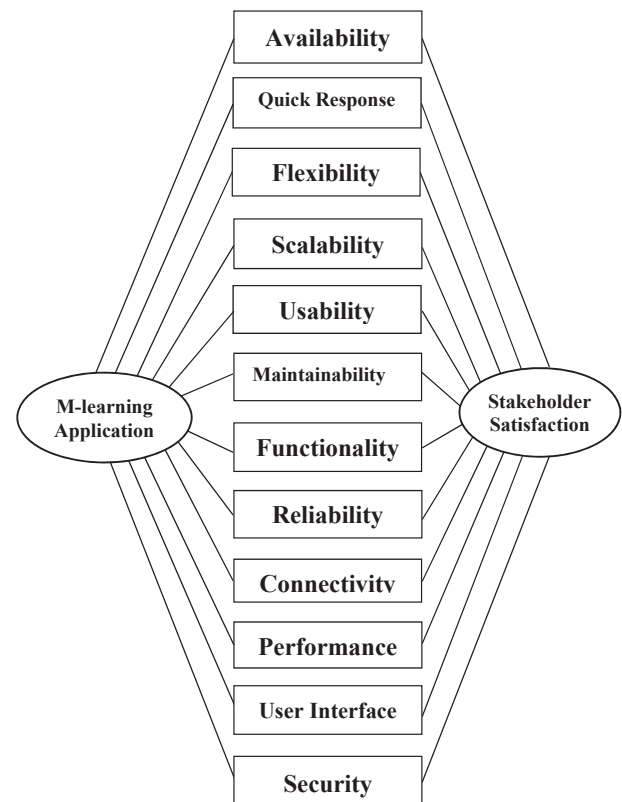


Fig. 1. Proposed technical quality model.

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