Development of A Preliminary Usability Guidelines of Mobile Game Applications for Children: From the User Interface Perspectives

Amalina Farhi Ahmad Fadzlah*, Mohd Afizi Mohd Shukran, Norshahariah Wahab, Muhamad Lazim Talib, Suresh Thanakodi

Department of Computer Science, Faculty of Science and Defence Technology, National Defence University of Malaysia, 57000 Wilayah Persekutuan Kuala Lumpur, Malaysia.

* Corresponding author. Tel.: +60389213400; email: amalina.farhi@upnm.edu.my
Manuscript submitted March 11, 2020; accepted June 15, 2020.
doi: 10.17706/jsw.15.5.123-129

Abstract: Usability guidelines is an important factor in designing and developing of successful user interfaces, and also the most widely used principle in the field of software engineering that defines the application's demand and usage. Due to this reason, there are strong demands to conduct a study that focuses in developing new usability guidelines to design user interfaces of mobile game applications for children. Therefore, this study aimed at exploring the usability guidelines and investigating the importance of these guidelines in designing the user interfaces for mobile game application to be used among 1 to 3 years old children. As a result, a total number of 87 guidelines in which categorized into 17 usability characteristics were found highly associated in designing usable user interfaces for mobile game applications for these categories of users. This research effort has been in a position to derive a preliminary specification and scheme specifically for designing usable interfaces as well as developing mobile game applications from the perspective of children aged 1 to 3 years old.

Key words: Usability, mobile game applications, user interface, children.

1. Introduction

According to the 21st century learning method that has been implemented in almost every country is more towards the "Technology in the Classroom" [1]. As ideas were discussed, some mobile applications for children that focus on the combination of both entertainment and educational purposes were then created [2]. After surveys end with a conclusion that states the unlimited benefits of mobile applications that highlight both entertainment and educational purposes, higher demand of these kinds of mobile applications were received, especially the ones that focuses on younger children [3]. Regarding the high demand, software companies tend to greed on launching this type of mobile applications without following the usability guidelines that were supposed to be followed upon developing one. As a result, some companies will find themselves drowning into failure because of the unfitting and dull mobile applications that have been designated [4]. Therefore, the usability guidelines of mobile game applications exclusively for children need to be developed in order to succeed higher in the future.

2. Theoretical Background

The increase in the number of young mobile users has led to the significant importance, and relevance to design and developed mobile games applications that cater for children as well. There are also several works done on developing guidelines for designing user interfaces of mobile game applications for children [5]-[7]. These guidelines focus on designing game for interaction paradigms suitable for rehabilitation therapy, entertainment and cognitive, interface design and visual adaptability However, none of the researchers concentrated on developing guidelines to design user interfaces exclusively for children aged 1 to 3 years old. Due to this reason, there are strong demands to conduct a study that focuses in developing new usability guidelines to design user interfaces of mobile game applications for children aged 1 to 3 years old. The usability guidelines proposed were not only to help researchers understand the current state of designing usable user interfaces of mobile game applications but also to be considered while developing mobile game applications from the very beginning by the developers.

3. Usability Guidelines

A number of 40 students from Human Computer Interactions class who have basic information and experience about usability, user interfaces and mobile applications were involved in this study. In order to develop the guidelines, this study was designed to follow 3 main procedures: collection of usability characteristics, design of mobile game user interfaces, and development of usability guidelines.

3.1. Collecting Usability Characteristics

Each of the students were given a task to gather information regarding the general usability characteristics of mobile game applications considering specifically to the user interface design. These students were asked to observe numbers of mobile game applications especially on the design of the user interfaces and further directed to study and list down the usability characteristics of these user interfaces design in detail. As a result, a total number of 88 usability characteristics were then gathered to further develop the usability guidelines to design the user interface of mobile game applications for children.

3.2. Designing Mobile Game User Interfaces

Again, these students were asked to observe numbers of mobile game applications and its user interface designs. However, they are required to focus only on the design of the user interfaces of mobile game applications for children aged 1 to 3 years old. These students were randomly distributed into two main groups: educational group; and entertainment group. Later on, students in each group were directed to work in pairs and thus a number of 10 groups were equally performed for entertainment and another 10 groups for educational purposes.

3.3. Developing Usability Guidelines

Students were randomly reformed by combining 2 groups into 1 group in which consisting of both the educational and entertainment groups that made up in total of 10 main groups. Each group were given 10 video presentations that represent the real mobile game applications developed previously in which consisted of 5 video presentations on educational purposes and 5 on entertainment purposes. They were then asked to observe each of the simulated mobile game applications given and further instructed to study the detail design of its user interfaces specifically focusing on the perspective of usability.

4. Experimental Design

A number of participants with knowledge and experience in usability, user interfaces and mobile applications were selected in experimenting the usability of mobile game user interfaces design for children aged 1 to 3 years old. All participants were randomly distributed into two experimental groups:

BuBuChak group where participants need to manipulate entertainment tasks; and ReadAloud group where participants need to manipulate educational tasks. Both groups followed the same procedures: between-subjects experimental design in which each participant is tested under one condition only, one group of participant is tested under BuBuChak game and another group is tested under ReadAloud game.

The procedures were designed to fit into a single 1-hour for each session and the experiment was conducted in a private computer laboratory while participants were attending classes. Participants were first given an open ended survey question to measure their prior experience on mobile applications as well as their knowledge on usability and user interface design. Then, participants were asked to complete their task before completing a background questionnaire to collect their demographic information. Finally, a self-reported subjective data was collected using 5-point Likert scales (i.e. strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree) on the usability of user interface design.

4.1. Study 1: BuBuChak Game

An entertainment based mobile game application which is known by the name BuBuChak, was designed and developed to give pleasure to the children aged 1 – 3 years old who are actively involved in game activities. This BuBuChak game is designated to test children's motor skills by directing them to strike the moles that happen to appear above the holes in each level. There are three objectives in the development of BuBuChak game: 1) to design user interfaces for children for entertainment purposes, 2) to embed multimedia elements by compiling a variety of artistic or communicative media such as texts, audio, animation, video and graphic, and 3) to develop a mobile game application for children aged 1 to 3 years based on Android platform.

Tasks. Participants were firstly asked to launch the BuBuChak game by clicking on the start icon displayed on the main page. A number of holes were shown and participants were asked to wait until a mole that appear above the holes were shown. Participants need to strike the moles as many as possible in a given time. After completing the task on the first level, participants were directed to play on level 2 until level 5. As the level increases, the holes will be increased too, which also lead to the increasing of the number of moles that will appear per game and gradually increases in speed, with each mole spending less time being above the hole. As the level rises, the difficulty of game rises as well. After successfully completing all the five levels, participants were asked to repeat the cycles into another four trials that made a total of 5 trials in experimenting the design of BuBuCak user interfaces.

Subjects. Overall, a total number of 13 subjects participated in the study of participants with 11 females and 2 males. Out of all participants, 2 were found as advanced mobile users, 9 expert mobile users, and 2 intermediate mobile users, while none of them were categorized under novice mobile users. Level of usability knowledge were also measured in which all of them were declared as highly knowledgeable in usability and experienced in designing user interfaces with more than 5 years. All participants in this study were regular mobile game users in which none of them have experience working with the BuBuChak game.

4.2. Study 2: ReadAloud Game

ReadAloud is an educational mobile game application developed to make learning fun and designed to assist in learning a skill as they play. This game was designed for this category of children aged 1 – 3 years old to learn and trace both of the capital letters and small letters.

Tasks. Participants on the evaluation tasks, were firstly asked to launch the ReadAloud game by clicking on the start icon displayed on the main page. A main page of a list of alphabets is shown and participants have to choose the letter that they want to learn followed by an audio stating the chosen letter. Participants were asked to write the letters however, before the players write the letters on their own, there will be a guide on how to write the letters in the correct way. Participants were then asked to use a finger to write

the letter by connecting the dots that were displayed in the letter twice. The dots in the first round will be more than the dots in the second round. After successfully completing the tracing tasks, participants were directed automatically to the main page and again participants have to choose the letter that they want to learn. All participants were asked to repeat the cycles into another four trials that made a total of 5 trials in experimenting the design of ReadAloud user interfaces.

Subjects. Overall, a total number of 13 subjects participated in the study with the majority of participants were women with 10 females and 3 males where 1 participant was found as advanced mobile users, 6 expert mobile users, and 6 intermediate mobile users, while none of them were categorized under novice mobile users. A number of 9 participants stated with high knowledge in usability whereas the remaining 4 participants stated having average knowledge on usability. All participants declared that they have more than 5 years experiencing in designing user interfaces. Participants in this study were all regular mobile game users in which none of them have experience working with the ReadAloud game.

5. Results and Findings

A number of 87 measured usability guidelines involved in this study were categorized based on the 17 distinct usability characteristics. Results from the experiment showed that the score of usability guidelines "Interactive animation must be used" (*M*=4.62, *SD*=0.77), "Contents preferably in animations" (*M*=4.31, *SD*=0.85), "Simple and interesting interface must be used" (*M*=4.46, *SD*=0.88), "Clear and consistent layout must be used" (M=4.62, SD=0.77), "Layout should be properly organized" (*M*=4.54, *SD*=0.66), were slightly higher with BuBuChak experimental group if compared to participants dealing with ReadAloud game. In addition, usability guidelines of "Appropriate background images should be used" (*M*=4.62, *SD*=0.77), "High quality images should be used" (*M*=4.46, *SD*=0.78), "Bright and clear images should be used" (M=4.62, *SD*=0.77), "Images used must be creative" (M=4.77, SD=0.44), "Images used must be in appropriate sizes" (*M*=4.54, *SD*=0.66), and "Images used must match with children skills" (*M*=4.62, *SD*=0.77) were also found slightly higher with BuBuChak experimental group if compared to participants dealing with ReadAloud game whilst only one guideline of "Images should be abundant than words in contents" (*M*=5.00, *SD*=0.00), were remain the same score.

Furthermore, usability guidelines of "Icon should be large enough to be seen" (M=4.69, SD=0.63), "Icon used must be attractive and motivating" (*M*=4.46, *SD*=0.78), "Sounds used must be clear and appropriate" (*M*=4.92, *SD*=0.28), "Errors should be identified by using sound effects" (*M*=4.62, *SD*=0.65), "Appropriate sound effects must be used" (M=5.00, SD=0.00), "Motivating sound should be played for lost game" (*M*=4.54, *SD*=0.52), "Sounds and volume should be suitable" (*M*=4.46, *SD*=0.78), and "Sound effects should be played throughout the game" (*M*=4.54, *SD*=0.66) were found slightly higher with BuBuChak experimental group. All usability guidelines "Suitable fonts must be used" (*M*=4.38, *SD*=0.65), "Fonts with suitable colors should be used" (*M*=4.92, *SD*=0.28), and "Spacing and text size should be readable" (*M*=4.62, *SD*=0.65), in the Text usability category were also found slightly higher with BuBuChak experimental group.

As can be observed, the score of usability guidelines of "Adaptable user interface must be used" (*M*=4.23, SD=0.73), "Icon should be simple and understandable" (*M*=5.00, *SD*=0.00), "Clickable icon should be designed in 3D" (*M*=4.46, *SD*=0.66), and "Tutorials should be prepared by using audios" (*M*=4.54, *SD*=0.66) were slightly higher by participants working on ReadAloud game in the educational task if compared to BuBuChak entertainment group. Usabiliy guidelines of "Sufficient help buttons must be provided" (*M*=4.77, *SD*=0.44), "Save buttons must be provided" (*M*=4.54, *SD*=0.78), "Reset button must be displayed" (*M*=3.92, *SD*=0.95), "Setting buttons should be designed" (M=4.23, SD=0.83), "Pause and resume buttons should be visible" (*M*=4.00, *SD*=0.91), "Buttons should be clearly seen" (*M*=4.38, *SD*=0.87), and "Search button must be seen" (*M*=4.85, *SD*=0.38) in the Button usability category were also found slightly higher with ReadAloud

experimental group whilst only two usability guidelines of "Visible navigation buttons should be displayed" (*M*=4.15, *SD*=0.90), and "Buttons should be simple and understandable" (*M*=4.46, *SD*=0.78) were remain the same score.

Further, all usability guidelines "Bright and cheerful colors must be used" (*M*=4.54, *SD*=0.78), "Colorful user interface design should be designed" (*M*=4.23, *SD*=0.83), "Errors should be highlighted with colors" (*M*=4.15, *SD*=0.80), "Dull colors should be replaced with cheerful colors" (*M*=4.46, *SD*=0.78), and "Color used should be contrasted with the background" (*M*=4.77, *SD*=0.44) in the Color usability category were found lower with ReadAloud experimental group however only one usability guideline of "Appropriate background colors should be used" (*M*=4.46, *SD*=0.78) remain the same score. Further, all usability guidelines "Contents should be arranged in the correct sequence" (*M*=4.77, *SD*=0.44), "Contents should be related to the information given" (*M*=4.62, SD=0.65), "Contents used must be appropriate with age" (*M*=4.92, *SD*=0.28), "Contents should be in animations" (*M*=4.31, *SD*=0.85), and "Contents of gameplay should be educational" (*M*=4.23, *SD*=0.73) in the Content usability category were found lower with ReadAloud experimental group whilst only two usability guideline of "Contents used should not be copyrighted" (*M*=4.23, *SD*=0.93), and "Contents should not be explicit" (*M*=4.62, *SD*=0.77) remain the same score.

Again, results from the experiment showed that the score of usability guidelines of "Responding time for tasks should be appropriate" (*M*=4.62, *SD*=0.51), "Design should be child-friendly" (*M*=4.85, *SD*=0.38), "Child-friendly theme should be picked" (*M*=4.85, *SD*=0.38), "Control buttons should be child-friendly" (*M*=4.85, *SD*=0.38), and "User guide should be displayed before the game starts" (*M*=4.08, *SD*=0.86) were slightly higher with BuBuChak experimental group if compared to participants dealing with ReadAloud game. In addition, usability guidelines of "Language used must be understandable" (*M*=4.54, *SD*=0.78), "Language used should not be explicit" (*M*=4.62, *SD*=0.77), "Loading time should be shorter" (M=4.38, *SD*=0.77), "Main menu must be accessible to all" (*M*=4.31, *SD*=0.85), "Gameplay should be easily accessible" (*M*=4.38, *SD*=0.51), "Functionality must be accessible" (*M*=4.38, *SD*=0.65), and "Advertisements should be avoided" (*M*=4.00, *SD*=0.82) were also found slightly higher with BuBuChak experimental group if compared to participants dealing with ReadAloud game.

Usability guidelines of "Parental guide must be displayed" (*M*=4.38, *SD*=0.77), "Tutorials on how to play the game should be provided" (*M*=3.92, *SD*=0.86), "Violent concepts should not be included" (*M*=4.46, *SD*=0.88), "Difficulty of game must differ in every levels" (*M*=5.00, *SD*=0.00), "Gameplay should be interesting" (*M*=4.69, *SD*=0.63), "Gameplay should be understandable for children" (*M*=4.46, *SD*=0.78), "Gameplay must be attractive and creative" (*M*=4.46, *SD*=0.88) were found lower with BuBuChak experimental group whilst usability guidelines of "Clues and hints to solve problems should be prepared" (*M*=5.00, *SD*=0.00), "Language should be in multiple languages" (*M*=4.23, *SD*=0.83), "Respond to touch screen must be fast" (*M*=4.46, *SD*=0.78), "Auto save system should be designated" (*M*=4.46, *SD*=0.78), "Advertisements should be related to the gameplay" (M=4.69, SD=0.63), "Reduce the appearance of pop-ups" (*M*=4.92, *SD*=0.28), and "Avoid in-app purchase advertisements" (*M*=5.00, *SD*=0.00) were found lower with BuBuChak experimental group. Meanwhile, usability guidelines of "Help service section should be provided" (*M*=4.31, *SD*=0.75), "Permission box should be displayed" (*M*=4.92, *SD*=0.28), "Reconfirmation box should be presented" (*M*=4.23, *SD*=0.73), "Permission to allow profile accessibility" (*M*=4.85, *SD*=0.38), "Time management must be allocated by parents" (*M*=4.69, *SD*=0.63), and "Link clicked must be directed to the accurate page" (*M*=4.92, *SD*=0.28) were also found lower with BuBuChak experimental group compared to ReadAloud group.

However, no comparisons between groups can be made regarding the remaining usability guidelines of "Animation used must be creative" (*M*=4.85, *SD*=0.38), "Animations should match children skills" (*M*=4.62,

SD=0.77), "Layout page must be wide" (M=4.69, SD=0.48), "Setting buttons for audios need to be visible" (*M*=4.31, *SD*=0.85), and "Difficulty of game must be suitable with skills" (*M*=4.54, *SD*=0.66). Overall, slightly higher scores of 51 usability guidelines were found in participants dealing with entertainment task on BuBuChak game while the number of 25 usability guidelines were found slightly higher in ReadAloud game.

6. Discussion and Conclusions

Both the theory and practice for designing usable user interfaces of mobile game applications usage have been hampered by the absence of a thorough statistically based approach as a method for developing usability guidelines. As a result, this research effort has been in a position to derive a preliminary statistical based specification and scheme specifically for developing usability guidelines of mobile game applications from the perspective of designing for usable interfaces. The ultimate value to develop a statistical oriented approach is to provide systematic method for conducting evaluation research on the area of designing user interfaces for mobile game applications.

Since the study is an evolutionary process, a comprehensive work should be focused upon the mathematical-based guidelines for measuring the level usability of mobile game applications specifically from the perspectives user interfaces. As for a conclusion, the adaptation of future mathematical formulas thus provided further direction towards measuring the overall usability of the mobile game applications. By integrating usability guidelines and mathematical formulation, this future work is predicted to be successfully implemented to the overall mobile game application development practices.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Amalina F. A. F., Afizi M. S., Norshahriah A. W., Muhamad L. T. and Suresh T. conceived and planned the experiments; Amalina F. A. F., Afizi M. S. and Norshahriah A. W., carried out the experiments; Amalina F. A. F. and Muhamad L. T. contributed to sample preparation; Amalina F. A. F. and Norshahriah A. W., contributed to the interpretation of the results; Amalina F. A. F. and Suresh T. took the lead in writing the manuscript. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors had approved the final version.

Acknowledgment

My thanks specially dedicated to Human Computer Interactions students participated in this research, Faculty of Science and Defence Technology, National Defence University of Malaysia, Centre of Research and Innovation, National Defence University of Malaysia, and Ministry of Higher Education, Malaysia.

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Amalina F. A. F. is currently a senior lecturer at the Department of Computer Science, Faculty of Defense Science and Technology, National Defense University of Malaysia. She has almost twenty years of extensive experience in teaching and mentoring students, and fifteen years of comprehensive experience in the research and development of mobile–based application as well as the design of user interfaces, with an interest in the field of software engineering.

Afizi M. S. is currently teaching computer science in Universiti Pertahanan Nasional Malaysia (UPNM). He has several research experiences and published more than 100 journals indexed by SCOPUS, IEEE and others. His education background is bachelor in information system from Melbourne University. Then he did his master of IT in Sydney University and the PhD in Sydney University, Australia.

Norshahriah A. W. is a senior lecturer at the Faculty of Defence Science and Technology, under the Department of Computer Science in National Defence University of Malaysia also known as UPNM. She obtained her Ph.D. in visual informatics from Universiti Kebangsaan Malaysia (UKM). She did her attachment program during her PhD. study at culture lab in Newcastle University in UK. Her research interests are in the field of battlefield visualization, human computer interaction and virtual reality.

Muhamad L. T. is a junior lecturer at the Faculty of Defence Science and Technology, under the Department of Computer Science in National Defence University of Malaysia. He obtained his Ph.D. in digital image forensic from Universiti Kebangsaan Malaysia (UKM). He did his attachment program during her PhD. study at digital forensic lab in Japan Advanced Institute of Science and Technology (JAIST). His research interests are in the field of psychological computing, digital image forensic and computer vision.

Suresh T. obtained his first degree in bachelor of electrical engineering in 2006 and a master of electrical engineering (Power) in 2010 from Faculty of Electrical Engineering, University of Technology Malaysia (UTM). He is currently a lecturer at the Department of Science and Maritime Technology, National Defence University of Malaysia. He has thirteen years of extensive experience in teaching and mentoring students and five years of comprehensive experience in the research and development of electrical engineering, renewable energy and Internet of Things (IoT) applications.