# SYSTEM QUALITY CHARACTERISTICS
# FOR SELECTING MOBILE LEARNING APPLICATIONS

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## ABSTRACT

The majority of M-learning (Mobile learning) applications available today are developed for the formal learning and education environment. These applications are characterized by the improvement in the interaction between learners and instructors to provide high interaction and flexibility to the learning process. M-learning is gaining increased recognition and adoption by different organizations. With the high number of M-learning applications available today, making the right decision about which, application to choose can be quite challenging. To date there is no complete and well defined set of system characteristics for such M-learning applications. This paper presents system quality characteristics for selecting M-learning applications based on the result of a systematic review conducted in this domain.

**Keywords:** Mobile learning; M-learning; Mobile Application; System Quality
Characteristics.

## INTRODUCTION

With the current improvement in Information and Communication Technologies (ICT) and mobile computing platforms, new types of learning and educational tools have been reported, e.g. SMS registration, learning vocabulary, learning using short messages, and practice questions (Cavus & Ibrahim, 2008: 79; Sarrab, 2014: 2). Advancements in technology gave us Ubiquity and Mobility convenience, which enhanced our productivity considerably. Ubiquity is the ability to access computing devices 24/7 from anywhere, where mobility is the ability to have that access while on the go using portable devices such as wireless laptops, tablets, smart phones and PDAs. These have led to the development of Mobile learning (M-learning), which is defined as the use of portable devices equipped with the internet in the learning process. Availability and portability features of mobile devices are behind the popularity of M-Learning, where mobile devices can be accessed and carried around much easier comparing to static or fixed devices.

In education and despite the number of wide spread uses of desktop computers all over the world, learners are enjoying using portable devices than fixed ones (Cohen, 2002:

136). Mobile devices are believed to provide a promising, effective and flexible learning platform (M-learning). This can change the current learning system to become more interesting, interactive and widely available. Despite the benefits of M-learning , it is still considered new and has some drawbacks and limitations such as limited computing and processing power, small screen size, limited storage capacity, limited battery, relatively low transmission rate,  lack of standard of selection criteria (Filho & Barbosa, 2013).

In addition, many educational institutions explicitly prohibit the use of mobile devices during formal study (lectures or labs). Learners also rarely use the capabilities of their mobile devices in education such as browsing the internet for lectures related information during lectures. In addition, very few learners may opt to photograph the teaching board as means of notes taking, audio record the lectures, or even use mobile devices as a dictionary to search for Definitions for ambiguous  terms and vocabulary. In order to promote more effective adoption and wide dissemination of M-learning initiatives, this paper aims to investigate significant system quality criteria that should guide learners and organizations in the selection, development and evaluation of M-learning applications. Specifically, this study attempts to highlight the most relevant system quality characteristics that could encourage individual learners and education decision makers in selecting their M-learning application products. Such criteria were drawn mainly from the literature, users' feedbacks, and analyzing standards for software quality.

The criteria selection also utilized a bulk of the scaled based analysis including: published research papers,  official discussion forums, software documentation, technical reports, online technical articles, user manuals, domain experts and personal knowledge to understand all possible system quality selection criteria used by potential learners to evaluate M-learning applications. To achieve the study objectives, it was necessary to investigate empirically the quality characteristics of different M-learning applications using qualitative analyses of system quality characteristics. The proposed quality characteristics will be used to identify the system characteristics considered significant by learners and organization decision makers to select appropriate M-learning product.

This paper starts with a general overview of M-learning and discusses the used quality characteristics to select M-learning applications. The paper then discusses the methodology process. The paper also introduces the selected mobile learning application. Then the paper empirically study each selected M-learning application against the system quality characteristic.

## M-LEARNING

The recent improvements in Internet technology helped to improve distance learning using E-learning tools. It also helped enhance the overall learning process, and encouraged better interaction among learners and their instructors and improved participation in various learning activities such as collaborations, discussion and problem solving. Moreover, the fast development of mobile technologies has changed the platform for social and business activities using mobile software apps. Mobile technologies support high capabilities of photo and video processing, and contain built-in web page browsers, global positioning sensors, voice recognition systems and overall fast Internet wireless connectivity (Sarrab, Al-Shihi & Rehman, 2013: 828; Dong, Zheng, Yang & Qiao, 2009: 126; Sarrab & Elgamel, 2013: 1412). These features helped to develop a new trend in learning called M-learning. Simply, M-learning is a mobile app that provides various learning activities and utilizes the advantage of mobility and wireless technologies in the learning process (Farooq, Schafer, Rosson & Caroll, 2002). M-learning can be also defined as the learners' creation and consumption of learning contents using mobile devices. Moreover, some researcher has referred to M-learning as E-learning on a mobile device Sarrab, Elgamel & Aldabbas, 2012: 33; Sarrab, Alzahrani, Alalwan, & Alfarraj, 2014: 3; Geddes, 2004). M-learning approach is concerned with enabling learners to access knowledge and learning contents anywhere and anytime. The target of M-learning approach is to provide flexible, easily access and always on learning mechanism.

However, M-learning offers different benefits and brings many challenges too, which are not found in traditional software engineering applications (Oulasvirta, Wahlström & Ericsson, 2011; Alzahrani, Alalwan & Sarrab, 2014: 2; Ostashewski & Reid, 2010: 2862).

## QUALITY CHARACTERISTICS

System quality characteristics denote the desirable features of the M-learning application, such as availability, usability, dependability, performance and functionality. These selected criteria differ from another set of criteria found in an empirical study of software quality characteristics based on open source software selection (Sarrab & Rehman, 2014: 3). In selecting adoption criteria for open source software (Sarrab & Rehman, 2013: 2), features about system quality, information quality and service quality were found to be critical. Our approach focuses on the system quality characteristics only, which include availability, usability, dependability, performance and functionality. These may contribute to the success of M-learning development and adoption among potential developers and users.
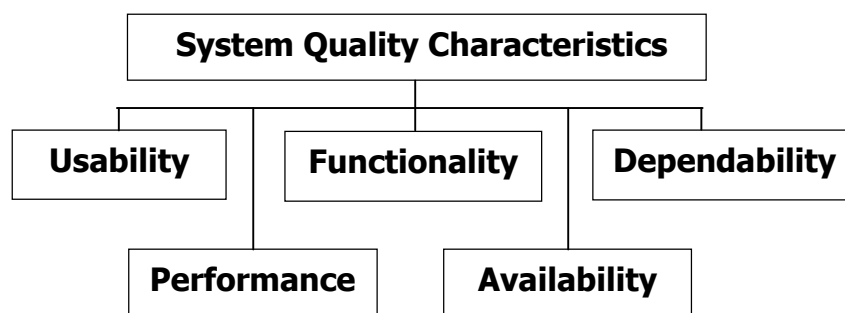


**Figure: 1**
**The used quality characteristics to select M-learning Applications**

## METHODOLOGY

Four M-learning applications were selected and weighted based on different research literature review, online articles, tools documentations, technical reports, user manuals, usage experience, performance assessment, user feedback and personal knowledge. The second step was to focus on extracting the needed information from these resources, then, a summarized qualitative valuation is delivered for each of the selected tools. Moreover, quantitative representations have been used for additional analysis, such as averaging the quality characteristics of the individual M-learning system. A method of three steps was considered for deducing the scaled values, where the steps are carried out in a sequential manner for all OSS.

> ➢ **Select targeted M-learning applications**
> ➢ **Extracting the needed information from the considered resources**
> ➢ **summarizing qualitative valuation**

## SELECTED M-LEARNING MANAGEMENT SYSTEMS

With the huge number of M-learning applications available today, four different M-learning products were selected for the study to demonstrate the feasibility and effectiveness of the proposed approach; therefore, the choice of tools for conducting the study was important to reflect sufficient assessment of the proposed approach.

In order to demonstrate the applicability of the proposed approach, few of the most common M-learning tools were used in this study, which includes Moodle, Blackboard, SkillPort and Schoology.

### Moodle

MOODLE M-learning system is a free open source learning management system (MLE-Moodle) available on Android and iOS platforms. With this system learners can access their required courses and work virtually anywhere. Instructors can use MLE- Moodle to develop online courses, or to improve their face-to-face classes with online components in which learners are able to access MLE-Moodle using variety of mobile devices. MLE-Moodle is HTML5 web app that requires an internet connection to provide the best performance level, with some offline tasks (Moodle,2014)

### Blackboard

Blackboard M-learning is a mobile software application that is available to be downloaded and installed on mobile device to support user access to different features of courses. The Blackboard M-learning system focuses on interactive teaching and mobile learning, offering learners and instructor's access to the required materials, courses, and organizations on different platforms including iOS and Android smartphones. Blackboard mobile solutions make it easy to implement M-learning system that has the power to take learning and education steps farther than expected (Blackboard, 2014).

### SkillPort (+version 7.3)

Skillport learning management system (LMS) was upgraded recently to version 7.3 with many new learners' features such as Skillport Mobile. Skillport 8 online learning system is another new optimized version for different tablets delivery and suited to empower variety of organizations learning initiatives. In fact, Skillport Mobile is not a separate mobile app; rather, it delivers learning material through different mobile device's native browser. Skillsoft Mobile MLS offers a learning solution that supports wide range of learners' needs using mobile devices as learning tools (HR, 2014).

### Schoology

Schoology is a learning management system available as free native mobile app that extend learning beyond the limitations of the classroom. Schoology /extend the CODiE-award-winning learning management system to Android, Apple and Kindle Fire mobile devices. Schoology redefined the learning management system to offer online education as a collective effort and to increase the impact of all students involved in the education process. With flexible collaborative interface, Schoology robust M-learning apps empower engaging instruction and system wide collaboration on any device (Schology, 2014).

### THE STUDY

The case study focuses on analyzing the quality characteristic of selected M-learning tools. With the huge number of M-learning systems available today, making the right decision about which M-learning tools to choose, can be quite overwhelming. However, only five different systems were selected for the research study to show the effectiveness and feasibility of the proposed approach. To prove the applicability of the selected software quality characteristics in different M-learning system, the most popular M-learning tools were selected to be evaluated, including Moodle, Blackboard, SkillPort and Schoology. This paper discusses various M-learning systems and evaluates them according to the selected criteria. The selections of M-learning criteria are independent of the application type. Below is a brief introduction to five selected M-learning factors currently available

### Availability

The availability of the M-learning applications is concerned with the processing and response time which is related to the time ratio of the application usage, from the execution of application component to the required and expected overall time associated with the running M-learning application. Learners are always in demand to the maximum level of availability which can be offered through different M-learning services or applications.

The M-learning application high level of availability is a key feature of mobile application products that different companies and individual users depend on today (Sarrab, 2014: 64).

Generally, mobile applications and specifically M-learning applications are essential to learners' applications, i.e. email software tools, bilingual mobile dictionary, mobile banking programs and mobile discussion ports. There are several M-learning applications that support learning with high level of availability, such as audio and video file sharing application and learners mobile discussion ports using VoIP (Voice over Internet Protocol) (Moodle, 2014; Blackboard, 2014; HR, 2014; Schology, 2014).

### Usability

Users should be able to use and access M-learning applications regardless of their age, state, ability and condition. Moreover, M-learning application should support various types of communication and different languages, including all types of learners with special needs. M-learning application should support various formats and tools (Sarrab, 2014: 68). The M-learning application used protocols should be understandable, usable and easy to learn. M-learning application has to be attractive to grip the learners' attention and focus

### Dependability

M-learning applications should be quick and easy to setup and install in any system or device which leads to the availability in any environment. M-learning applications should be reconfigurable without any issues and difficulties, and all its components have to be replaceable, in case of modification needed in scope or operation (Sarrab, 2014: 67). Moreover, M-learning application has to be fast and easy to upgrade and revise. Finally, it should be free of errors and allows all operations to be accurate, consistent and free of any faults (Moodle, 2014; Blackboard, 2014; HR, 2014; Schology, 2014).

### Functionality

The functionality of M-learning application should be useful and suitable enough to meet different learning and educational objectives, instructors and learners needs and the situation. M-learning applications should be flexible, simple and self-explanatory, to provide the required services to suit demand (Sarrab, 2014: 67). M-learning application has to support mobility to offer learning anywhere, across larger coverage areas, at the best mobile processing speed. The M-learning application should support various communication types, such as user to user, user to device, synchronous or asynchronous … etc (Moodle, 2014; Blackboard, 2014; HR, 2014; Schology, 2014).

### Performance

One of the main concerns of M-learning application's performance is the energy consumption of the application itself, where M-leaning application should not consume a lot of energy. In case of lack of availability of bandwidth, the M-learning application communication bandwidth should adjust the required operation to the available bandwidth. In order to increase application performance, the M-learning application should use appropriate storage management mechanism (Sarrab, 2014: 67). The M-learning application has to utilize the existing input and output devices to the highest possible extent. The M-learning application has to offer and enhance the quality for the displayed images and the transmitted audio packets (Moodle, 2014; Blackboard, 2014; HR, 2014; Schology, 2014).

### DISCUSSION

The following tables provide description of how the selected application differs across the above criteria. Table 1 for example shows that all four applications support different languages with English as the primary one. They differ in the number of languages each application supports, with Moodle supports the largest number.

**Table: 1**
**Mobile LMS availability**

| Mobile LMS | Availability |
|---|---|
| MOODLE | Moodle is available in English, but its site supports different hundred languages and presented in around 235 countries. |
| BLACKBOARD | Blackboard is available in 15 different languages in over 140 countries. |
| SKILLPORT | Skillport is available in 26 languages to support different global organizations which can be install at user side or hosted by skillsoft. |
| SCHOOLOGY | Schoology is available in English language around 135 countries. |

Table 2 shows the usability features across the four applications, where each application emphasize a unique approach. For example, Moodle is more customizable, Blackboard offers more scalability, and Schoology supports third-party programs like Google docs.

**Table: 2**
**Mobile LMS Usability**

| Mobile LMS | Usability |
|---|---|
| MOODLE | It is modularity gives the user's ability to reconfigure the system to fit their needs. Moodle is customizable, flexible and ease of use system. |
| BLACKBOARD | It is flexible system that has the ability to develop and expand. |
| SKILLPORT | Skillport provides several learning methods to each individual learner where learners will be able to study several programs through skillport in easy way. |
| SCHOOLOGY | Schoology is flexible enough to integrate third-party program such as google Docs, Turnitin and more, to make it easily accessible for instructor at any time. But it is still difficult to upload any student work that is image or video based. |

Table 3 describes the dependability feature in all four applications. It is clear that the majority are closed-sourced which not offer the dependability level required by some developers, especially when open-source is more preferred. Despite that, the literature shows that all four application where reliable enough in terms of up-time and processing.

**Table: 3**
**Mobile LMS Dependability**

| Mobile LMS | Dependability |
|---|---|
| MOODLE | Moodle is very reliable learning management system at its the most popular LMS over the world where its market share is increasing continuously. Moodle is Open-source platform. |
| BLACKBOARD | Blackboard is closed-source platform. Blackboard different features enable it to be as reliable system that used in different education providers. |
| SKILLPORT | Skillport is closed-source platform that is cloud-based mobile LMS provides unparalleled learning experience by connecting formal, informal and collaborative learning. |
| SCHOOLOGY | Schoology is a closed source platform which makes it difficult for the users to customize according to their needs. |

Table 4 summarizes that different functionalities offered by each application. All of the applications offer common functionalities related to learning but usually have unique tools.

For example, **Moodle has an e-portfolio tool that allows learners to keep track of their submissions and deliverables.**

**Table: 4**
**Mobile LMS Functionality**

| Mobile LMS | Functionality |
|---|---|
| MOODLE | Moodle provides different functionality layers such as integration with other systems, installation of third-party add-ons, and integration with ever more popular e-portfolio systems. |
| BLACKBOARD | Students and faculty has many functionality benefits such as increased availability, quick, feedback, improved communication, and skill building. |
| SKILLPORT | Skillport in compensation of simplicity, scalability and dependability ensures that learner can easily access, manage and report on their learning resources and activity. |
| SCHOOLOGY | Schoology has high functionality as long as it is integrated with existing school reporting and information systems. |

**Table 5 describes how the four applications differ in terms of performance. It is clear that performance level is very similar across all four applications but the open-source feature in Moodle may give it an edge over the rest since developers are able to tune its processes.**

**Table: 5**
**Mobile LMS Performance**

| Mobile LMS | Performance |
|---|---|
| MOODLE | Its simple design, ease of installation and time to implement, is the main criteria make its performance scaled very high. It's an open source that makes it cost less compared with other LMS. |
| BLACKBOARD | Blackboard has a completeness of service and performance that makes it very attractive to higher education and academia in general. |
| SKILLPORT | Skillport is provided as a solution to thousands of organizations that value the dependability, ease of use, flexibility and speed to deployment |
| SCHOOLOGY | It's an easy to use and implement online learning management and social networking platform that improves learning through better communication and collaboration with high performance |

## CONCLUSION

**In this paper, a systematic methodology for the selection of M-learning applications was presented. Based on a number of factors such as users' input, research background review, and different software quality standards, a number of criteria were developed for the selection of M-learning applications. These criteria should serve as a guide and should help educational institutes as well as students and lecturers choose the right applications that best suit their needs.**

**The paper focused on system quality characteristics for selecting M-learning applications including availability, usability, dependability, performance and functionality. Future**

research may lie in all system features such as system quality, service quality and information quality.

Service quality may include commercial support, community support, developer skills and documentation. Information quality may include desirable sub features of M-learning application, such as maintainability, reusability, testability and security.

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