New Usability Guidelines with Implementation Ways of Mobile Learning Application based on Mobile Learning Usability Attributes

Fadhl Hujainah[1*], Halina Dahlan[2], Basheer Al-Haimi[3], Ammar Hujainah[1] , Hael Al-Bashiri[1] and Mansoor Abdullateef Abdulgabber[1]

[1]Department of Computer Science and Software Engineering, University Malaysia Pahang, Pahang, Kuantan; fadelhogina@gmail.com, ammar.hogina@gmail.com,Hailealbashiri1@gmail.com, hakmansoor@ump.edu.my
[2]Department of Computer Science and Information System, University Technology Malaysia, Skudai, Johor Bahru; halina@utm.my
[3]Department of Industrial Management, University Malaysia Pahang, Pahang, Kuantan; basheerump@gmail.com

Abstract

Objectives: This work aims to propose new improvements to mobile learning application. These improvements are presented by proposing new guidelines of mobile learning application along with their implementation ways and propose mapping each proposed guideline with mobile learning usability attributes. **Methods/Statistical Analysis:** The researchers review the existing usability guidelines for mobile learning application in related work in order to identify the current challenges. Proposed solutions are presented to solve the identified challenges by producing new guidelines along with their implementation ways. Also, the researcher proposed mapping these guidelines with mobile usability learning attributes to ensure that proposed guidelines covers the usability issues of mobile learning. Moreover, the proposed improvements are evaluated using expert usability review method to measure its acceptance. **Findings:** Expert usability review method is used to evaluate the proposed guidelines, proposed implementation way of guidelines, and proposed mapping guidelines with usability mobile for mobile learning application. The researchers used quantitative approach for the data collection purpose. Evaluation result shows that 81% of the participated experts' opinions are agreed with the proposed improvements of the usability guidelines based on produced guidelines, proposed ways to implement each guideline, and proposed mapping the guidelines with mobile learning usability attributes. Followed by 11% of the experts' opinion are undecided and only 7% of the experts' opinion are disagree the proposed improvement of the usability. **Application/Improvements:** From findings, it is obvious that the proposed improvements can be used for developing mobile learning application with meeting usability standards efficiently. New guideline can be added in order to handle new issues that might be appeared in the future.

Keywords: Expert Usability Review, Mobile Devices, Mobile Learning Application, Mobile Learning Usability Attributes, Usability Guidelines

1. Introduction

The technology has introduced the smart mobile which can be used to browse the internet and most of people are using them in doing their duties. Current technology enabled the mobile devices to perform the computerized activates such as it allows the mobile devices to have its own computerized applications[1,2]. One of the computerized activities that can do using mobile devices is educational activities[2,3]. The educational activities have revealed many of benefits in using them via the mobile devices[4,5]. This is because the student can learn anywhere and anytime using their mobile devices with internet connections[6]. Therefore, it is essential to have useable mobile learning

application that is used as interface between the organizations and students[6]. Moreover, it is significant to ensure that the interface of the mobile application can be used and do not make the user uncomfortable about its content and appearance and this will affect the mobile learning system since the user will not be interested to use the application[7–9].

Furthermore, the existing usability guidelines of mobile learning application have limitations in term of meeting the usability standards[9–11]. Thus, the main purpose of this paper is to utilize the limitation of current usability guidelines of mobile learning application and then purpose new improvements for existing usability guidelines of mobile learning application in term of adding a new guideline, providing the details information of implementation ways of each proposed guidelines and mapping each proposed guidelines to usability attributes of mobile learning application. The rest of this paper is comprised of eight sections. Section 2 presents the description of the usability attributes of mobile learning. Section 3 explains the related work to the usability mobile learning by illustrating the existing usability guidelines of mobile learning application. Discussion on the identified challenges of existing usability guidelines for mobile learning application is presented in section 4. Section 5 elaborates proposed improvements in order to overcome the identified challenges, while the evaluation of the proposed improvements is provided in section 6. Constraints and challenges of this research are included in section 7. Lastly, section 8 concludes this paper with the summary of the main findings providing future enhancements.

2. Mobile Learning Usability Attributes

There are various usability attributes that can be used to measure the usability factors for web application and mobile application domain. While, each mobile application domain can have specific usability attributes. However, the usability attributes of mobile learning were produced by Ali Mostakhdemin-Hossieni[12]. These attribute are namely as adjustability, funability, reliability, and satisfaction. They were produced based on the previous prototype testing[13]. The explanation of these mobile learning usability attributes is as following[12,13]:

- Adjustability: it refers to the degree of the user acceptability to the used platform as a learning platform that focuses on the interaction style and the quality of the content in the platform.
- Funability: it refers to the mobile learning platform and the concept pleased the users; the application has less uncertainty which force the users to quite the application.
- Reliability: it refers to the mobile m-learning platform that should not perform in unexpected ways.
- Satisfaction: it refers to leaner's satisfaction and leaner have to feel that he /she will be able to perform the tasks with any external activities via their mobile devices.

3. Related Work

Researchers have developed different mobile usability guidelines in order to enhance the usability factors in mobile application and attempt to eliminate usability issues. However, there are few usability guidelines and models that are relate to mobile learning application domain. These usability guidelines and models have been produced based on the previous research, experiments or usability testing for mobile learning usability issues. Majlinda has presented M-learning usability framework[14]. This proposed framework is based on the previous general rules or usability guidelines such as Shneiderman's golden rules of Interface design[15,16]; ten Nielsen's usability heuristics[17]; duma's guidelines for good design[18], and guidelines for human-computer interface design[19]. Moreover, another mobile learning usability framework has been by researcher Daniel and Jalan[20]. The guidelines of this framework divided into categories namely as user analysis, human interaction, and mobile learning interface design factor[15]. The proposed essential factors of the mobile learning interface Design that should be handled during designing interface for mobile learning application. In the presence of these frameworks and guidelines still the M-learning usability guidelines are not mature and still face challenges in term of covering usability's issues of mobile learning application[10]. Discussion of existing limitations of mobile learning usability guidelines are illustrated precisely in challenges section.

4. Challenges

In this section, the researchers highlight limitations of the existing usability guidelines for mobile learning application. These limitations have identified from the related works and literature review[10]. These limitations are as follows:

- Variety type of mobile screen is an issue which is not discussed on the existing usability guidelines of mobile learning application. Where, the current existing guideline of mobile learning application discuss only the size of the screen, but there is not guideline that provide guides for dealing with variety type of mobile screen such as touch and non-touch screen.
- There is no guideline of the existing mobile learning usability guidelines concerned of reducing the short term memory load. Even though, it is really significant to produce mobile learning application that can be responded fast in term of loading the required information.
- Navigation term is not completely covered well in the current usability guidelines of mobile learning application, since the existing mobile learning usability guidelines discuss the navigation term only from the consistency side. , whereas, the other usability guidelines for another type of mobile application discussed the navigation term in side of the navigation elements such avoiding the scrolling specially the horizontal scrolling because it is not good option for the user to use in the mobile application. Therefore, this guideline can be added to the existing mobile learning usability guidelines.
- Ways of implementing the guidelines are not explained: the current guidelines of mobile learning application do not demonstrate details information of implementation ways for each guideline. However, some of them are not provided any ways to implement the guidelines.

5. Proposed Improvements

The purposed improvements of guidelines will provide the solutions for the above identified limitations of the existing usability guidelines of mobile learning application. The proposed improvements of the guidelines consist of 9 guidelines for mobile learning application. Three of these guidelines are new to the mobile learning application domain. The first three guidelines are considered as new proposed guidelines by researcher, while others have been improved. Moreover, details information of implementation ways for those new and improved guidelines will be discussed as well. The researcher proposed implementation ways for usability guidelines for mobile learning by studying each guideline in details, this help the researcher in investigating on how to implement it which will help the developers to have clear view of implementing each guideline. In addition, the research will propose mapping each guideline into the mobile learning usability attributes. The propose mapping is performed by categorizing each proposed guideline into the suitable mobile learning usability attributes to ensure the proposed guidelines covers the usability issues of mobile learning application. Below here are detailed descriptions of each proposed guideline, discussion/ justification, and the ways to implement each proposed guidelines and mapping each proposed guideline into the usability attributes of the mobile learning.

Guideline 1:
Tile: Understanding level of leaner.
Description: One of the most important factors in meeting the user's requirement is to understand who they are and what they want. Therefore, before developing any mobile learning application, the development team has to study the level of the learner who is going to use it. This is because, the leaner will not face problem when he/she interacts with it and this will provide following benefit of enhancing the readability of the system contents, because of selecting the convenient language that can be used to interact with the level of the leaner.
Discussion/justification: It combines the two essential factors of mobile learning application[14]. First factor is the type of the leaner, skills and background factor. Second factor is match between the mobile learning system and the real word factor which concern on the enhancing the readability of the application.
Mapping to M-learning usability attribute: Adjustability attribute, since it helps to provide a learning platform which will be acceptable to user by making the content of the application same with level of the leaner which will lead to enhance the readability of the applications content.
Implementation Ways:
- By investigating who will be using the application

during the planning phase of the application development phases. Therefore, they can set with intended user s and understand their level in order to make the user satisfied with produced application in term of language level that will be used to display the content:

- Examining the users' characteristics, such as age, nationality (languages used), users' degree of familiarity with mobile devices, and special needs or physical disabilities.

Guideline 2:

Tile: Avoiding much content in one page.

Description: One of the most important issues in the mobile usability is small screen of the mobile devices, thus this load to the problem of displaying and organizing the information on the small screen.

Discussion/justification: This guideline combines the two essential usability factors of mobile learning application[20]. The first factor is the small screen size display and another factor is named as do not overuse the content. The concept of these two factors has been embedded in this above guideline.

Mapping to M-learning usability attribute: adjustability attributes, since this guideline helps the application to handle the quality of the content that will be present in the application platform.

Implementation Ways:

- When the developers need to develop mobile learning, he/she should do the following: Include and display the relevant and important information and remove the low priority information.
- If the page contains long information, then it should be divided into subpages to allow the leaner to have clear view of the information, so this will lead to eliminate the scrolling especially the horizontal scrolling which is not good option for mobile learning application.

Guideline 3:

Tile: Design convenient navigation system.

Description: Designing suitable navigation system for the mobile learning application seems to be one of the important factors that lead the learning application to be useable. As result, the selecting of an appropriate navigation system decides the success and the failure of the learning application's usability.

Discussion/justification: This guideline adds new value to the existing usability guidelines of mobile learning application by extending the navigation term. This is

because, the existing usability guidelines of mobile learning application discussed the navigation in term of having constant navigation system such as using a regular navigation system but they did not discuss or figure out which navigation elements that is suitable to mobile application such as attempting to avoid the scrolling especially horizontal scrolling and using a flat hierarchy structure with fewer step is preferred. Therefore, there is a need to extend the navigation term which will lead to provide clear idea of having good navigation system for mobile learning application.

Mapping to M-learning usability attribute: funability attribute, since this guideline assists in producing navigation system that will easy the usage of the application and make the user pleased with the application.

Implementation Ways: the developer should do the following:

- The navigation system should be same as the regular navigation system of the desktop application such as provide back option and exit option, so the learner will not get confused when he/she uses the application via his/her mobile devices.
- Providing the selecting option rather than asking the learner to input the data.
- Attempt to avoid the scrolling especially horizontal scrolling and using a flat hierarchy structure with fewer step is preferred.

Guideline 4:

Tile: Utilize the advantage of the feature that are provided by mobile devices.

Description: Using the available features in mobile device to enhance the application 's performance, this will lead to making the leaner satisfy with mobile's features that are used to perform the activities of the application.

Discussion/justification: this guideline is new guidelines to the mobile learning usability guidelines. It is not declared on the existing mobile learning usability guidelines. It is embedded from Web credible usability guidelines for websites[20]. It is significant to be added, since, it encourages the developers to use new available features of mobile devices to enhance the usability of mobile earning application.

Mapping to M-learning usability attribute: satisfaction attribute, since it makes the leaner satisfy with mobile's features that are used to perform the activities of the application.

Adjustability attribute: can be also mapped to

Adjustability attribute, since it is providing the user new way of the interaction style like sound interaction with the application.

Implementation Ways: The mobile learning application should use some features of the mobile devices to make the learner performs the task or the functions of the application in an easy way such as:

- Input the information or allowing the application to receive the instruction from the learner using the sound technology.
- Viewing the address using the map of mobile devices.

Guideline 5:

Tile: Consistency

Description: The consistency should be provided with mobile learning application to enable the learner to interact with application efficiently without any confusion.

Discussion/justification: it refers to the consistency usability factor which seems to be one of the important factors in usability guidelines of mobile learning application[20,21].

Mapping to M-learning usability attribute: funability attribute. This is because, it is providing clear sequence of performing the activities of the application, so this will reduce the possibilities of uncertainty.

Satisfaction attribute: also can be mapped Satisfaction attribute, since it enables to achieving the leaner's satisfaction via providing consistent design layout across different types of mobile devices platform.

Implementation Ways: The consistency should be provided with mobile learning application in different form such as

- There must be clear sequence of performing certain function using the mobile learning application such as the provided function should have start and end scenario and the learner should be informed with suitable manner of the starting and finishing function that he /she performs. Therefore, this will enhance the usability of the application.
- Provide consistent design layout (label names, colors and the appearance) across the various mobile devices and platforms.

Guideline 6:

Tile: Providing freedom to the learner for controlling the application.

Description: this guideline provides steps of how to let the learner feels that he/she can control the application.

Discussion/justification: this above guideline is derived from one factor namely as leaner control and freedom. It discusses the ways of making the mobile learning application to be controlled by users (learner).

Mapping to M-learning usability attribute: satisfaction attribute: since it leads to producing an application that make the leaner to feel that he/she control it by starting the action instead of required the leaner to reply to the action, this will enhance the satisfactions of the leaner.

Implementation Ways: By given the leaner the functions that allow him/her to control the application as much as possible such as:

- By prompting him/her to start the action rather than required him to reply to the action
- The leaner can exit and enter the application at any time even if he/she made mistakes.
- The application should support the facilities for Undo and Redo which allow the leaner to have control their work in the application.

Guideline 7:

Tile: Preventing and handling error.

Description: Design the system such that users cannot make a serious error and if users make an error, the application should detect the error without changing its state, and offer simple, constructive, and specific instructions for recover.

Discussion/justification: this guideline provides ways of producing a learning mobile application that is free from an error and the ability to handle the error if it is happened, so this will enhance the system visibility and the acceptability.

Mapping to M-learning usability attribute: reliability attribute, since this guideline provides steps that have to be followed to avoid the application to perform in unexpected ways.

Implementation Ways there are no general rules how errors can be prevented, there are some typical "patterns" which may help you to find new solutions. Below we provide ideas and steps. Not all of these steps prevent errors, but they help to reduce the possibility of errors, which is a step in the right direction. These steps are as following:

- Prevent wrong or invalid inputs: Prevent users from entering letters or other invalid characters by parsing the input string. Also, in case of date and time fields, the application should provide "intelligent" date and time fields that are preformatted, or provide selection

controls instead of input fields (dropdown lists, spin buttons, calendar controls). While with Currency fields, it should use preformatted fields for the different units.

- Prevent incomplete inputs by indicating the required fields (e.g. through a red asterisk * and an explanatory text).
- Prevent invalid actions by disabling pushbuttons that cannot be used in the current context and by do not offer functionality that is not needed (reduces complexity).
- Prevent disastrous actions: if actions can have severe consequences for the user, add explanatory texts to the respective buttons and inform the users about the consequences and if users might lose data display confirmation dialogs.
- Use the correct Screen elements: do not use screen's elements that may lead to false user expectations. Example: Do not use tab strips for views that depend on each other and cannot be viewed at random and do not use checkboxes for single-selections.
- Follow the usual flow of control: typically, the flow of control on a screen goes from left to right and from top to bottom. If this direction is changed arbitrarily, users may be puzzled and, for example, overlook the consequences of their actions, or not know how and where to proceed.

Guideline 8:
Tile: Design application to be suitable with variety type of mobile screen.
Description: this guideline helps to produce application that can be used with various types of mobile screen (touch screen and non-touchscreen of mobile devices).
Discussion/justification: This guideline adds new value to the existing mobile learning usability guidelines. It is not discussed or included in the existing mobile learning usability guidelines. Since, it is important to produce learning application that can be used with touch screen and non-touch screen of mobile devices, so this will help the interaction between the leaner and the application as well as it will enhance the usability of the application.
Mapping to M-learning usability attribute: Adjustability attribute, since this guideline enable to producing design that can be used with touch screen and non-touch screen of mobile devices, so this will help the interaction between the leaner and the application.
Implementation Ways: it is important to that your design

is easy for both touch screen and non-touch screen users, thus, the developer team should follow these steps:

- The most common difficulty with viewing the mobile learning application on a smart phone is in selecting, particularly tapping, small text links accurately. Fingers tend to be too thick to hit a small link accurately, and if there are 2 or more links close together then it's easy to accidentally tap the wrong one.
- Links should be avoided for any important calls to action (it's less of an issue to use them for footer links). Instead, design calls to action that take up more screen space and which can be tapped easily. For example, use thick rows than span the width of the screen or square boxes can both of which can be tapped easily.

Guideline 9:
Tile: Reduce the short-term memory load.
Description: Previous studies shows that humans brain can store only seven pieces of information in their short term memory[20]. Therefore, the developers should design an application that reduce the short memory load when the user perform the functions of the application.
Discussion/justification: This guideline does not cover by any existing mobile leaning usability guidelines. However, it is useful to add it to the existing mobile leaning usability guidelines; this is because it concerns to reduce the short memory load, so this will enhance the usability of mobile learning application usability of the application.
Mapping to M-learning usability attribute: Adjustability attribute, since this guideline enables to producing design that can be used with touch screen and non-touch screen of mobile devices, so this will help the interaction between the leaner and the application.
Implementation Ways: The developer can reduce short term memory load by:

- Designing screens where options are clearly visible, or using pull-down menus and icons
- Response times must be fast enough between 0.1 seconds to 10 seconds that users don't forget what they're in the middle of doing while waiting for the next page to load.
- Don't make the user memorize workflows; instead make them obvious.
- In task driven processes, keep all relevant information visible or easily accessible.

6. Evaluation and Result

Expert usability review method was used as evaluation method to evaluate the proposed usability guidelines for mobile learning application. The researcher used quantitative approach for the data collection purpose.

Expert usability review document contains the evaluation questions about proposed improvement of usability guidelines, proposed mapping each guideline to the convenient usability mobile learning attributes, and proposed implementation ways for each guideline for mobile learning application.

In addition, it was distributed to 15 experts of mobile learning application and developers who have good experience in developing mobile learning application via hard copy and soft copy using the Google doc online service which helps the researcher to get responds from variety experts that are from different countries around the world with huge experience in the mobile learning application domain.

The first section of the questionnaire was aimed to identify expert's experience with developing mobile learning application and to know the mobile application platform that experts have work or knowledge with it. The Figure 1 represents years of experience of respondents. Based on the Figure 1 which shows amount of the years' experience of the participated experts with mobile learning application, we could firmly that over of 85% of the experts have at least 3 years' experience of developing or working in mobile learning application domain. This indicate that the respondents were qualified to judge the proposed improvement of usability guidelines, proposed mapping the guidelines with mobile usability attribute, and ways to implement each proposed guideline for mobile learning application.
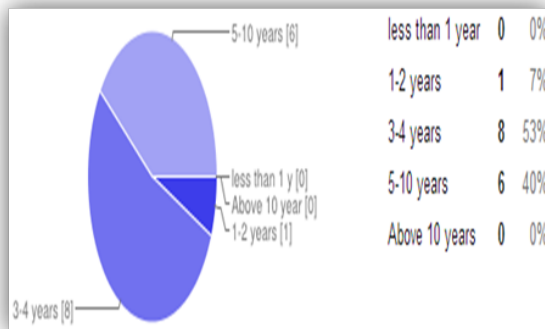

Figure 1. Experience rate of the participated experts.

However, the Figure 2 present the mobile application platforms that participated experts have work or familiar with.
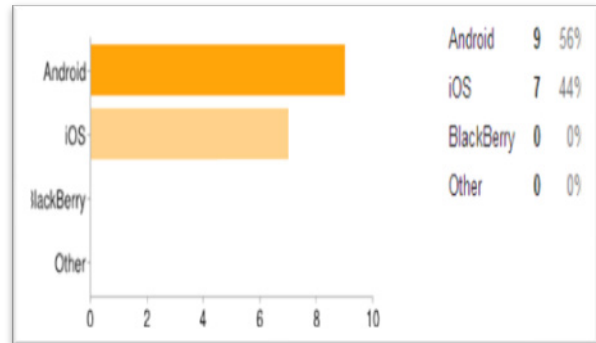

Figure 2. Familiar mobile application platform with participated experts.

As shown on the Figure 2 that most of the 15 participated experts have experience work with or familiar with the android mobile platform, since 9 of experts have chosen android platform, and followed by the 7 of the experts have selected the iOS platform as mobile application platform which they have work with or most familiar with.

Second section of the Expert usability review document was introduced to evaluate the proposed improvement of the usability guidelines and ways to implement the proposed guidelines for mobile learning application. The participated experts evaluated the proposed improvement of the usability guidelines and ways to implement the proposed guidelines for mobile learning application by rating each proposed improvement of usability guidelines for mobile learning based on their valuable knowledge of the mobile learning application.

Based on the expert's opinion about the proposed improvement of usability guidelines for mobile learning application, the researcher calculated the mean for each proposed guideline with its ways of implementing, and mapping guidelines with MLUA by rating the expert opinion as following:

- Strongly disagree rated to 1 point.
- Disagree rated to 2 points.
- Undecided rated to 3 points.
- Agree rated to 4 points.
- Strongly agree to 5 points.

The mean value should be between 1 to 5, since the provided rates during the evaluation were among 1 to 5

as shown above. However, the mean value was calculated using the below formula:

$$M = \sum(RP_i * \sum ER_i) / N$$
where,

i= is the rate

RP is the Rating Point

ER is the number of the experts who select the rate

N: is the total number of the expert who participated in the evaluation process which is 15 experts.

As shown in the above formula that the mean was calculated by multiplying the rate point with the sum of experts' number who select that rate, then sum the result of that multiplying and divided the sum by 15 which presents the number of all participated experts.

The evaluation's result of each proposed guidelines is shown in the Table 1, the guideline 1 has the highest mean (4.8) among the other guidelines, since it seems to be the most essential guideline. This because, guideline 1 allows the developers to identify the level of the applications' learners which will lead to understand and meet the learners' requirements. The guideline 8 and guideline 9 are new to mobile learning application guidelines domain, since the researcher added these two guidelines from another domain of mobile application to cover the usability issues that are covered by the existing study as explained in the chapter 4. Even thought, these two guidelines are new to application guidelines domain, but they still have reasonable means that are closely to 4 which indicate the acceptable of introducing these guidelines to application guidelines domain.

Table 1. Mean of each proposed guidelines

Proposed Guidelines	Mean over 5
Guideline 1	4.8
Guideline 2	4.5
Guideline 3	4.3
Guideline 4	4.2
Guideline 5	4.2
Guideline 6	4.0
Guideline 7	4.3
Guideline 8	4.4
Guideline 9	4.1

In addition, the Table 2 illustrates evaluation's result of the proposed mapping each guideline with Mobile Learning Usability Attributes (MLUA). The result of calculating the mean for each purposed mapping is reasonable and acceptable since the most of them are closely to 4 point over 5. Also, the proposed mapping for guideline 8 has the highest mean with value of 4.4 among another proposed mapping. This is because experts' rates for this mapping were high.

Table 2. Mean of each proposed mapping guidelines with MLUA

Proposed mapping the guidelines with MLUA	Mean over 5
Mapping guideline 1 with adjustability MLUA	4.1
Mapping guideline 2 with adjustability MLUA	3.9
Mapping guideline 3 with funability MLUA	4.3
Mapping guideline 4 with satisfaction and adjustability MLUA	4.0
Mapping guideline 5 with satisfaction and funability MLUA	4.3
Mapping guideline 6 with satisfaction MLUA	4.1
Mapping guideline 7 with reliability MLUA	4.0
Mapping guideline 8 with adjustability MLUA	4.4
Mapping guideline 9 with funability MLUA	4.1

Not only that, but also Table 3 illustrates the mean of the evaluation's result for proposed ways to implement each proposed guideline. The mean was derived based on the expert's rating for each proposed over five rates. The results of calculate mean for each proposed ways of implementing proposed guidelines considered to be acceptable since the most of their mean are closely to 4 over 5.
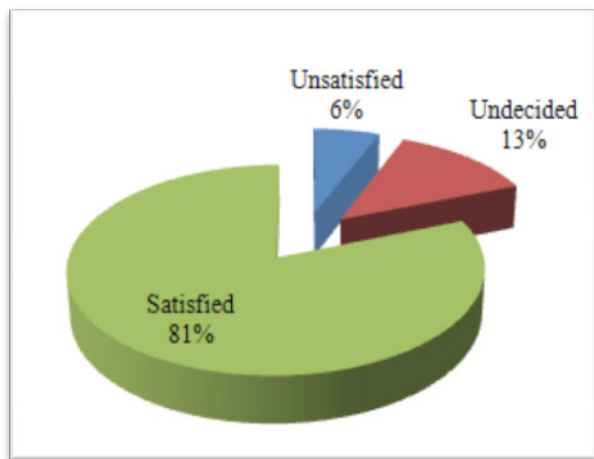
Table 3. Mean of proposed Implementation ways of each proposed guideline

Proposed implementation ways of each proposed guideline	Mean over 5
Implementation way of guideline 1	4.3
Implementation way of guideline 2	4.2
Implementation way of guideline 3	4.1
Implementation way of guideline 4	4.2
Implementation way of guideline 5	4.0
Implementation way of guideline 6	4.1
Implementation way of guideline 7	3.9
Implementation way of guideline 8	4.0
Implementation way of guideline 9	3.8

However, the Figure 3 presents the overall average

percentage of the 15 experts' opinion who participated to evaluate the proposed improvement of the usability guidelines based on MLUA and proposed ways to implement each guideline for MLUA.

Figure 3. Overall average percentage of the participated experts' opinions.

The above pie chart shows the overall percentage of the experts' opinion who participated on evaluation phase. It shows that 81% of the experts' opinions are agreed with the proposed improvement of the usability guidelines based on MLUA and proposed ways to implement each guideline for MLUA. Followed by 11% of the experts' opinion are undecided and only 7% of the experts' opinion are disagree the proposed improvement of the usability.

7. Constraints and Challenges of this Research

The researcher has faced avoidable challenges and constraint along the progress of this research, but at the meantime, these challenges and constraints have not been as barrier for the researcher to reach the objectives of this research, below here is example of the challenges and constraints were faced:

- The researcher has faced obstacle of getting references or previous studies in usability guidelines of mobile learning application domain. Since they are not a lot of previous researches have conducted in this domain.
- The researcher has been faced one of the major obstacle which is getting respondents who have an

excellent experience in mobile learning application domain. It was problem of getting right professional respondents (evaluators) to evaluate the proposed improvements of usability guidelines for mobile learning application. This is because; the research has been spent a lot of time to search for respondents who have an acceptable experience with mobile learning application.

8. Conclusion and Future Enhancement

The present study, however, makes several noteworthy contributions to mobile learning usability guidelines by proposingnew improvements based on the previous identified issues with usability mobile learning. These improvements are included by proposing new usability guidelines along with implementation ways of each proposed guideline. Also, these proposed guidelines have mapped to the mobile learning usability attributes in order to ensure that the proposed guidelines cover the usability issues of mobile learning application. Moreover, the proposed improvements have been evaluated using expert usability review method. The evaluation results reveal that 81 % of the experts' opinions were satisfied with the proposed improvements be used for developing mobile learning application with meeting usability standards efficiently. However, the researcher notices there are some good potential that can be developed based on this research, so the researcher wants to highlight the areas which can be enhanced to further study this research. Below here are some of the areas that need enhancement:

- Getting responses from more number of professional respondents who have an excellent experience in usability guidelines of mobile learning application domain.
- The possibility of adding new convenient guideline with its implementation ways which can handle new issues that might be appeared in the future because of certain reason such as having new style mobile devices.

9. References

1. Lee DH, Shon JG, Kim K. Design and implementation of OSMD based learning management system for mobile

learning. Indian Journal of Science and Technology. 2015 Jan; 8(S1). DOI: 10.17485/ijst/2015/v8iS1/57891.

2. Rehiman KAR, Veni S. A secure authentication infrastructure for IoT enabled smart mobile devices – An initial prototype. Indian Journal of Science and Technology. 2016 Mar; 9(9). DOI: 10.17485/ijst/2016/v9i9/86791.

3. Cho J, Kang H, Kim S. A mobile application development tool based on object relational mapping solution. Indian Journal of Science and Technology. 2015 Aug; 8(18). DOI: 10.17485/ijst/2015/v8i18/75937.

4. Denk M ,Weber M, Belfin R. Mobile learning challenges and potentials. International Journal of Mobile Learning and Organization. 2007; 1(2):122–39.

5. Khaddagef, Lanham E, Zhou W. A mobile learning model for universities - Re-blending the current learning environment. International Journal of Interactive Mobile Technologies. 2009; 3:18–23.

6. Fetaji M, Fetaji B. Universities go mobile – Case study experiment in using mobile devices. Proceedings of 30th International Conference on ITI (Cavtat); 2008. p. 123–8.

7. Maguire M, Bevan B, Jokela J. ISO/IEC, human-centred design processes for interactive systems. International Organization for Standardization (Gineve,Switzerland): ISO/IEC 13407. 1999; 55(4):587–634.

8. Zhang D, Adipat B. Challenges, methodologies, and issues in the usability testing of mobile applications. International Journal of Human-Computer Interaction. 2005;18(3):293–308.

9. Treeratanapon T. Design of the usability measurement framework for mobile applications. International Conference on Computer and Information Technology ICCIT', Bangkok; 2012. p. 71–5.

10. Hujainah, Fadhl, Dahlan H, and Al-haimi B. Usability guidelines of mobile learning application. Journal of Information Systems Research and Innovation. 2013; 5(2):70–7.

11. Deegan R, Rothwell P. A classification of m-learning applications from a usability perspective. Journal of the Research Center for Educational Technology RCET. 2010; 6(1):16–27.

12. Mostakhdemin-Hosseini. A usability considerations of mobile learning applications. International Journal of Interactive Mobile Technologies. 2009; 3(1):29–31.

13. Mostakhdemin-Hosseini A, Mustajärvi J. Framework for mobile learning system based on education component. Proceedings of the International Conference on Theory and Applications of Mathematics and Informatics – ICTAMI, Alba Iulia; 2003. p. 191–6.

14. Fetaji1 M, Fetaji B. Devising m-learning usability framework. Proceedings of the International Conference on Information Technology Interfaces, Cavtat: Croati; 2011. p. 275–80.

15. Shneiderman B. Designing the user interface. Addison Wesley Longman, 3th edition; 1998.

16. Alfredo JS, Oleg S, Aguilar EC, Marisol M. Generation of usable interfaces for mobile devices. 05' Proceedings of the Latin American Conference on Human-computer Interaction, Cuernavaca: Mexico; 2005. p. 348.

17. Nielsen N. 10 usability heuristics for user interface design. Nielsen Norman Group, USA; 1995. p. 413–14.

18. Dumas JS, Redish JC. A practical guide to usability testing. Revised edition, Pearson Education Limited; 1999. p. 55–62.

19. Norman D. The design of everyday things, New York, NY: Doubleday; 1988.

20. Seong DSK, Broga J. Usability guidelines for designing mobile learning portals. The 3rd Conference on Mobile Technology, Applications and Systems—Mobility, Thailand; 2006. p. 1–8.

21. Quesenbery Q, Whitney W. Choosing the right usability technique: Getting the answers you need. A workshop for User Friendly Shenzhen, China User Friendly, China; 2008. p. 1–32.

22. Quesenbery Q, Whitney W, Jarrett C. Conducting a user-centered expert review. STC Proceedings UK; 2007. p. 1–19.