RAPID PROTOTYPING OF NEWTON'S LAW EDUCATIONAL GAMES

SITI NURSAILA ALIAS & FARIDAH IBRAHIM
School of Distance Education
Universiti Sains Malaysia,
Pulau Pinang, Malaysia
eylaa86@gmail.com

ABSTRACT

The objective of this study is to develop Newton's Law educational games for form four Physic students. This software developed in Malay Language and the contents arranged according to Form Four Physics syllabus. This game was developed based on Rapid Prototyping model. Unity3D software used as main software in developing this game and also supported by Photoshop Adobe 7. This software contains multimedia elements which made this software more attractive, interactive and consequently could help students understanding of the Newton's Law. This educational games gives hopes that inspire and help students to master the concepts and skills of Physics.

Keywords : Educational games, Newton's Law, Physics, form four, Rapid Prototyping model

1.0 INTRODUCTION

Country's vision is towards produce and nurture a society that is modern and progressive, namely society that always visionary towards country's future progress. Therefore, education is one of the sources in development of the nation. In aiming globalization era, development in lesson system and learning (T&L) is very important in producing proactive and skilled society in facing competition in global level (Awang & Mohamed, 2011).

Nowadays, education system undergoes fast changes. Various new methods was introduced and used so that lesson of a teacher becomes more effective and more meaningful for student learning. Since the past few years instruction method and computer aided learning have first introduced and present with information and communication technology (ICT) era that is rapidly increase and getting attention by many people (Jamaluddin & Zaidatun, 2003).

As Physics need for development of a country, so an education approach and teaching aid material that are suitable should be used to give understanding that is comprehensive to students in learning Physics. Technology assistance in education system seemed able to increase effectiveness of the teaching process and learning (Yahya Othman & Raini Pakar, 2011). Thus, development based on technology is easier developed and beneficial for student.

2.0 BACKGROUND OF PROBLEM

Physics often assumed difficult and uninteresting to the detriment of mastery and student achievement (Agwagah, 2005; Mazur, 1997; McDermott, 1993). Some factors which influenced level of student's mastery towards Physics are they do not understand the concept, lack of critical and creative thinking, insufficient exposure toward concepts, lack of new and modern learning facilities and boring learning methods (Ifeanacho, 2012; Agommuoh, 2010; Ogbonna 2007; Agwagah, 2005). The use of technologies for instance computer simulation and computerized interface equipment will

help students in understanding the abstract physics concept therefore learning become more meaningful and attractive to students. However, to develop software packages to the purpose is not an easy thing to be done. It requires a group of builder or one who willing to vacate time, have high creativity and having knowledge in programming languages like Authorware, Director and so on (Krishna, 2000).

3.0 PROBLEM STATEMENT

In Form Four Physics syllabus, Force and Motion are difficult to be learnt because it contains many sub-topics (Lilia *et al.*, 2002). Study carried out by Phang & Noor Izyan (2012) finds that topic that is weakest among student is Newton's Law.

Students have limited time to master this topic in school because each topic needs to be taught according to plan. Teachers should complete syllabus according to examination calendar that had been set by the top level. This is because education system in Malaysia is examination based. This system seems students will only be given exercises and memorize important facts which finally will be forgotten (Razali Ismail, 2002). Student that memorize can only store information in short period of time (Aminah Ayob, 2008).

Diagnostic test result carried out on 189 form four Physics student in Kuala Kangsar, Perak find that students face problems in force concept. They still not able to construct the force schema due to existing knowledge owned by them depend on exposure that they received before learn something and premised their own experience. Students always give Physics concepts which are contradictory to the real scientific concept (Anderson, 1986; Fisher, 1985; Gilbert & Watts, 1983; Helm, 1980).

Therefore, it is necessary to develop an educational games software that could assist teacher diversify T&L technique in increasing student's comprehension and also of their interest in Newton's Law. Software developed will use Malay Language as medium of instruction.

4.0 RESEARCH OBJECTIVES

a) To develop effective and efficient educational games software
b) To implement effective lesson strategy that can help students learn Newton's Law by itself

5.0 LITERATURE REVIEW

Technology has been implemented in T&L to improve student's achievement. Many studies were carried out to study the technology implementation in education field (Bell *et a.l*, 2013; Plass *et al*., 2012; Zheng *et al*., 2008; Mayer, 2005). Technology assistance can encourage student to involve actively in learning (Roy & Chi, 2005; Markey, Power & Booker, 2003) beside deepen their understanding towards scientific concept that is complex and abstract (Bell *et al.*, 2013; Plass *et al*., 2012; Trundle & Bell, 2010). Actively engaged student in learning process will help further to increase their comprehension toward learning, further produce effective and efficient.

In line with the impact of sudden change of technology implementation in education, education system should be upgraded continuously coherent to the development of technology. Malaysian Ministry of Education (MOE) must emphasise the use of technologies in T&L as a need in supplying students with scientific and quality study. In this study, technology is applied as teaching aid is education game software.

5.1 Newton's Law Learning Gap

Research showed that student's achievement that learns Newton's Law is low. Table 1 show Newton's Law learning problem could be categorised into two aspects, namely terminology education approach and problem solving approach.

Table 1: Newton's Law learning problem

Approach	Learning Problem
Terminology	a) Definition of force i) Fragmentted critical element usage ii) Definition usage from textbook / reference books iii) Formula usage iv) Misconception b) Force arrow size c) Force and Motion term i) Synonymous terminological usage ii) Self interpretation
Problem Solving	d) Resultant force e) Force resolution i) Draw diagram ii) Memorize the force resolution rule

5.2 Educational Games Software

Educational games software is teaching aid material which involves education pedagogy (Zyda, 2005) and arranged based on by MOE syllabus description (KPM, 2012; Royle, 2008). It can make the T&L process more effective and efficient (Squire 2002; Soloway & Bielaczyz, 1996; Emery & Enger 1972).

Educational games software combine tutorial and simulation. It designed in the form of game to attract attention (Tuzun, 2007) and not just focus on commercial value solely. Education game software which combines multimedia elements like texts, graphics, animations, audios and videos can motivate the learning process (Jonker, *et al.*, 2009; Gee, 2004), contructing schema (Schnittka & Bell, 2009; Bell & Trundle, 2008; Allen, 2007; Mohd Arif, Abdullah & Rosnaini, 2000; Zaidatun & Yap, 2000) and improve the period of long-term memory (Toh, 1999; Najjar, 1996; Nastasi & Clements, 1993; Sewell, 1990).

Educational games software development designed especially to help students, either high ability student or low ability student. They can get particular skill while playing (Milosevic, *et al.*, 2010). For high ability student, they can construct their own schema through existing knowledge and new knowledge received without with help from outside (Clark, 2008; Mayer, 2001). For low ability

student with their poor existing knowledge, they need help during learning process in order to strengthen their schema construction (Mayer, 2001; Hannafin, 1997). Therefore, scaffolding technique in design of certain education software for low ability student need to be emphasized.

5.3 Mayer Rapid Prototyping

Newton's Law educational games software developed using Rapid Prototyping model. Rapid Prototyping model can be used in educational games software development (Tripp & Bichelmeyer, 1990). There is five phases to design educational games software like Figure 1, namely (a) Assess needs and analyze content, (b) set objective, (c) construct Newton's Law Educational Games Prototype (design), (d) construct Newton's Law Educational Games Prototype (research) and (e) install and maintain system.

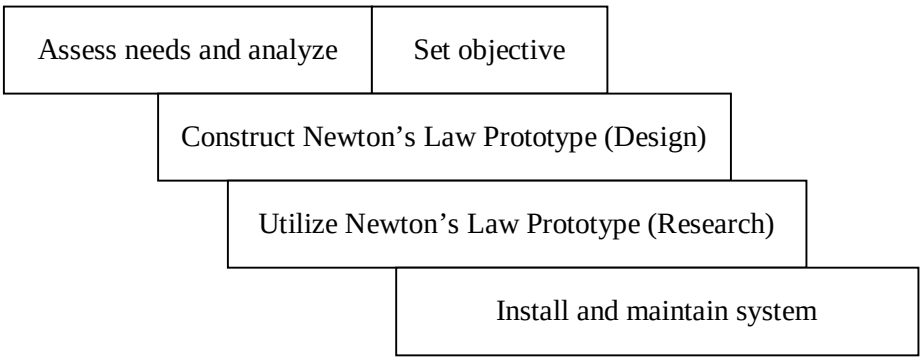

Figure 1: Rapid Prototyping Instructional Design Model for Newton's Law (adapted from Model Allen, 2007)

Phase 1: Assess needs and analyze content

In this phase, researcher gather information through survey research from journal, reference books and information from the internet about Newton's Law learning problem. Apart from that, researcher interviewed a few excellent teacher and Physics committee teacher to help researcher identify problem faced by students in Newton's Law topic. After that, researcher built diagnostic test based on Form 4 Physics syllabus which contains Newton's Law topic. There were 13 questions built based on by Taxonomy Bloom level as shown in Table 2. This diagnostic test purpose is to identify the problem faced by students in every question level.

Table 2: Diagnostic based on Taxonomy Bloom level

Taxonomy Bloom Level	**Question Number**
Memorizing	1,2
Understanding	3
Applying	4,5,6,7,8,9,10
Analysing	11
Evaluating	12
Creating	13

To determine Newton's Law learning gap, researcher evaluated student existing knowledge through diagnostic test. Researcher had conducted preliminaries study on 189 students from secondary school in Kuala Kangsar, Perak. Based on the early survey results, it shows that student face difficulties applying the abstract force concept in order to construct new knowledge of forces. Thus, Newton's Law educational games software are designed with regard the early survey results towards Newton's Law learning gap to activate again existing knowledge and construct new knowledge for student so that they can concrete the abstract force concept further and build force schema to increase student's achievement in Newton's Law.

Phase 2: Set objective

Learning objective construction need to be detailed on what will be learned so students can agree with complete and suitable design (Allen, 2007). So, researcher fix first learning objective that want to be achieved in the form of learning behaviour that need to be controlled in learning end as shown in Table 3. Stimuli chosen must follow the learning objective so that learning objective will be responded and accepted.

Table 3: Newton’s Law educational games learning objective

No	**Learning Objective**
1	Describe situation of force
2	Identify resultant force
3	Resolution of forces
4	Solve problem involving force

Learning objective in Newton's Law educational games software built according to Taxonomy Bloom level namely remember, understand and apply level to help students conceptualize and skill of effort. Remembers and understand level requires student to use mental process to remember again and interpret what has been learned (Krathwohl, 2002; Gierl, 1997). The level of apply test

the students' capabilities in using all concepts, procedure and principle to solve problems (Castle, 2003; Krathwohl, 2002).

Phase 3: Construct interactive Newton's Law prototype (design)

Researcher had developed educational games software that integrates multimedia element and based on game related to student daily life. In this study, there are two educational games software design type, namely educational games software with self explanation (SE) and educational games software without self explanation (NSE). Both games have same design and content but only one difference, namely self-explanation. Newton's Law educational games software developed in Malay Language because the language has been transferred from English Language to Malay Language.

SE and NSE educational games software developed by researcher provide the opportunity to integrate idea, construct force schema and develop automation (through picture and self-explanation) knowledge transfer in near transfer and far transfer (Renkl *et. al*., 1998). Educational games software SE and NSE which combines verbal model design element and authentic, scaffolding technique and prior knowledge. All games designed based on daily life situation in form authentic to stimulate intrinsic learning motivation and encourage actively engaged student in learning (Markey, Power & Booker, 2003).

Phase 4: Utilize interactive Newton's Law prototype (research)

Newton's Law educational games software implemented to Form 4 Physics student in pilot study. This phase involve detection of any educational games software weakness developed. Change on design and force content will be made if there is weakness. Based on pilot study, there is improvements that need to be given attention are terminological usage reduction and optimization of force content that is too long and excessive subtopics.

Phase 5: Install and maintain system

Through install and maintain system, researcher needed to determine whether problem faced has been completed, Newton's Law learning objective has been achieved and Newton's Law educational games software effectiveness based on the ability level different students. Result of install and maintain system carried out will help in making suggestions for improvement.

6.0 DISCUSSION

Educational games software is a teaching aid material which using the computer for T&L. Entire content education and training prepared followed all the Secondary School Integrated Curriculum Syllabus (KBSM). In developing this software, researcher had used Rapid Prototyping Model design as guide. This software built by using Unity3D. Software built based on cognitive learning theory and behaviourism learning theory. At the same time, software also used multimedia elements like text, graphic, animation, audio and video. These elements are important to convey information and fill education with more effectiveness to students. With this software, hoped it can provide assistance and reference to students in learning Newton's Law. For software developer on the other hand, hoped it could give a bit guide and reference in an effort to produce more high quality software.

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