Evaluating Educational Mobile Games for School Children

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ABSTRACT

Computer and mobile games are being used as a tool to increase students' productivity and efficiency. It is necessary that educational games should be in balance with the elements of game and knowledge. However, it is not clear what features in these two elements that should be in place to produce an effective and efficient educational game. To address this, a study was conducted to evaluate four android mobile games based on different educational subjects. The target group of this study was school children age ranging from 7-12 years. A questionnaire was formulated based on heuristics for educational computer games. 58 participants participated in this study. The study results reveal that educational mobile games have potential to improve students' productivity. Even though knowledge and fun features should have a proportionate balanced, the game should not drop the essence of fun and entertainment. This study also suggests a framework for developing educational games should be created in the future.

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1. INTRODUCTION

Video game industry is growing very fast with an increasing demand of casual and serious games. Casual games provide fun, entertainment, and enjoyment whereas serious games are developed for education, training and research [1]. The use of serious games in learning environment has gained higher interest among schools, communities, and offices. Serious games deliver an approach of experimental learning, where knowledge results from interaction and feedback, are entertaining [2]. With the experimental learning approach, video games are playing an important role in modeling new learning techniques for children.

In schools, video games are used as a tool for children to increase the productivity, efficiency and to deliver knowledge in an interactive way. Not only schools but colleges and universities have also adapted serious games to train students in major subjects like "City Planning", "Business Management", "Aeronautical", "Electrical" and "Computer Engineering" [2]. Game based learning addresses the methods of traditional learning more effectively. Incorporating educational elements in games are engaging students towards expressive learning than traditional learning tactics [3][4]. It is reviewed from literature that educational games provide sufficient knowledge to involve in discovering knowledge, while at the same time it helps in improving skills [5].

In the last decade, Educational Computer Games (ECG) became very popular in classrooms, and commonly used to improve the skills of students in an effective manner [6]. Currently, mobile phone technologies are advancing and replacing computers in educational institutes by having the advantage of the mobility features. It is claimed by [7][8], that the mobile phone technologies can be an effective tool for students in this era, where there are possibilities of motivating probable and conceivable learning advances of games played on mobile phones [1].

Considering the importance of games in the classroom, it is necessary to ensure that the design and integration of pedagogical elements are in suitable order to develop an effective education game. It is also suggested that the fun and pedagogical elements should be well-ordered and balanced for producing good quality educational games [6].

Usability evaluation of educational games is very much important to measure the efficiency and effectives of games. Several methods are being used to evaluate educational games, such as questionnaire [9][10], observations, interviews, and log files. It is reviewed that earlier researches have used questionnaire as a primary source [6]. Every evaluation method has its own importance and standards. However, the selection of evaluation method is slightly mattered on the mode of study.

Heuristic evaluation is also being used to evaluate educational games. Heuristic evaluation is considered as an effective method for evaluating games with usability heuristics since 1982 [11]. In 2004[12] Playability heuristic for evaluating computer games was proposed. This is followed by Playability heuristic for evaluating mobile games introduced in 2006 [13]. Later in 2010 [6] Playability heuristic to evaluate educational games (PHEG) were proposed.

This paper presents a study that evaluates four androids mobile educational games. The aim is to investigate what features within the elements of game and knowledge exist in these selected mobile educational games. The evaluation involves the use of questionnaire that consists of important elements such as Interface, Pedagogical, Content, and Playability. The target group of this study is school children, age ranging from 7-12 years.

2. LITERATURE

Since two-decade ago video games have been evaluated with different methods. The most popular methods for evaluating video games are playtesting and heuristic evaluation. Heuristic evaluation proved to be the more efficient and effective method over playtesting [14]. Several heuristics for games have been proposed by scholars to evaluate games using heuristic evaluation. For evaluating computer games several researchers have proposed Playability heuristics for computer games [12] [15][16][17] [18][19].

In recent years, mobile games are also being evaluated using heuristic evaluation. To evaluate mobile games with heuristic evaluation, a set of Playability heuristics for mobile games is required. Computer game heuristics are also applicable on mobile games as well, but some mobile features still remain unidentified. Therefore, in 2006 [13] and 2007 [20] Playability heuristics for mobile games have been proposed. Author divided heuristics into four categories; Usability, Mobility, Gameplay and Multiplayer. Later in 2012, Soomro et al. [21] proposed additional ten heuristic for mobile games, which are missing in the heuristics proposed by Hannu Korhonen [13] [20].

However, Playability heuristic for mobile games lack in evaluating educational games. These heuristics do no cover the pedagogical features of game. In 2010, Hasiah Mohamed and Azizah Jaafar [6] proposed heuristic for evaluating computer educational games. The authors address the challenges in evaluating educational games. They mentioned that evaluating an educational game is challenging and need to consider these factors: the evaluation criteria, the evaluator and the evaluation process. The authors presented five evaluation criteria, which combine them as a Playability Heuristic for Educational Games (PHEG). These heuristics are divided into five categories: Interface, Pedagogical, Content, Playability and Multimedia.

It is reviewed from literature that most of the educational games are evaluated using questionnaire, interviews and observations. Heuristic evaluation on evaluating computer educational games is not practiced as much as other methods although heuristic evaluation on educational games is a potential method claimed by [11] in 1982.

In this paper, the study presented adapts and applies a survey approach. A questionnaire is formulated based on PHEG proposed by [6]. The reason for selecting these heuristic in this study is because these heuristics cover the Playability and Pedagogical features of an educational game.

3. METHODOLOGY

This section describes the methods used in conducting the study.

3.1 Need of Developing Educational Mobile Games

It is reviewed from literature that mobile education games can be an efficient method of teaching children in schools. It improves the knowledge of student along with their skills. Educating with games considered as more effective as compare to the traditional method of education.

3.2 Selection of Games

This study has selected four android educational games of different curriculum. Games is available on android google play store for download [22] [23] [24] [25].

Table 1. Games Characteristics

Games	Genre	Subject	Player Mode
Spell It	Educational	English	Single Player
Animal Idioms	Educational	English	Single Player
Comic Maths	Educational	Math	Single Player
Chase Me	Educational	Math	Single Player

- Spell It!!

"Spell It!!" is a mobile game for learning basic English. The game is designed for children age ranging between 5 to 7 years old. However, the children still need assistance from teachers or parents. Game is focused on "Self-Kingdom" and "Life Kingdom" using flash card. This game is based on very common subject for teaching children, especially for the introduction of foreign language [22].

- Animal Idioms

"Animal Idioms" is a mobile educational game subjects to learn English idioms. Game is designed for primary school children. Game provides hint in a form of image of the word related to idiom that children require to complete. Children need to achieve the objective within time constraint in order to process to next level. Game is easily available to download from android google play store [23].

- Comic Maths

"Comic Maths" is educational mobile games focused on math curriculum. Game allows children to learn basic mathematic in an interactive way with a storyline. Game contains two basic math operations; addition and subtraction for primary school children. Game is easily available to download from android google play store[24].

- Chase me

"Chase Me" is a mobile game, which aimed to help kids to learn mathematics in an interesting and fun way. It is focused on multiplication and division operation[25].

3.3 Designing Questionnaire

A questionnaire was designed to get reviews and ratings from the users for games. This technique is adopted from [9]. Questionnaire is divided into two sections. Section one contains demography of students. Second section contains questions related to Usability, Pedagogical, Content, and Playability. Likert scale (1-5) is used from strongly agree to strongly disagree.

3.4 Selection of Sample

Random sampling techniques have been used in this study. A total number of 60 sets of questionnaires were distributed. 30 questionnaires were distributed among school students, and 30 questionnaires were distributed in university students pursing undergraduate and postgraduate studies. The reason for selecting 30 postgraduate students is to get feedback on usability of games. School children prefer to play only game, and they do not pay attention towards usability factors of games.

3.5 Evaluating Games

Each student was provided with smart phone on which games were installed. They were allowed to play the game freely as they wish. They were not guided to achieve any objectives. At the end of each session, each student was asked to fill up questionnaire and their experience regarding game. They were free to ask any question if they find any difficulties while answering the questions.

4. RESULTS AND DISCUSSIONS

The demographic results from first section of questionnaire advocate that 71% of the participants play mobile games regularly. Participants prefer to play mobile games over computer games because of mobility feature of mobile phone. 53% of the participants agree that playing game on mobile phone is very much interesting, and it can be played anytime and anywhere. The participants responded very positively, which shows interest in mobile learning games. They state that the mobile learning games are very helpful and also enjoyable to play, skills can be improved very fast by playing mobile games. Participants also agree that learning through games is very creative and interesting as education games provide fun and knowledge together. Some of participants also contradict on this statement. Some participants argue that education game

does not provide sufficient knowledge as traditional teaching methods do. They argue that games are meant to provide fun not knowledge.

The second section of the questionnaire was consisting of questions regarding usability, pedagogical, content, and Playability factors of game. The total numbers of 18 questions were presented in the questionnaire, to enlighten the important factors of educational games.

Participants were provided a smart phone on which games are installed, and the participants were free to play any game they prefer. Some of the participants also query about the games that which game represents which subject before starting.

The total numbers of 58 questionnaires were returned with the positive response, and two questionnaires were returned unfilled.

Cronbach's α was computed for 18 questions of each games individually to check whether the questionnaire form a reliable measure. George and Mallery [26] defined rule of thumb for Cronbach's α which states that, > .9 is Excellent, > .8 is Good, > .7 is Acceptable, > .6 is Questionable and > .5 is Poor. As shown in Table 1. Cronbach's α is > .9 for each game, which advocates that the reliability measure is Excellent. Cronbach's α computed individually for each game to justify that that the questions were reliable for games of different curriculum.

Table 2. Reliability Statistics: Cronbach's α

Game	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
Animal Kingdom	.956	.958	18
Chase Me	.947	.950	18
Comic Maths	.960	.961	18
Spell It	.955	.956	18

The results of game "Animal Kingdom" are analyzed as shown in Table 2. Each factor of game is individually analyzed to see the significant difference. Mean of each factor is compiled, Usability has mean index (M = 20.44; SD = 3.162), Playability has (M = 18.75; SD = 3.109), Pedagogical (M = 15.31; SD = 3.092) and Content has (M = 16.19; SD = 2.613). Usability and Playability factors have slightly difference, whereas Pedagogical and Content factors have significant difference. This advocates that the usability and playability of games has high impact on users. However, Pedagogical and Content factors scored low.

Table 3. Scale Statistics of game "Animal Kingdom"

Factors	Mean	Variance	Std. Deviation
Usability	20.44	9.996	3.162
Playability	18.75	9.667	3.109
Pedagogical	15.31	9.563	3.092
Content	16.19	6.829	2.613
Overall	70.69	113.163	10.638

The statistics of game "Chase Me" are analyzed as shown in Table 3. Usability has mean index (M = 19.17; SD = 3.664), Playability has (M = 17.17; SD = 3.070), Pedagogical (M = 13.25; SD = 2.179) and Content has (M = 13.75; SD = 2.667). Similarly, usability and playability factors have slightly difference, whereas Usability of game has significant difference over Pedagogical and Content factors.

Table 4. Scale Statistics of game "Chase Me"

Factors	Mean	Variance	Std. Deviation
Usability	19.17	13.424	3.664
Playability	17.17	9.424	3.070
Pedagogical	13.25	4.750	2.179
Content	13.75	7.114	2.667
Overall	63.33	95.697	9.782

Table 4 shows statistical results of game "Comic Maths". Usability has mean index (M = 20.14; SD = 4.240), Playability has (M = 19.71; SD = 4.232), Pedagogical (M = 16.29; SD = 2.972) and Content has (M = 16.07; SD = 2.973). Likewise results of above games, usability of game scored high although there is slightly difference in usability and playability factors. Also, there is no any significant difference in Pedagogical and Content factors of game whereas there is significant difference in Usability.

Table 5. Scale Statistics of game "Comic Maths"

Factors	Mean	Variance	Std. Deviation
Usability	20.14	17.978	4.240
Playability	19.71	17.912	4.232
Pedagogical	16.29	8.835	2.972
Content	16.07	8.841	2.973
Overall	72.21	158.335	12.583

The results of game "Spell It" are shown in Table 5. Usability has mean index (M = 19.86; SD = 3.009), Playability has (M = 20.57; SD = 3.228), Pedagogical (M = 16.43; SD = 2.875) and Content has (M = 16.43; SD = 2.901). Playability of games score high following Usability Playability have slightly difference over Usability, whereas Pedagogical and Content factors have significant difference. Playability of game "Spell It" has high impact on users, whereas Pedagogical and Content scored low.

Table 6. Scale Statistics of game "Spell It"

Factors	Mean	Variance	Std. Deviation
Usability	19.86	9.055	3.009
Playability	20.57	10.418	3.228
Pedagogical	16.43	8.264	2.875
Content	16.43	8.418	2.901
Overall	73.29	111.451	10.557

Table 3, 4, 5 and 6 demonstrating the statistics results of pedagogical, content, usability and playability factors of game. It is analyzed that most of the participants are satisfied with the game features. However it is analyzed that the Pedagogical and Content scored in every games, which advocates that game usability and playability has high impact on participants. The Games used in evaluation were first release version. The game developing teams are suggested to improve the usability of games in order to release the new version with better efficiency and effectiveness.

The results of this study state that the use of educational games in school and colleges is very much effective. Participants from school were happy to play game, and they were deeply engaged in achieving objectives. PHEG proposed by [6] was found to be very useful for evaluating educational game. PHEG was proposed for computer game, but these heuristics are also applicable on mobile games as well. However, PHEG did not cover some mobility feature of mobile phone. It is recommended that there should be specific heuristics for evaluation of educational mobile phone games.

5. CONCLUSION

This study demonstrated that educational mobile games can promote education in school with new interactive methods of learning. The findings of this study indicate that educational mobile games should be balanced with fun and knowledge. The method used in this study adapted from [6] to evaluate educational games is very much useful. It is highly recommended that there should be a proper framework to develop educational games in which major aspects of knowledge and fun must be balanced.

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