

The use of PBLMathGame as a Problem based learning tool.

Faaizah Shahbodin¹, Zareena Rosli^{1, 2}

¹ Department of Interactive Media, Faculty of Information and Communication Technology,
Universiti Teknikal Malaysia Melaka, Locked Bag No. 1752, 76109 Durian Tunggal, Melaka, Malaysia.
Phone: +606 3316740 Fax: +606 3316500

² Department of Mathematics Science and Computer,
Politeknik Merlimau, Melaka, Locked Bag No. 1031, 77300 Merlimau, Melaka, Malaysia.

Abstract

This paper revealed the framework of PBLMathGame prototype and discussed the effectiveness of using game as a tool in PBL environment. The development of the PBLMathGame is based on the skills needed in problem solving in Related Rates topic. By understanding the relationship between educational needs and game elements, the PBLMathGame is developed that include visualisation and problem solving skills. The experiment was carried out for two weeks involving 28 students who enrolled into Engineering Mathematics 2 course. The experimental group (EG) was exposed to PBL and Educational Game instruction whereas the control group (CG) was taught by PBL only. There are two set of instruments used in this study namely PBLMathGame courseware, problem solving answer sheets and rubric sheets for problem solving. The data were analyzed using independent t-test. The result showed that students improved their problem solving skills in solving Related of Change problem when incorporating game in their learning. Thus, this study has shown some value added to the area of PBL learning.

Keywords: Education game; Problem based learning; Mathematics; PBL tools

1. Introduction

Playing games is a common skill to our social and mental development. According to YanHong *et. al.* (2010) and Costu *et. al.* (2009), with the advent of computer technologies and internet, games can be used for the development of education area. Nevertheless, with the rapid technological innovation that influence competencies, knowledge and skills, there is a need for pedagogical change in Malaysian education program Zakaria *et.al.* (2010).

Problem Based learning (PBL) is the integration of specific concepts and classroom contexts for enhancing students' critical-thinking skills and problem solving ability. Moreover, the challenge of globalisation today requires students to master problem solving skills and positive attitude and values besides good conceptual knowledge of mathematics. PBL also serves as a powerful tool in empowering learners to have a sense of control of their learning Tan and OS (2004).

In order to obtain the cognitive and affective benefits of educational games in the classroom, a well-designed educational game needs to be grounded in the prototype. In this study of PBL, the game was used as one of the learning resources for students to learn Related Rate topic. The game developed intended to develop and improve students' skill in problem solving especially in developing mathematics concept and procedural knowledge among students. The PBLMathGame was designed as an in class activity to assess students understanding of Related Rate topic. In a research conducted by Martin (2000), the result shows that while performing problem solving, students are proficient in performing algorithms, but lack of ability to connect procedure with their conceptual knowledge. The inability to connect both knowledge was the thought of students' difficulties in higher level mathematics (Zahrah *et. al.* and Ismail, 2009; Tarmizah, 2005). Thus, an initiative of integrating game in PBL environment has been taken to improve student's quality in problem solving skill in mathematics.

In this paper, we will describe the prototype of PBLMathGame created to enhance students' skills in mathematics problem solving and to assess the impact of PBLMathGame in enhancing students' skills in problem solving based on rubric scores. The game consists of content that develop student's knowledge in relating mathematics concept and procedural steps in solving related rate problems. The game design, create a game environment that allowed players to learn Related Rate topic while having fun with the game and interactive environment as game in education has shown improved motivation and students' engagement and improved participation and achievement (Ishikan *et. al.* and Yan Hong *et.al.*, 2010, Papastergiou, 2009 and Alan *et.al.*, 2000).

2. PBLMathGame Prototype

The game was used as an in-class activity to assess students understanding of Related Rate topics. In the PBL environment, the game was embedded in the learning resources, for the students to practice and learn problem solving in Related Rates word

* Corresponding Author : Zareena Rosli. Tel.: +606-2636687
E-mail address: zareena703@yahoo.com

problem. The settings of the game started with questions on mathematics concept that covers diagram sketches and understanding mathematics notation from word problem. Then, for the medium level student will be tested on understanding conceptual and procedural steps in related rate problem and the higher level they will be asked to solve real life problem. Throughout the game, students are going to solve each level's question based on their understanding of the topic. The questions developed emphasized on assessing students' ability in problem solving. At the end of the game, the score will be posted to the score board for assessing student level of knowledge in solving each problem. This game activity can be used as a class activity or it can be played individually. Therefore, the student can freely try the game; find out their mistakes with discussing with peers, facilitators or searching information from other sources provided in the courseware or by internet. By this way, the student can learn from their mistakes to solve the problem. Figure 1 and 2 shows the interface of the game



Figure 1. Introduction page for PBLMathGame

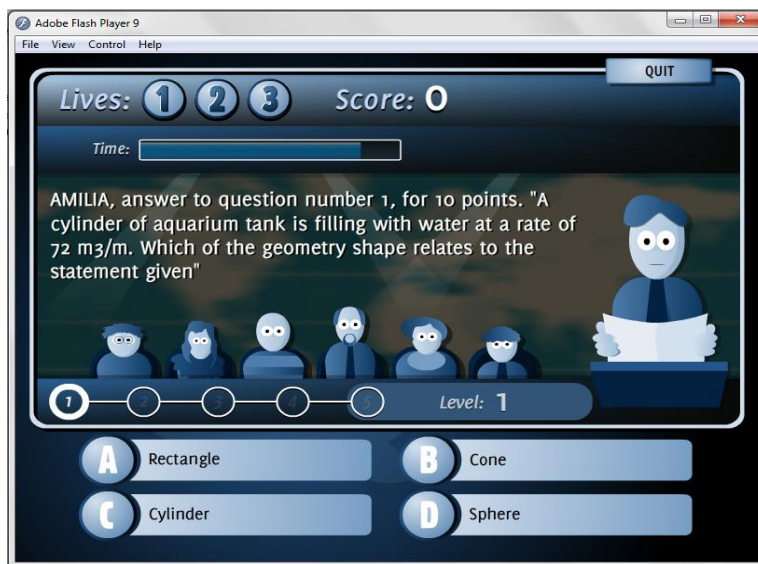


Figure 2. One of the questions for PBLMathGame

3. Method

In order to meet the objective, a prototype courseware PBLMathGame has been developed. There are 28 students from Year 2 who participate in this research. The students were divided into two groups; experiment group (EG) and control group (CG). They are equally in term of academic achievement. Both groups will undergo PBL learning method but for the EG, there is a game use as one of their learning resources. Students' skills in problem solving were tested by during problem solving session. An answer sheet will be given to each student for the solution answer and a rubric scores for problem solving is used to evaluate their scores. A t-test was conducted to analyze the mean scores between each group. Below is a list of research question and research hypothesis in order to achieve the objective:

Q1: Is there any significant difference in term of problem solving skills between PBLGame group and non-PBLGame group?

H₀ 1: There is no significant difference in term of problem solving skills between PBLGame group and non-PBLGame group.

In order to answer the research question, a testing model has been developed as shown in Figure 1.

The problem solving rubric was used to evaluate the students' answer. The score of the students were evaluated based on 6 constructs on the ability of problem solving which is i) Diagram and Sketches, ii) Mathematical Terminology and Notation, iii) Mathematical Concepts iv) Strategy/Procedures, v) Mathematical Reasoning and iv) Completion. The resulting are starting score from 1(Beginning), 2(Developing), 3(Accomplished) and 4(Exemplary).

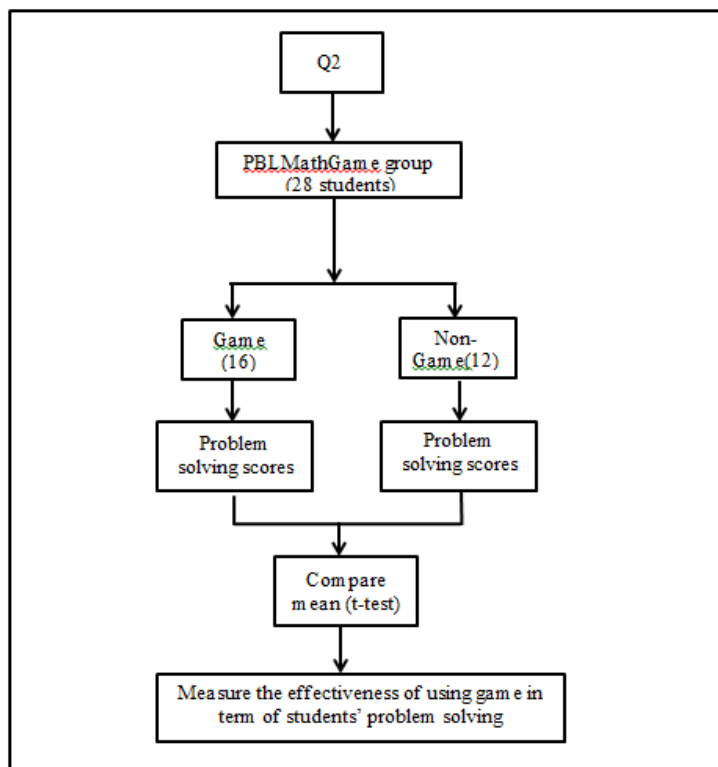


Figure 1. Testing Model for using game in integrating problem solving skill

4. Result and Discussion

Enhancing Students' Skills in Problem Solving: The purpose of study was to determine the effect of educational game (PBLMathGame) in enhancing students' skills in problem solving. There were 28 students participated in the study. They were divided into two groups namely PBLMathGame group and non PBLMathGame group. During the problem solving sessions,

both groups were evaluated by a rubric score. These scores were used to determine the impact of game use in the learning session. The result of the study is shown in Table 1.

From the result, it shows that students in PBLGame are more competent in (i) identifying diagram and sketches ($M=3.88$, $SD=0.34$) compared to PBL-nonGame ($M=3.5$, $SD=0.52$) conditions $t(26)=2.30$, $p=0.30$. The game content that challenge students on identifying geometry shape is believed helps the student on identifying shapes as well as able to sketch it correctly. The result also shows that there was a significant difference in the scores for item (ii) mathematical terminology and notation between PBLGame ($M=3.69$, $SD=0.47$) and PBL-nonGame ($M=3.17$, $SD=0.83$) conditions $t(26)=2.09$, $p=0.047$. The game content that provides students with sort of mathematics notation and terminology established student's capability in knowing tu use it correctly. Lastly on item (iii) mathematics concept, the result reveals that there is a significant difference PBLGame ($M=3.63$, $SD=0.50$) and PBL-nonGame ($M=3.08$, $SD=0.79$) conditions $t(26)=2.22$, $p=0.036$.

Table 1. T-test result for problem solving skills

		Independent Samples Test		
		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Diagrams and Sketches	Equal variances assumed	2.297	26	.030
	Equal variances not assumed	2.164	17.844	.044
Mathematical Terminology and Notation	Equal variances assumed	2.087	26	.047
	Equal variances not assumed	1.936	16.364	.070
Mathematical Concepts	Equal variances assumed	2.215	26	.036
	Equal variances not assumed	2.077	17.404	.053
Strategy/Procedures	Equal variances assumed	.450	26	.656
	Equal variances not assumed	.469	25.998	.643
Mathematical Reasoning	Equal variances assumed	.156	26	.877
	Equal variances not assumed	.158	24.717	.876
Completion	Equal variances assumed	1.138	26	.265
	Equal variances not assumed	1.130	23.203	.270

5. Conclusion

The result of this study shows the element of game in PBL can foster student in learning. With the element of critical thinking, self-exploration and group discussion while playing the game in PBL environment helps them in the learning process. Thus, supports that games can give impact in enhancing students' problem solving skills in mathematics. As a conclusion, building a creative learning environment such as leveraging PBL and game can foster students' interest in learning and improves their capability in learning. Hence it will help the education ministry in producing a knowledgeable and skill able engineers in future.

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