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MEASURING EFFECTIVENESS OF CHALLENGE CHARACTERISTIC IN MOBILE EDUCATION GAME IN THE LEARNING OF MATHEMATICS

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ABSTRACT

The research was aimed to measure the effectiveness of an education game (EG) which employed challenge characteristic for learning mathematics among primary school students. A game prototype with two different versions were developed using a multimedia authoring tool namely EG *(challenge alone)* and EG *(challenge and score)*. A quantitative approach using quasi-experiment design was used to measure the effectiveness of the education game. A usability study has also been carried out, particularly focusing on testing the mobile-device and measuring reliability and validity aspects of the game. Forty standard one pupils were chosen using a purposive sampling technique as studied subjects. The subjects were divided into two groups of twenty pupils for the control and treatment groups equally. Data were collected and recorded for score achievement analysis for pre-test and post-test session. Data were statistically analysed using Mann Whitney U Test to investigate the differences between the two conditions. The result indicated that there was significantly higher increment in student achievement for EG *(challenge alone)*. The study implicates that the use of challenge characteristic in education game (EG) can improve student performance and enhance their learning style for mathematics subject

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MENGUKUR KEBERKESANAN CIRI CABARAN DALAM PERMAINAN PENDIDIKAN MUDAH ALIH DALAM PEMBELAJARAN MATEMATIK

ABSTRAK

Kajian ini bertujuan untuk mengukur keberkesanan permainan pendidikan (EG) bercirikan cabaran untuk pembelajaran matematik dalam kalangan pelajar sekolah rendah. Satu prototaip permainan dengan dua versi telah dibangunkan menggunakan alatan pengarang multimedia yang dinamakan EG *(cabaran sahaja)* dan EG *(cabaran dan skor)*. Pendekatan kuantitatif menggunakan reka bentuk kuasi-eksperimen telah digunakan untuk mengukur keberkesanan permainan pendidikan berkenaan. Kajian kebolehgunaan turut dilaksanakan, khususnya tumpuan kepada pengujian peranti bimbit dan pengukuran aspek kebolehpercayaan dan kesahan permainan. Empat puluh murid tahun satu telah dipilih menggunakan teknik persampelan bertujuan sebagai subjek yang dikaji. Subjek telah dibahagi kepada 20 orang murid rawatan dan 20 orang murid kawalan. Data dikumpul dan direkod untuk tujuan analisis pencapaian skor untuk sesi ujian-pra dan ujian-pasca. Secara statistik, data dianalisis menggunakan analisis ujian Mann-Whitney U. Dapatan kajian menunjukkan terdapat peningkatan pencapaian yang lebih tinggi secara signifikan pada EG *(challenge alone)*. Implikasi kajian menunjukkan penggunaan permainan pendidikan (EG) bercirikan cabaran dapat meningkatkan prestasi pelajar dan meningkatkan gaya pembelajaran mereka bagi subjek matematik.

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TABLE OF CONTENTS

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

CHAPTER 6 DISCUSSION AND CONCLUSION

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF TABLES

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF FIGURES

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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LIST OF ABBREVIATIONS

MEG	Mobile Education Game
EG	Education Game
mGBL	Mobile Game Based Learning
CIPM	Cognitive Information Processing Model
SM	Sensory Memory
STM	Short-term Memory
LTM	Long-term Memory
PC	Personal Computer
MOE	Ministry of Education
VLE	Virtual Learning Environment
KSSR	Kurikulum Standard Sekolah Rendah
TIMSS	Trend in Mathematics and Science Study
PISA	Program for International Student Assessment
APAC	Asia Pacific Digital Overview
SPSS	Statistical Package for Social Science
IV	Independent Variable
DV	Dependent Variable
ADDIE	Analysis, Design, Development, Implementation and Evaluation
CAMCE	Computer Aided Multimedia Software Design
IBM	International Business Machines

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05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

LIST OF APPENDICES

Appendices

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi
05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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CHAPTER 1

INTRODUCTION

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1.1 Introduction

Digital games have become popular among children and adolescents. According to a survey made by Malaysian Communications and Multimedia Commission (MCMC), the penetration number of mobile phone per 100 inhabitants increases from 142.5% to 143.4% in the second quarter of 2013 since 2012. Moreover, 68.8% of the smart phone owners used their phone to gain access to the internet. This means games have become an integral part of their daily life (Liu, 2008). Although some people still believe that games are usually more associated to many negative elements such as violence and addiction, the good digital

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games could be powerful learning tools to attract learners to learn actively. Despite the negative influence of games on the youngster, they could also be

used to promote learning and motivation which include features that prompt learners to actively process the educational content (Erhel & Jamet, 2013). Therefore, it is crucial to investigate the beneficial elements in games that could prompt learners to actively process instead of assisting them to improve their score achievement in the examination.

1.2 Background of study

Digital game is known by individuals of all ages and is very popular among the children and adolescent. Furthermore, digital game nowadays can be played via multiple devices such as computer, laptops, tablet, and smart phone. Therefore, the development of an effective mobile education game (MEG) with specific learning content should be taken seriously so that learners are not wasting time without learning anything.

Researchers believe that games with pedagogical content have positive impact especially for learning purpose. Most international schools such as Chempaka International School and Sri Emas International School have implemented the use of game in the classroom. Besides, FrogAsiaSdn. Bhd. has brought digital games in the government schools classroom by implementing Frog Virtual Learning Environment (Frog VLE) in teaching and learning. According to The Star online (Rabecca, 2016) most of the teachers

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strongly agree that games have brought not only learning motivation but also social interaction and confident levels among the children especially for the slow learners. This is one of the efforts to diversify learning approach among the children and make them realize that learning is fun. MEG is a game with specific learning content and it offers more fun through mobile devices. The objective of MEG should match the learning goal to promise learning, while the achievement of the EG should match the learning outcome. To develop an effective MEG, the instruction designer has to think creatively. Therefore, the game designer must know the key elements that lead to learning activities among the students when they are engaged with the game. Motivation is the key behind the successful educational outcome (Malone, 1981; Malone & Lepper, 1987) in an educational game. Indeed, an important key to the student achievement is the amount of time students are engaged in educational game. To promise the effectiveness of educational game, good game design has to be combined with good pedagogy content (Osman & Bakar, 2012). Challenge, goals, feedback and storyline are among some of the elements that to include during designing MEG in order to develop the good game design (Prensky, 2001; Grassioulet, 2002; Owen, 2004; Sauve, 2007; Klopfer, Osterweil, & Salen, 2009).

Motivation that occurs in MEG can promise a lot of benefit to the learner especially for learning purposes. Motivation is an outcome that learner able to achieve after they play with MEG. The existence of motivation within EG has attracted many researchers, as well as game designers to investigate how this happens. Motivation is an attitude needed by learners to focus on their learning. Motivational game should make learner repeats cycles

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within the game context (Pivec, & Kearney, 2007). However, the main characteristic of an MEG is that the instructional content is blurred by game chapter 2seriously take into consideration the MEG content. Malone and Lepper (1987) indicate four major factors that make learning environment of educational game intrinsically motivated. The four elements were fantasy, challenge, curiosity and control which were all need to be included by game designers in educational game to create intrinsic motivation (Malone,1981). However, this study will only focus on challenge elements because from the review, challenge was the most frequent element mentioned by the researcher to motivate learners. Challenge in MEG could inspire motivation. Therefore, it is very important to have challenge characteristic in MEG to create motivation among the learners.

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Researchers also believed that appropriate challenge in EG always offers opportunity for reinforcement regardless of the level of learner ability (Linehan, Kirman, Lawson, & Chan, 2011). Players always strive towards achievable goals and forward the game at the quick pace and at thispoint the game begin presenting the rewards (Linehan et. al, 2011). In most cases, people like to play games with greater challenge that leads to greater rewards. For instance, most educational environments may offer greater status (e.g, score, grades and teacher reports) for those who choose to play challenging activity (Lomas, Patel, Forlizzi, & Koedinger, 2013). Therefore, status and challenge are key motivational element in games because it will often correlate however the question is whether games with challenge alone would be motivating the student especially at increasing their test achievement (Lomas et. al, 2013).

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The word “game” will always be related to fun, enjoyment and most of children always attracted to it. Instructional designer must consider fun during developing the EG rather than enhancing student learning performance (Shi & Shih, 2015). This is because fun element in game could promote student motivation and they would have advanced learning outcome naturally (Huang, Huang, &Tschopp, 2010). To promise fun, the game must offer pleasurable experiences. User experience always occurs by creating the goals. Players which successfully achieve the goal which is considered intrinsically motivated. Players have to complete challenges consist in every level and stage to achieve the goals. Challenges are the game tasks or activities provided in the game (Malone &Lepper, 1987). Coincidentally, challenge and goal can make player intrinsically motivated to learning. In EG perspective, if the players complete their challenges, it means that they complete their learning (Charsky, 2010). However, knowledge through educational games is always measured by referring to the score without evaluating the player achievement.

The idea of EG is to bind games and learning together in order to make learning environment more entertaining. The acceptance of EG as teaching aids can be seen when most of the students feel highly interested and fascinated in their learning process (Ibrahim, et.al, 2011; Ibrahim, Yusoff, Mohamed, &Jaafar, 2010). EG not only promises a fun learning environment but it also could inculcate learning motivation to the student by using educational characteristics.

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As to date, learning has become ubiquitous, whereby it can be retrieved at any place and anytime. This leads to the trend of mobile learning; whereby there are researches done on mobile game based learning (mGBL). Technology of wireless network along with the latest technology of mobile phone with interesting features encourages the development of mGBL (Hillmann & Hillmann 2009), (Norshuhada &S yamsul 2009). The convergence of mobile devices using games technology to support learning practice has been approved by some researchers (de Freits& Griffiths, 2008). However, information about mobile game as learning mode is left underutilized due to lack of literature in developing mGBL (Norshuhada & Syamsul 2009). In Malaysia, the concept of mobile game as learning tool is still in its infancy, but it has potential to be the teaching aid for the educators (Norshuhada & Syamsul 2010). Learning trough mobile devices could take place anywhere and anytime which means they can promote a lifelong learning especially for the secondary students. It can assist students' acquisition of knowledge in their own way and the process is full of pleasure (Yen, Wang & Chen 2011). However, there is an argument regarding of mGBL especially about knowledge acquisition from the students during the learning session (Caron & Marty 2009).

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1.3 Theoretical Framework

1.3.1 Learning Theory

Theory of learning for this study is grounded on Cognitive Learning Theory. This theory is derived from several cognitive psychologists such as Jean Piaget (1896-1980, Lev Vygotsky (1896-1934), and Jerome Bruner (1978). Cognitive learning theory is focused more on how people think (Ormrod, 2008), understand and know. The idea of cognitive approach is to look at the student mental processes rather than behavior. Cognitive learning is also viewed as an active learning process of knowledge construction (Yilmaz, 2011). Yilmaz (2011) suggested that all teachers should implement cognitive structure in their teaching to help students to integrate new knowledge with prior knowledge.

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The key element that is in line with cognitive approach is the memory system as an active organized processor of information and prior knowledge that play an important role in learning. Cognitive psychology has seen human mind similar to computer information processing (McLeod, 2008). Information processing process ideals with the sequence and execution of cognitive events and it is a generic name that is applied to various theoretical perspectives (Cognitive Information Processing Theory, 2011). Learning and memory will always work together to make learning more meaningful. Learning might happen if someone acquires new knowledge or information while memory is present to keep that

05-4506832 pustaka.upsi.edu.my Perpustakaan Tuanku Bainun Kampus Sultan Abdul Jalil Shah PustakaTBainun ptbupsi

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new knowledge or information remain and can be assessed at any time. Such is the basis of cognitive approach which often concentrates on the information transformation in the environment into new knowledge that is stored in mind. Information processing theory which is derived from cognitive learning theory plays an important role in influencing educational games.

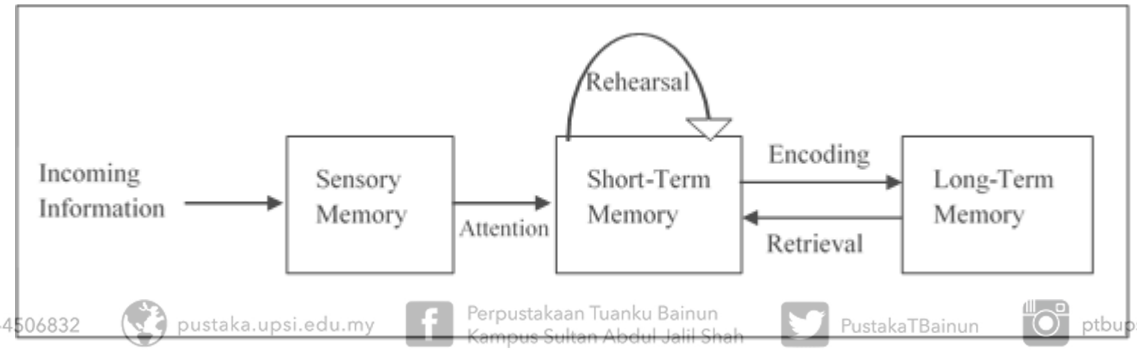

Figure 1.1. Cognitive Information Processing Model. (Atkinson & Shiffrin, 1968).

The Information processing approach is based on a computer analogy. Figure 1.1 shows the model of memory proposed by Atkinson and Shriffin (1968). It assumed that information came in from environment, was processed by a series of temporary sensory memory systems (a part of the process of perception), and then fed into a limited capacity short-term memory and then allowing to be used to perform a wide range of cognitive tasks from long-term memory (Kandarakis, &Poulos, 2008). The Cognitive Information

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Processing Model (CIPM) which consists of Sensory Memory (SM), Short-term Memory (STM) is also known as Working Memory and Long-term Memory (LTM).

The information is transformed as it passes from one stage to another memory stage. The new information or knowledge is assumed to flow starting from left to the right, entering through the sense and moving through the short-term memory (process of attention, perception, rehearsal) and encoding into long term memory for later retrieval. Then, the sensory memories will stimulate the initial stage perception. Information in sensory memory decays rapidly and disappears in only a few seconds if it is not transferred into working memory (Weibell, 2011). However, the learner will be able to select or focus on certain information only and the other information will be ignored. Short-term memory stage, is often viewed as active or conscious memory because it is the part of the memory being actively processed while new information is being taken (Weibell, 2011). During this stage, concepts from LTM will be activated for use in making sense of the incoming information. Information that is being manipulated will only remain in working memory for a short interval, perhaps as little as 2 seconds (Dehn, 2011). To prevent from the loss and ensure that information is transferred to LTM, two necessary processes which are rehearsal and encoding should occur. Rehearsal is the repetition of the information while encoding is a process of relating new information to concepts such as imaginary, mnemonic, outlines and group of information (Cognitive Information Processing Theory, 2011).

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1.3.2 Game Theory

Game theory for this study is grounded on Intrinsic Motivation Theory, Flow Theory and Game Based Learning Theory. Intrinsic Motivation Theory was developed by Malone and Lepper (1987). This theory is more broadly applicable to any instructional design (Rees, 2011). The features were so popular until today because it can create an intrinsically motivating computer learning game. There are four components that were presented by Malone (1980) and Malone and Lepper (1987) which are challenge, fantasy, control and curiosity. Each of these components should be included in the game to promise learning.

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a) Challenge

Challenging games with uncertain outcomes can increase player motivation compared to easy-goals games. Motivation theory such as flow theory shows that player motivation depends on challenges of a gaming experience that are related to the player skills, perceiving competence, autonomy and relatedness as well as the player himself, trying to reach several goals. Challenge was one of the features that was always associated with being influential to player motivation to continue playing (Belanich, Orvis, & Sibley, 2013). Challenge in games had positive effect in learning when the players engagement increased (Hamari, Shernoff, Rowe, Coller, Asbell-Clerk, & Edwards, 2015). Besides, game challenge was a strong predictor of learning outcome. Therefore, it is very important

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