



EXISTING TRENDS IN USABILITY EVALUATION METHOD (UEM) FOR M-LEARNING APPS: A SYSTEMATIC REVIEW

Azham Bin Hussain¹, Raed Mohammed Hussein², Jasim Mohammed Dahr³ and Mohammed Abbas Neamah³

¹School of Computing, Universiti Utara Malaysia, Malaysia

²Directorate of Education in Dhi-Qar, Iraq

³Directorate of Education in Basrah, Iraq

E-Mail: azham.h@uum.edu.my

ABSTRACT

Recent estimates indicate that by 2017 the number of mobile devices per capita will be increased to 1.4 billion, as reported by the Cisco Global Mobile Data Traffic Forecast 2013 Update. This increase has led to the strong emergence of mobile learning in many institutions and countries. However, although several studies concerning Usability Evaluation Methods have been reported, there is scarcity of the systematic review that has been published in the field on Mobile Apps, in particular Mobile Learning Apps (MLA). Therefore, this article aims to review the current information on Usability Evaluation Methods (UEMs) that have been used by many researchers and practitioner to evaluate Mobile Applications in general, and specifically in the Mobile Learning Application. The review focuses on articles published between 2010 and 2015. A systematic review was performed to answer the main research questions. The researchers found the Expertise, Focus Group, Interview, Observation, Questionnaire and Thinking Aloud commonly use in Mobile Application Studies. While, this study found the Interview, Observation and Questionnaire more popular in the mobile learning application. This study provides an overview of current and most popular UEMs to the evaluators and developers.

Keywords: usability, m-Learning, systematic review.

INTRODUCTION

Usability Evaluation Methods (UEMs) is among the top approach in term of usability to evaluate system, application, prototype (Bernhaupt, 2009). During the previous years, various methods of usability evaluation have been to evaluate the usability of systems (Hasan, 2014; Hussain *et al.*, 2015). Implementing usability testing for mobile applications is one of the emerging research field in human computer interaction (HCI). The core challenges in implementing mobile evaluation are to collect the data for usability testing (Isomursu, Kuutti and Väinämö, 2004).

Moreover, a mobile information and communication technology (ICTs) has been the current trend of users to help their everyday life and work has managed to new groups of mobile devices. The functionality of mobile devices has expanded step by step. Nowadays generation of mobile phones, various functions is offered. In various situations and contexts used mobile devices (Ogawa, Takada, Akagiri and Kobayashi, 2010). They allow a new ways of communication and direction, behaviors and used to support social life, peoples' social network. But so far, just a few in-depth studies of the Usability Evaluation Methods with the field of mobile learning application have been undertaken. The aim of this work is to examine which methods of usability evaluation have been used in the Mobile Application in general, Mobile Learning Application in specific.

Literature review

In later years, one of the major growth areas in computing is mobile (Ham *et al.*, 2008). Mobile devices are becoming increasingly diverse, and are continuing to shrink in size and weight. In addition, Mobile devices are known as an evolving technology with the possibility to simplify teaching and learning approaches that exploit individual learners' context (Jeng, Wu, Huang, Tan and Yang, 2010; Johnson, Levine, Smith, and Smythe, 2009; Cobcroft, Towers, Smith, and Bruns, 2006). Mobile learning is defined as the method of learning and teaching that happens with the use of mobile devices, providing flexible on-demand access to learning resources, experts, peers, and learning services from any place (Traxler, 2009; Kukulska-Hulme and Pettit, 2009). Similarity, Ally (2009) stated that, Utilize Mobile devices in the educational process allows anyone to access information and learning materials from anywhere and at anytime. As a result, learners have control of when they want to learn and from which location they want to learn. A key benefit of using Mobile devices is to reach people who live in remote locations where there are no schools, teachers, or libraries.

However, screen size, computational power, battery capacity, input interface and network bandwidth are limited aspects of mobile devices for learning (Chen, Chang and Wang, 2008). Thus, a critical issue in a mobile learning environment is how to adapt information for delivery to mobile devices. Usability is a crucial factor in the development of any system. To determine the success or failure of this kind will depend on the ease or difficulty



that users experience with systems (Insfran and Fernandez, 2008).

In the last few years, some researchers aimed to compare the techniques of usability evaluation for system development in general, such as (Dubey and Rana, 2012; Alva Ch and López, 2003; Ivory and Hearst, 2001; Zapata *et al.*, 2015). The study published by Ivory and Hearst was one of the best complete studies in 2002. They suggested taxonomy for categorizing automated usability evaluation methods. The taxonomy was applied to 128 usability evaluation methods, where 58 of them are appropriate for web user interfaces. The outcomes of these studies suggest promising ways to expand current methods to better support automated usability evaluation.

An assessment of seven methods and tools for usability evaluation in software products and artifacts for the web has been offered in a different study by Alva *et al.*, (2003). Determine the degree of similarity among the methods using the principles defined in the ISO 9241-11 standard was the purpose of this study.

Although, a significant increase of the Mobile devices and penetration in many sectors in our life. There are few studies concentrates on usability methods of the Mobile applications. There is a recent study conducted by Zapata, Fernández-Alemán, Idri, and Toval (2015). Zapata *et al.*, focus on the Mobile health applications. In their research, they have analyzed 22 studies that perform usability evaluations of mobile health applications.

Even though there are many studies published about the systematic review in many disciplines, we found there are scare of systematic review on the usability evaluation methods with the mobile application. Therefore, this paper presented a systematic review on mobile application and usability methods to identify existing techniques for evaluation mobile learning applications.

Research method

The Systematic reviews have increasingly replaced traditional narrative reviews and expert commentaries as a way of summarizing the research evidence (Hemingway and Brereton, 2009). It has gained significant popularity among software engineering researchers since 2004 (Zhang and Babar, 2013). In this systematic review, the researchers applied the guidelines presented in Kitchenham, Mendes and Travassos [5], as discussed below.

Formulating the systematic review questions

Formulating the research questions that a Systematic Review will address is the first step in the review process as Kitchenham *et al.*, (2007) referred. Therefore, in this paper in order to find out the Usability Evaluation Methods (UEM) that have been used with Mobile Application (MA) in general, the researchers formulated the first research question thus: What are Usability Evaluation Methods (UEM) that have been used

with Mobile Application (MA)? And because the researchers concentrated on the Mobile Learning Application (MLA) especially, thus in the second question the researchers formulating the following question: What is most popular Usability Evaluation Methods (UEM) in Mobile Learning Applications (MLA)?

Constructing the search

In order to implement the search and choice research studies, the researchers defined their tactic based on the keyword, date and digital libraries to answer the questions.

Search process

In this Systematic evaluation, the researchers decided to concentrate on particular digital libraries available to students in Universiti Utara Malaysia, which were: ACM, Elsevier Science Direct, IEEE and SpringerLink. The researchers also searched in the most popular search engine for academic purposes known Google scholar search engine.

Terminology

In order to complete the automatic search of the particular digital libraries, in this study, the researchers concentrate on the search terms (keywords) related to this research to answer the research questions. Therefore, based on the questions for this study, the search terms in this article defined the following basic search strings: (1) "Usability Evaluation Methods"(2) "Usability Evaluation Methods" AND " Mobile Application"(3)"Usability Evaluation Methods" AND " Mobile Learning", and (4) "Usability Evaluation Methods" AND "M- Learning".

Study selection

There are some criteria were used in this systematic review to determine which piece of literature found by the search term will be excluded: Studies that are not relevant to the research questions, Studies that are not within the specified time period, Studies that do not determine the a specific Usability Evaluation Methods (UEMs), Studies that do not provide an empirical basis for their findings, Duplicate studies in different sources; and Studies not written in English.

Moreover, in this study, we focused on studies published between 2010 and 2015 which involved usability evaluation of a mobile application and mobile learning applications. This beginning date was selected since on this date witnessed a major development in Mobile Phone devices, based on the statistic that conducted by Wishpond Technologies Ltd (2014).

Strategy of data extraction

The aim of this stage is to design data extraction formulae to exactly record the information researchers acquire from the primary studies. Data extraction also



includes drawing up a complete table describing every study that is studied in detail (not each study that was placed in the review, only those studies that meet all the inclusion criteria) (Petticrew and Roberts, 2008). In general, data extraction will define a set of statistical values that should be extracted from each study. However, statistical data are significant for any attempt to summarize the results of a set of primary. This systematic review, the researchers adopted data extraction strategy from Salvador, Nakasone and Pow-Sang (Salvador, Nakasone and Pow-Sang, 2014).

Synthesis of the extracted data

Synthesis of the extracted data includes collecting and summarizing the results of the involved primary studies. The first round from the search includes all the studies related to phenomena. The second round, study of the Usability Evaluation Methods with mobile applications in general. The results from this round were (43) out of (152) studies met the inclusion criteria. More specific, to identify the most popular usability method in mobile learning application, (25) out of (43) studies met the inclusion criteria for this stage. The details regarding the amount of studies found during the search process are shown in Figure-1, and the complete number of selected studies is 43 studies, all the extracted information can download through this link: <https://www.dropbox.com/s/aeaonj2fna3aps2/Studies%20Selected.pdf?dl=0>.

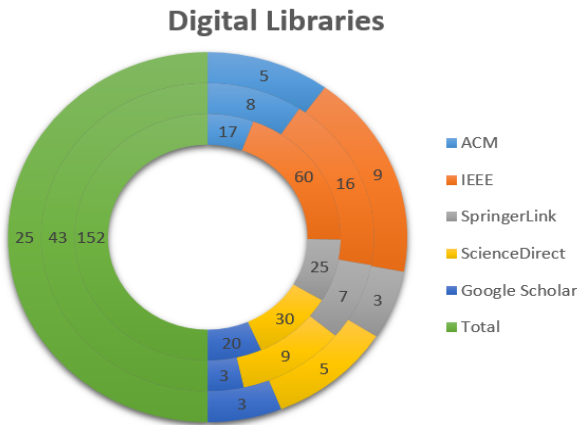


Figure-1. The complete number of selected studies.

RESULTS

To understand with the usability evaluation methods used in the Mobile Apps in general. Question (RQ1) was established to examine which methods of usability evaluation have been used in the mobile context. In addition to this, the researchers wanted to understand what are the most popular Usability Evaluation Methods in Mobile Learning Application? Therefore, second research question was recognized.

The above research questions were answered by investigative the literature on mobile applications. The variety of literature on the subject of mobile applications is so wide it was significant to limit the literature review of the most related and latest publications and to bound the publication interval to papers published between 2010 and 2015, as well as focuses especially on the Mobile learning applications. RQ1: What is Usability Evaluation Methods (UEM) that has been used by Mobile Application (MA)? This research question was recognized to discover recent research trends into usability evaluation methods with mobile applications in general. Figure-2 classifies the results for this stage based on the digital libraries was available to the researchers.

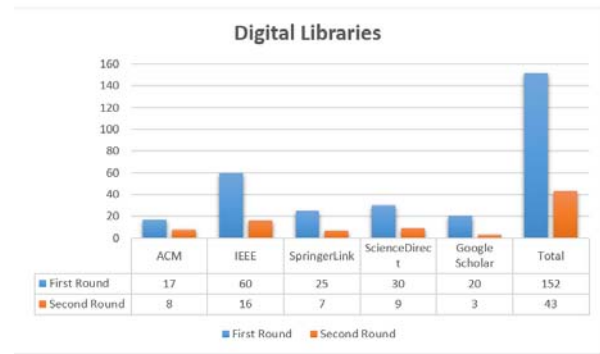


Figure-2. The results, based on the second round.

Based on the results of the systematic literature review process, the usability evaluation methods were used with mobile application according to included criteria are: Expertise, Focus Group, Interview, Observation, Questionnaire and Thinking Aloud, as depicted in Figure-3.

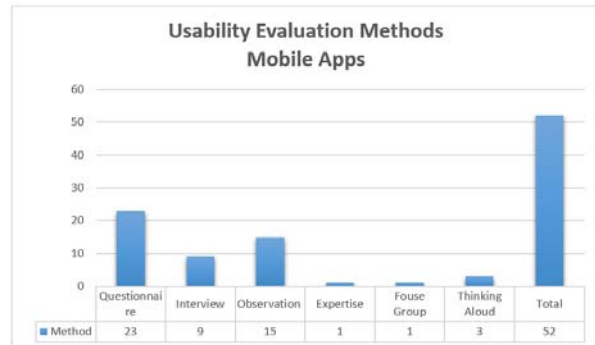


Figure-3. Usability methods used with Mobile Apps.

RQ2: What are most popular Usability Evaluation Methods (UEM) in Mobile Learning Applications (MLA)?

There are various methods in which mobile applications can be evaluated, including Questionnaire,



Interview, Observations, etc., as illustrated previously. This research question specifically goals to find the most common methods of usability evaluation used to evaluate mobile learning applications. From 43 studies only 25 articles met the inclusion criteria for this stage, as depicted in the Figure-4.

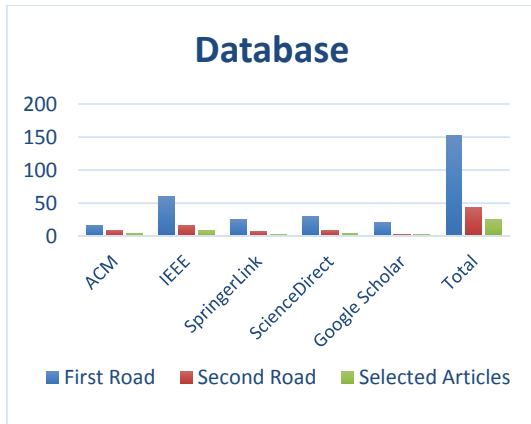


Figure-4. The results, based on the Third Round.

With respect to the second research question, this systematic review discovered the interview, observation and Questionnaires more popular usability evaluation methods in the learning context by using mobile devices, Figure-5 illustrates this tangible findings.

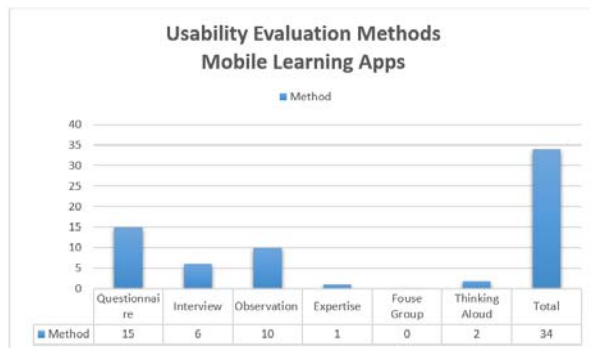


Figure-5. The most popular usability methods in Mobile learning Apps.

DISCUSSIONS

The growing adoption of smartphones has encouraged their usage in the learning system. The adoption of smartphone in learning sectors is leading to the emergence of the term mobile learning. Mobile learning solutions have been used in recent years to help many people in developing countries. In the mobile learning application, the researchers and the developers often were evaluating the usability of their mobile learning proposals by working with empirical methods that involve real users.

In this paper, the researchers seek to answer two research questions for this systematic review. Thus, the researchers analyzed 43 studies that perform usability evaluation of mobile learning applications. Our findings show that mobile learning applications started their expansion in the year 2013, and research is therefore still growing.

The method most frequently used to evaluate the usability of a Mobile application is that of questionnaires (15 studies). Questionnaires consist of a set of questions that users answer after having tested the application being studied. McNabb (2002) stated that, questionnaires can be custom designed to meet the objectives of almost any type of research project. As well as, Kirakowski (2000), Osterbauer, Lackner, and Weinberger (2010) and Kulkarni and Dixit (2012), stated that, there are many advantages of using questionnaires in usability research, for instance, (1) questionnaire gives researchers feedback from the point of view of the user, (2) another big advantage is that measures gained from a questionnaire are to a large extent, independent of the system, users, or tasks to which the questionnaire was applied, and (3) Additional advantages are that questionnaires are usually quick and therefore cost effective to administer and to score and that you can gather a lot of data using questionnaires as surveys. Furthermore, six of the evaluations that work with questionnaires were also supported by interviews and observations. Observations are the second most frequently adopted methods, appearing in ten studies. Two studies are evaluating usability by implementing a Thinking aloud. Therefore, based on these results, in future work, the researchers must use automated evaluation tools.

However, this systematic review is limited for a number of causes. Firstly a small number of digital libraries were available to the researchers. Secondly, some articles need to buy it from these digital libraries to become available for researchers. Besides, the period collecting these articles was too short. But generally, the researchers strive to attain the objectives of this research in the ideal way.

REFERENCES

- Ally, M. 2009. Mobile learning: Transforming the delivery of education and training: Athabasca University Press.
- Alva, M. E., Ch, H. S., and López, B. 2003. Comparison of Methods and Existing Tools for the Measurement of Usability in the Web Engineering: Springer. pp. 386-389.
- Bernhaupt, R. 2009. Usability and User Experience Evaluation Methods. Mass Customization for Personalized Communication Environments: Integrating Human Factors: Integrating Human Factors, 232.
- Chen, G.-D., Chang, C.-K., and Wang, C.-Y. 2008. Ubiquitous learning website: Scaffold learners by mobile



www.arpnjournals.com

- devices with information-aware techniques. *Computers and Education*. 50(1), 77-90.
- Cobcroft, R. S., Towers, S. J., Smith, J. E., and Bruns, A. 2006. Mobile learning in review: Opportunities and challenges for learners, teachers, and institutions. *Computers and Education*. 50, 77- 90.
- Dubey, S. K., and Rana, A. 2012. Analytical Comparison of Usability Measurement Methods. *International Journal of Computer Applications*, 39.
- Ham, D.-H., Heo, J., Fossick, P., Wong, B., Park, S., Song, C., and Bradley, M. D. 2008. Framework and model of usability factors of mobile phones. *Handbook of research on user interface design and evaluation for mobile technology*.
- Hasan, L. 2014. The Website of the University of Jordan: Usability Evaluation. *Int. Arab J. e-Technology.*, 3(4).
- Hemingway, P., and Brereton, N. 2009. What is a systematic review. *What is Series*. Bandolier, April.
- Hussain, A., Abbas, S. A. A., Abdulwaheed, M. S., Mohammed, R. G., and Abdulhussein, A. A. 2015. Usability Evaluation of Mobile Game Applications: A Systematic Review. *International Journal of Computer and Information Technology*, 4(3), 5.
- Insfran, E., and Fernandez, A. 2008. A systematic review of usability evaluation in Web development. Paper presented at the Web Information Systems Engineering-WISE 2008 Workshops.
- Isomursu, M., Kuutti, K., and Väinämö, S. 2004. Experience clip: method for user participation and evaluation of mobile concepts. Paper presented at the Proceedings of the eighth conference on Participatory design: Artful integration: interweaving media, materials and practices-Volume 1.
- Ivory, M. Y., and Hearst, M. A. 2001. The state of the art in automating usability evaluation of user interfaces. *ACM Computing Surveys (CSUR)*. 33(4), 470-516.
- Jeng, Y.-L., Wu, T.-T., Huang, Y.-M., Tan, Q., and Yang, S. J. 2010. The Add-on Impact of Mobile Applications in Learning Strategies: A Review Study. *Educational Technology and Society*. 13(3), 3-11.
- Johnson, L., Levine, A., Smith, R., and Smythe, T. 2009. The 2009 horizon report: K. Austin, Texas: The New Media Consortium. Cover photograph: "Chapped Lips" by Vox_ Efx on Flickr (http://www.flickr.com/photos/vox_efx/3186014896/). Creative Commons, 3.
- Ogawa, T., Takada, S., Akagiri, K., and Kobayashi, T. 2010. Speech enhancement using a square microphone array in the presence of directional and diffuse noise. *IEICE transactions on fundamentals of electronics, communications and computer sciences*. 93(5), 926-935.
- Petticrew, M., and Roberts, H. 2008. *Systematic reviews in the social sciences: A practical guide*: John Wiley and Sons.
- Salvador, C., Nakasone, A., and Pow-Sang, J. A. 2014. A systematic review of usability techniques in agile methodologies. Paper presented at the Proceedings of the 7th Euro American Conference on Telematics and Information Systems.
- Traxler, J. 2009. Current state of mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training*.
- Wishpond Technologies Ltd. 2014. *New Trends of Mobile Users and Their Shopping Behaviour*, from corp.wishpond.com/mobile-marketingresources/new-trends-of-mobile-users-and-their-shopping-behaviour.
- Zapata, B. C., Fernández-Alemán, J. L., Idri, A., and Toval, A. 2015. Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review. *Journal of medical systems*. 39(2), 1-19.
- Zhang, H., and Babar, M. A. 2013. Systematic reviews in software engineering: An empirical investigation. *Information and Software Technology*. 55(7), 1341-1354.