

# Knowledge Development through Constructionism Game-Based Learning Application: An Evaluation of Students' Performance

M. H. Yusoff

**Abstract**—At present time, the educators focus more on the use of technology in education such as e-games and e-learning. This paper introduces the research on the development of knowledge through constructionism learning theory by using e-games. It is foreseen to change traditional learning method into one that is ICT centered. The e-games were developed by Game Maker application and incorporated one of the learning theories that is constructionism learning theory. The parameter that is being tested is the level of knowledge in students. In the testing phase, 30 students of Software Engineering in University Malaysia Terengganu were tested on. They were divided into two groups, that is control group and treatment group. The control group used the traditional learning approach meanwhile the treatment group was tested by using e-games approach. The students' performances were recorded by their Pre-Test and Post-Test scores which is the dependent variable. The course that was used as the scope for this research is Tourism in Malaysia. The game that had been built allows students to obtain general knowledge about islands in Malaysia and unique info regarding every place in those islands. All data of the tests were analyzed by using SPSS, statistical software. The results of Pre-Test and Post-Test stated that the students of treatment group showed an enhancement in scores. Creating e-games learning environments for educators and students may help the future of education evolve in meaningful ways. This research applies constructionism learning theory in e-games application to improve the student's level of knowledge.

**Index Terms**—Games based learning, constructionism learning theory, the tourism game.

## I. INTRODUCTION

The problem with traditional learning is that the students learn "what" and not "how", the students and the teachers are busy completing the required subject matter quota [7]. Besides that, the student's motivation is low. By using computer mediated learning framework, students expressed higher satisfaction. At present, today's education courses mostly involve the role of ICT's approach. Along with the technological development, the education field was also affected. Computer games are more profitable and popular than ever before and are recognized as one of the significant cultural medium.

## II. PROCEDURE FOR PAPER SUBMISSION

To understand the theories in greater depth, a few sources

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have been used as references. Analysis of the sources have been applied in the research and development of The Tourism Game and used in addition to other information obtained. Through this research, the objectives and true scope of The Tourism Game were verified.

### A. What are E-Games?

Education can be taught in many ways. In addition, educators strive to find different methods of teaching students and improving their attention. As part of this plan, education through playing games also taking part. As a learning tool, E-games strategies have been shown to be more effective than traditional methods [2]. Students are more willing to learn when the learning is engaging and game-like.

Educational elements that have been applied in video or computer games can provide more enjoyable learning outcomes. [4] Defines electronic games (e-games) for education as an application that use video and computer to create an interesting learning experience. [1] which makes <e-Adventure> as their case study also supports that game-based learning can promote the learning process in many aspects. Based on [8], e-games are not only used merely for entertainment but can also be used for education and training, rehabilitation, development strategies, public policy development, simulation and wars. This emphasizes the use of e-games as not only for entertainment but also an education platform. Knowledge development can occur whilst playing e-games.

### B. Constructionism Learning Theory

There are many learning theories that can be applied through the process of learning such as cognitivism, behaviourism and constructivism. Behaviorism learning theory states that the learning is an externally observable behavior which includes acts, thoughts and feelings, when there is a repeated stimulus and response will then took place. Behaviorism also focuses on mental and behavioral activity of a human [10]. Cognitivism in turn is a response to behaviorism theory of human thought is as organisms that have goals in their behavior and constantly interacting with the environment. It is stated by Greenwald in 1968 [5] that study how people understand and represent the world outside of themselves and how it influences the behavior.

Constructivism considers learning as a process in which students actively build or construct new ideas or concepts. Based on the web (funderstanding.com), it is a philosophy of learning founded on the premise that, by reflecting a personal experience, an understanding of their own building in their world. Objectivist holds that human beings have direct

contact with reality through sense perception, that one can attain objective knowledge from perception through the process of concept formation and inductive logic. Objectivist approach shaped the view that knowledge is cumulative and based on the resulting learning prerequisites have been met, such as historical knowledge necessary for further learning. [11] stated in his study that that learning occurs through a model or symbol of the reality that has already been placed in the human mind based on past experience.

Meanwhile, the constructionism learning theory as stated by Seymour Papert is a theory that is based on constructivist theories of Jean Piaget. This theory encourages students to become designers of their own ideas. He also emphasized that if students are involved with artifacts or objects and communicate actively with other students, learning will be more effective. In the context of e-games, the diagram is considered as artifacts or extraneous matter[8] also stated that constructionism adds the idea that people construct new knowledge effectively, especially when they are personally involved in building the product. For example, building sandcastles, playing LEGO [9] and others. So with this, it can be concluded that the theory of constructionism adapted from the addition of external artifacts to work with more effectively. But in the context of electronic games, artifact is defined as diagrams or graphics in the game.

Constructionism theory also has its elements. Among the elements necessary for the purposes of learning theory in constructionism [6] are exploring a variety of strategies to address the task, discussion of learning, the projects include the revision and development of an ideas, partnership students, students work with professionals in situations that seems real and involvement of students in situations similar tasks in real situations.

### C. Integrating Constructionism Learning Theory Into E-Games.

Constructionism is both a theory of learning and a strategy for educational learning. Playing games can provide incidental learning for certain person. For example, *The Sims* [12] is said to teach consumerism, one of the values of capitalism: it encourages players to earn money so they can spend it and acquire goods [3]. The e-games that had been made absorbed the concept of constructionism learning theory by making the student actively engaged with learning and making their own ideas. One of the level in this game practicing the concept of constructionism by letting the student building their own city.

## III. MATH

### A. Research Design and Procedures

This research was using the pre-test and post-test control design. This research design consisted of treatment group and control group. Respondents were randomly selected into these two groups. The following are steps in making this research:

- Step 1: Prepared the research proposal
- Step 2: Prepared the product that the e-games.

- Step 3: Conducted a study about pre-test and post-test.
- Step 4: Samples selected for both control and treatment groups.
- Step 5: Conducted a pre-test on both control and treatment group
- Step 6: Conducted learning sessions for both groups. The treatment group did e-games for learning session meanwhile the controlled group did the traditional learning methods.
- Step 7: Conducted the post-test.
- Step 8: Carry out data analysis.

## IV. HELPFUL HINTS

### A. Knowledge Test (Pre-Test and Post-Test)

This study utilizes the design of pre and post tests. In this design, when the respondents completed the stimulation otherwise known as a treatment, they will be evaluated again. The respondents are asked questions containing each item. Pre-test questions were made to measure the ability of the participants before the training. Meanwhile, the post-test questions were made to evaluate the ability of the respondents after the training.

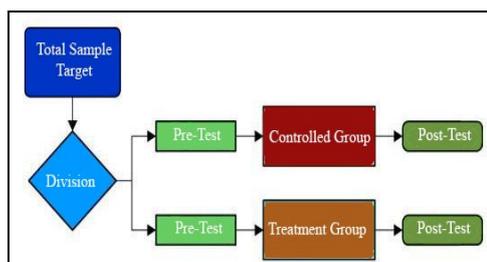


Fig. 1. Research design.

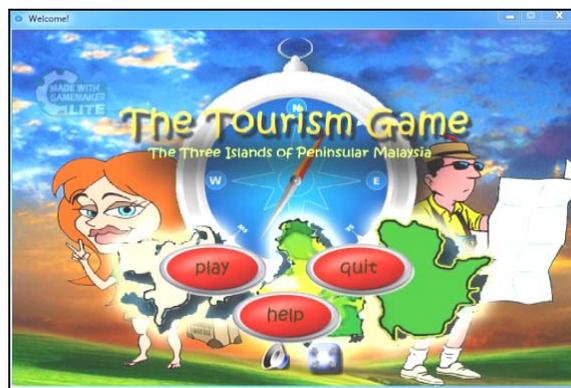


Fig 2. The first interface of the tourism game.

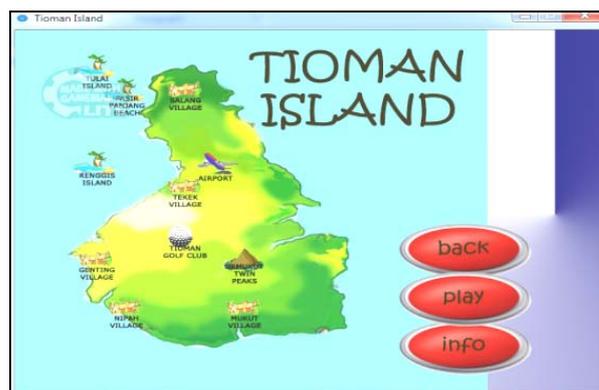


Fig. 3. The first stage.

The selected subject is Tourism in Malaysia. This topic is general knowledge. In Malaysia, this sector has been identified as the second largest foreign exchange earnings and to help strengthen the economy of this country [7]. In this research, three islands in Malaysia have been chosen as the experimental material, Pulau Langkawi, Pulau Redang and Pulau Tioman. Every place on the islands has its own information.

**B. E-games Development**

Game Maker allows users to create games without writing any lines of code using only the Interactive Development Environment (IDE)[13].

The game is entitled The Tourism Game. Fig. 2 shows that the player must press the 'Play' to play the game. It then shows the environment of the game. As depicted in Fig. 3, the game environment portrays the island chosen by the respondents. The respondents can then choose any place on the island and click on the island to get information. Here is the first stage.

The second stage in which the respondent built their own island based on the historical artifacts provided in the game. This stage applies constructionism theory. Fig. 4 shows that the respondents have to first select an island to be developed. Next, the respondent will build their own islands as well as marks obtained on the basis of their own creative ideas as shown in Fig. 5.



Fig. 4. The second stage interface.



Fig. 5. The interface where constructionism theory applied.

This game continues with the final stage in which the respondent will test the general knowledge they have learnt about the island. This level applies adventure game while answering questions about the island as shown in Fig. 6. If respondents answered correctly, they will get a score and vice versa.

In the implementation phase, the game was tested by a number of respondents. This was to ensure that the program would run smoothly. The game was then specifically tested on the 15 respondents for the research.

The next phase was the maintenance phase. Apart from ensuring that the game will run smoothly, it was also needed to allow any changes to be done should there be any need for corrections. If there is a new requirement, it should be changes in either coding or design.

Although Game Maker allows users to create games without writing any lines of code with only the functions of drag-and-drop, but to build any more complex games that still need to write a logical line of code.



Fig. 6. The final stage

**V. SOME COMMON MISTAKES**

**A. Research Hypothesis**

For this study, the initial hypothesis that was developed states that there were no significant changes in the level of knowledge on a respondent by the use of e-game constructionism theory.

The results showed that the initial hypothesis was rejected. There were some changes in the study. This supports the alternative hypothesis that there is some improvement in knowledge development.

The result of this research is that there is increased level of knowledge of the respondent after the training provided. Comparison of the results of the test questions and question-pre-post test was done to see changes in the level of knowledge of respondents. To identify any significant changes between the pretest and posttest, between treatment and experimental groups, data analysis were done. Dependent t-test was conducted to compare the levels of both groups.

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error	Confidence Interval of the Difference				
					Lower				Upper
Pair 1	pre-post	-3.533	2.997	.774	-5.193	-1.874	4.566	14	.000

Fig. 8. Paired samples test for controlled group.

In the Fig. 8, the average difference between the pretest and posttest was 3.533. On average, post-test respondents scored 3.533 higher than the same respondents the pre-test.

In the table above, the mean score during the Pre-test was 17.67 and the mean score during Post-test was 21.20. There were 15 scores at each time period, indicating that there were 15 participants. The standard deviation (SD) for each group was approximately 2.870 and 2.484.

	Mean	N	Std. deviation	Std. error mean
Pair 1 pre	17.67	15	2.870	.741
post	21.20	15	2.484	.641

Fig. 9. Paired samples statistics for controlled group.

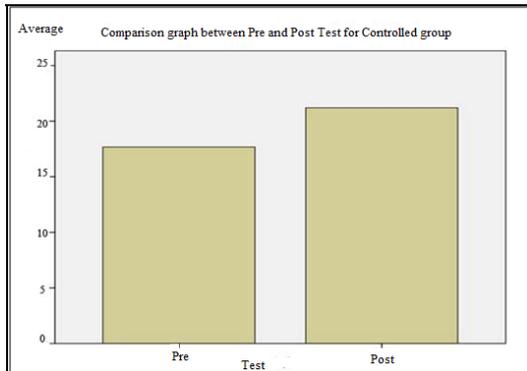


Fig. 10. Bar Graph of Average for Controlled group.

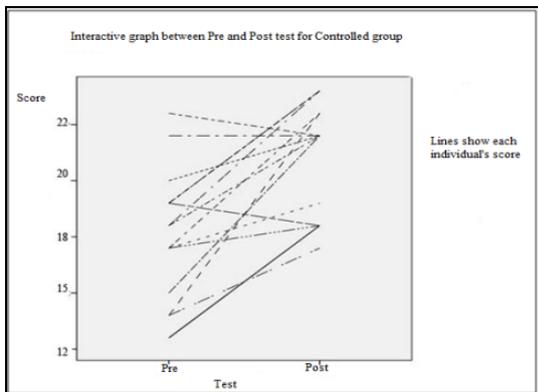


Fig. 11. Interactive graph of each individual's mark

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	(Confidence Interval of the Difference)				
				Lower	Upper			
Pair 1 pre-post	-3.400	4.102	1.059	-5.672	-1.128	-3.210	14	.006

Fig. 12. Paired samples test for treatment group.

	Mean	N	Std. deviation	Std. error mean
Pair 1 pre	17.93	15	3.127	.808
post	21.33	15	2.920	.754

Fig. 13. Paired samples statistics.

For the treatment group, In the Fig. 12, the average difference between the pretest and posttest was 3.4. On average, post-test respondents scored 3.4 higher than the same respondents the pre-test.

In the table below, the mean score during the Pre-test was 17.93 and the mean score during Post-test was 21.33. There were 15 scores at each time period, indicating that there were 15 participants. The standard deviation (SD) for each group was approximately 3.127 and 2.920.

Below is the mean graph and the interactive graph for treatment group.

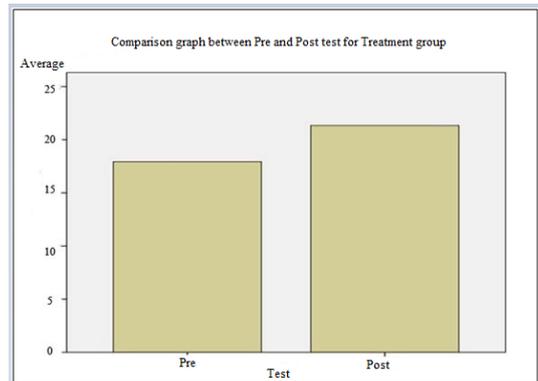


Fig. 14. Bar graph of average for treatment group.

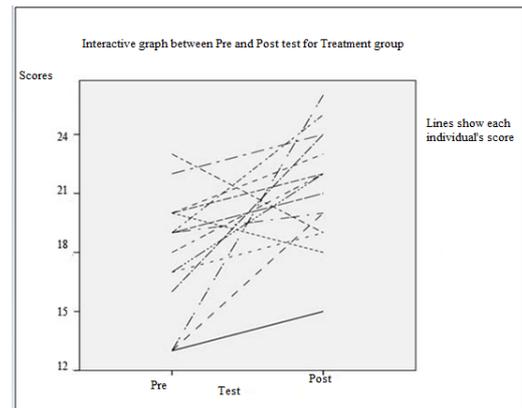


Fig. 15. Interactive graph of each individual's mark.

Looking at the average difference for the control and treatment groups, the control group had an average higher than the treatment group. However, scores for both groups have increased for each post-test.

## VI. CONCLUSION

The research that has been carried out can be said to have achieved the objectives and scope set at the beginning of the study as the developed game can facilitate knowledge development while providing fun environment to students. Besides that, it can provide some information to the students just by playing the game.

The control group and the treatment group succeeded in improving their achievement in learning. Both of the groups showed enhancement in their scores even though the increment of treatment group is a bit lower than the control group.

It is hoped that the e-games in learning can serve as one of the effective ways to educate the students in this country.

## VII. FUTURE PROPOSED STUDY

For future studies, perhaps the following elements need to improve further research by adding variables to measure the effectiveness of research. Elements such as the respondent motivation and retention of knowledge and raising the classification of users.

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