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Research paper

Design and Development of an Interactive Persuasive Mathematics Game for Primary School Children

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Abstract

It is a well-known fact in most countries of the world that primary school students do not favour mathematics. They are always subjected to high level of anxiety. This condition is clearly seen among Malaysian' primary school students and this might have a substantial impact on their understanding of mathematics. Furthermore, this is also known as the pathological fear which is considered infectious and normally extends to other subjects related to mathematics. This paper discusses the anxiety as a hindrance factor in resulting poor performance in mathematics. To remedy this problem, this paper introduces the digital wayang kulit (DWK) characters originate from the traditional Malay theatre as a motivational platform for primary school students to overcome their anxiety towards mathematics. Finally, recommendations are introduced to design a persuasive mathematics game using DWK to help primary school students in learning and improving their mathematics skills in the future. Finally, this paper proposes the design of interactive persuasive mathematics game using DWK to help elementary students in learning and improving their mathematics skills.

Keywords: *WayangKulit, Digital WayangKulit, Persuasive Technology, Anxiety, Mathematics, Math Fear, Mathematics game.*

1. Introduction

According to Ural (2015), fear of mathematics causes one to be tensed, stressed, and afraid due to the disruption of his/her thinking process when faced with mathematical problems in daily life. This fear is one of the important factors that affect the development and emergence of student's mathematics skills (Tok, 2015). Usually, this happened in the mathematics classes and is also known as the pathological fear whereby it is infectious and might extend to other sciences subjects that are related to mathematics (Yahya & Fasasi, 2012). The same problem happens in most countries of the world and the primary students do not love the subject of mathematics. The mathematics anxiety is high, or attitudes towards mathematics subjects are not at the prospect level (Arslan, 2013). In Malaysia, many primary school students are facing this issue and this matter shall affect their understanding in the mathematics (Kuldas, Sinnakaudan, Hashim, & Ghazali, 2016; Thien & Ong, 2015). Thus, such as these students need some methods to motivate them in acquiring knowledge and skills related to mathematics subject (Sinnakaudan, Kuldas, Hashim, & Ghazali, 2016). Sinnakaudan et al. (2016) suggested some recommendation for future research such as designing interactive mathematics games that contain many levels to motivate primary school students. Adding to that, based on an interview that has been conducted among mathematics teachers of Sekolah Kebangsaan Haji Abdul Rahman, Tokai, Kedah (SKHAR) revealed that 40% of the students obtained poor results in the topics of subtraction and addition and is considered to be a high percentage (Jasni, Zulikha, & Mohd-Amran, 2012). Hence, it seems negative results in the mathematics subject can leads students to frustration.

However, some researchers attempted to design a solution to this problem, such as e-waycool: embedding interaction design (IxD) and representation concepts in teaching mathematics (Ahmad & Jamaludin, 2015). The e-waycool was used in the animated two dimensions (2D) WK as a feature of the game concept. Still, it is yet to be tested with actual primary school students.

In this regards, combining play and games to learn with the technologies can bring improvement and more realism to game-based learning. Needless to mention that play and games to learn is an established and common method (Walls, 2012). Games can also be given interface and system that entice the students to play more and more, encouraging the students to do their best so that they may be better in the game (Mangowal, Yuhana, Yuniarno, & Purnomo, 2017). One of these technologies is persuasive technology that can be integrated into the design of the game to persuade and motivate children to improve their mathematical skills (Maqsood, 2018). As such, persuasive tool might be making target behaviour easier to do, leading children through a process and performing calculations or measurements that motivate them (Fogg, 2003).

This kind of technology tool is implemented in many domains, and one of them is technological pedagogy which is an educational field (Ahmad & Mutalib, 2015). Therefore, this paper adapted all the concept and guidelines provided by Ahmad and Jamaludin (2015) with persuasive technology (Fogg, 2003) in developing an interactive persuasive game among primary school children.

In Malaysia, there is a traditional performance known as Wayang Kulit (WK). The traditional characters for WK basically consist of shadow play characters and WK is famous in performing art. It is a symbol and heritage of the Malay society in Malaysia.

There are four kinds of Wayang Kulit in Malaysia namely; WK Melayu, WK Jawa, WK Gedek, and WK Kelantan (Nasuruddin, 2000). Figure 1 shows some of these WK characters.

Fig. 1: Kinds of Wayang Kulit Game

In many Asia traditional societies, the performances involving storytelling have been used for reflection promotion. These performances including Wayang Kulit are gradually degenerating because of the lack of younger generations' interest. However, researchers such as Ghani and Ishak (2011) have been putting efforts in preserving WK with digital multimedia technology. Therefore, Shadowplay characters are examples of the traditional Malay theatre arts including Wayang Kulit Kelantan. Unfortunately, the shadow play puppet has lost its touch and has slowly begun to fade among the society especially among children and teenagers in Malaysia. Consequently, this study used digital shadow play or Digital Wayang Kulit characters in Mathematics games as objects where the children can gain knowledge about these traditional characters and keep this traditional way in their minds when playing the game.

As mentioned before that the main problem in the mathematics subject is in the calculation with numbers and shapes. The way of tackling this problem is to motivate the students to perform mathematical operations interactively by providing persuasive attractive shapes or numbers with the used of shadow play characters incorporated into the game prototype design. Adding to that, this game also provides some levels for mathematical operations calculation. These operations also have attractive symbols which will be displayed when the students are playing the game. Moreover, this game also provides operations quizzes by providing examples to the missing parts. In sum, computer-based educational games consist of educational insights, entertainment and persuasive features that can be excellent tools in learning mathematics and reducing fear among primary school students.

This game has adopted Level I (Standard 1 – Standard 3) based on the Curriculum Standard Document produced by the Ministry of Education, Malaysia as a reference for this study as cited by Hurmuzan and Yahaya (2015). The main contributions of this paper include; identifying the core elements of an interactive persuasive game and design and development of a persuasive DWK game based on the identified core elements.

2. The Design and Development of Persuasive DWK Game

The persuasive DWK game was designed and developed based on the Analysis-Design-Develop-Implement-Evaluate (ADDIE) methodology. ADDIE is a method that can be effectively used in almost every condition. It is divided into five necessary phases, namely; Analysis, Designing, Developing, Implementing and Evaluating. These phases are classic and generic processes and are usually used by instructional training designers and developers (Molenda, 2003).

In the analysis phase of the ADDIE method, the core elements of the persuasive DWK game were analysed. For example, 1) identify the Standard 1 Curriculum for Year 1 contains learning numbers from 0 to 100 and two mathematical operations, which are addition and subtraction. 2) Identify the standard 1 Curriculum for Year 2 which includes the digits from 0 to 1000 with the four of mathematical operations, which are the addition, subtraction, multiplication and division. 3) Identify the standard 1 Curriculum for Year 3 contains the digits from 0 to 10 000 and four mathematical operations, which are addition, subtraction, multiplication and division. Therefore, based on this phase, a persuasive DWK game was designed based on the standard 1 Curriculum for Years 1, 2 and 3.

A persuasive DWK game has three levels: Level 1 which is called Ramayana; containing two mathematical operations: addition and subtraction, and the numbers 0 – 10. The Level 2 which is called Dewi Sita includes the four of mathematical operations, which are: addition, subtraction, multiplication and division, with numbers 0 – 100. Lastly, Level 3 called Laksamana that contained four mathematical operations namely; addition, subtraction, multiplication and division, and the numbers 0 – 999. Adding to that, identify the required text, graphics, audio and 2D animation. Figure 2 illustrates the core elements of the persuasive DWK game.

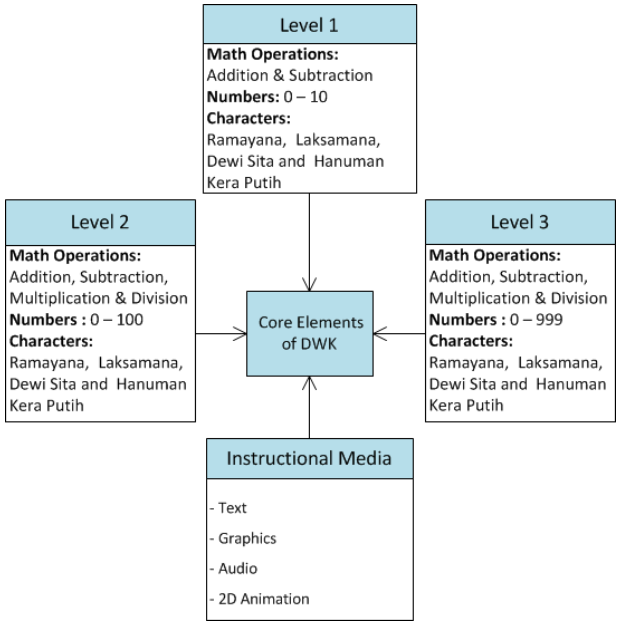

Fig. 2: core Elements of the Persuasive DWK Game

In the second phase of the ADDIE method, a persuasive DWK game was designed based on a storyboard as initial steps. According to Terrins-Rudge, Adamson, Ionescu, Peterson, and Hedman (1992), a storyboard is simply a concept of the prototyping without the use of a computer. The storyboard was used in designing a persuasive DWK game before the creation of the real content.

The designer uses the storyboard to visualise the flow of the persuasive DWK game. Therefore, the storyboard was designed before the development of the persuasive DWK game. Then the flow of the contents was sketched to be visualised while creating a persuasive DWK game. The persuasive DWK game was designed based on the materials needed for this study, which are the mathematical operations, the numbers 0 – 1000 and the Digital Wayang Kulit (DWK). The user starts a persuasive DWK game and in the first scene at the interface, he/she chooses any one of three different levels among Level 1, Level 2 and Level 3. The contents of these three levels are shown in Figure 3. The user can choose any level separately and come back to the main scene.

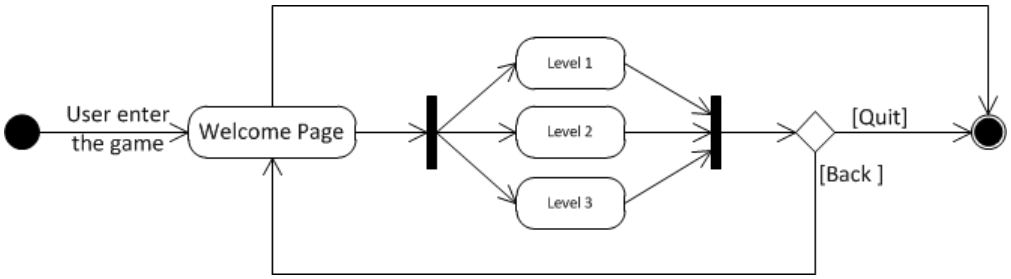

Fig. 3: Activity Diagram of DWK Game

More details in this regards, when the user starts the persuasive DWK game, it allows the user to choose one of the three levels. Thus, when the user goes to level 1, on the page, there are two choices to make: Addition or Subtraction. For each of the pages, he/she can get the math tutorial with many questions. As well as when the user goes to level 2 on the page, there are four choices: Addition, Subtraction, Multiplication and Division where each page has tutorials and quizzes. Finally, when the user goes to level 3, on its page, he/she finds what is similar to the page of level 2 chosen, but with a different range of numbers.

In the development Phase, a persuasive DWK game was developed based on the Standard 1 from the Mathematics Syllabus. The researcher was careful to make sure that a persuasive DWK game is suitable to be operated by users, especially the young students of the primary school. The prototype delivered by this study was developed using Adobe Flash CS6, and its program code was done using action script as a programming language. The development of the DWK game prototype started as soon as the storyboard was done. The storyboard involves the process of choosing the right graphics and animation, and the arrangement of these graphics and animation to produce a suitable combination of the storyline and animation. During this phase, multimedia components such as text and audio are included in order to produce an effective persuasive DWK game which is able to attract and captivate the students' attention and also provides a fun learning experience for them. In this phase, the study described the main pages of the persuasive DWK game based on the core elements of the persuasive DWK game that is illustrated in Figure 2 above.

The first scene (Homepage) contains the welcome message text; also this page has clearly shown the three levels to the user. This home page allows the user to select which level he/she wants. Figure 4 shows the first scene (home page).

Fig. 4: Home Page

The second scene (Level 1 page) contains text to indicate level 2 contents. It has two buttons, one to go to addition module (page) and the other one to go to the subtraction module (page). After that when the user clicks on the add button, it directly goes to addition module (page).

This same operation is applied to the subtraction button. Figure 5 and Figure 6 below show the Addition and Subtraction modules.

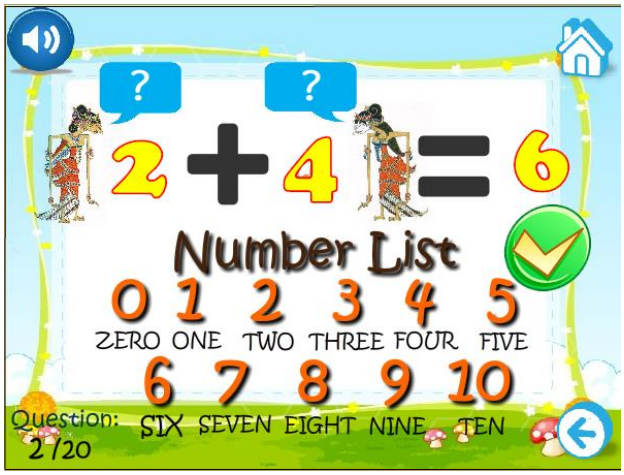

Fig. 5: Addition Operation

Fig. 6. Subtraction Operation

Based on the home page (scene 1), when the user clicks the button of level 2, its corresponding page shows directly. This level also contains text describing the level content, and with four buttons that can be used to select four mathematical operations namely; Addition, Subtraction, Multiplication and Division. Each of the operation has an independent page with its module. Each of the modules also has to sub-modules that are sequentially arranged as a tutorial and the other as a quiz. The DWK characters are also included in these modules.

Level 3 has the same content with the level 2, but the different is its range of whole numbers. The level 3 range is more advanced than that of the level 2. Figure 7 and Figure 8 illustrate the Multiplication and Division operations.

Fig. 7: Multiplication Operation

Fig. 8: Division Operation

The fourth phase of the ADDIE method is the implementation phase. This phase involves the final user testing and the implementation of the persuasive DWK game. It was first implemented as an SWF file and then transferred to the desktop PC. Adobe Flash CS6 enables publishing in various formats that will satisfy the users' requirements. For examples, a persuasive DWK game can be used as an APK file for an android smartphone and it can be used as IPA for iPhones. Both files are suitable to be published on websites.

The last phase of the ADDIE method is the evaluation phase. In this phase, a persuasive DWK game was verified by three experts to check the programming errors that may occur on the start of execution time and during the execution time, delays of running, and other functions. All experts were satisfied with a persuasive DWK game. In additions, it will be validated by actual users in future works.

3. Discussion and Conclusion

This study discussed the issues related to mathematics that are affecting primary school students of standard 1, 2 and 3 in Malaysia. The persuasive DWK game was developed to assist students in learning Mathematics. The persuasive DWK game was designed based on the primary school standard curriculum (KSSR) for mathematics. The purpose of the persuasive DWK game is to assist the students to be more active in the class and increase their interest in learning mathematics. The persuasive DWK game also contains the Digital Wayang Kulit (DWK) characters of the Malaysian tradition art which represent the actors in helping and motivating the students in Mathematics. The persuasive DWK game was developed using Adobe Flash CS6 with ActionScript as a programming language. In the end, this research is hoped to improve the students' skills in mathematics, help the teachers by providing a more interactive and unconventional method of teaching mathematics, help the students to be more interested in mathematics and reduce the phobia of mathematics among the students. Besides improving their mathematical skills, the students also understand the traditional Wayang Kulit which is almost forgotten by the young generations nowadays. The results of the expert evaluation indicated that all experts were satisfied with the design of the persuasive DWK game regarding the understanding of the design layout and the program coding parts. Future work includes user evaluation among Malaysian primary school students on the use of the persuasive DWK game.

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