Development And Evaluation Of Immersive Card Games As Booster Memory In Engineering Science

Nur Ismalina Haris¹, Amarul Talip²³, Mohd Zulfabli Hasan¹
¹Mechanical Engineering Department, Politeknik Tuanku Syed Sirajuddin, Perlis, Malaysia.
²Green Design and Manufacture Research Group, Center of Excellence Geopolymer and Green Technology (CEGeoGTech), Universiti Malaysia Perlis, Perlis, Malaysia.
³PP Diploma, Universiti Malaysia Perlis, Perlis, Malaysia.
E-mail: nurlyena@gmail.com

Abstract. Engineering science is one of the core courses that must be taken by students in engineering. There is no doubt that too many laws and concepts to be learned and understood will cause students to feel difficult and less interested in pursuing engineering science. Many studies have shown that learning motivation and understanding can be achieved through educational games. Therefore, the main purpose of this study was to help engineering students learn and understand concepts by using educational card games through immersive technology. Card development and evaluation methods have been done while pre and post test have been conducted to see the effectiveness of the card against respondents. As a result, it shows that card designs play a role in enhancing student understanding while providing positive attitudes towards the use of the educational card games with immersive technology in engineering science learning. Notwithstanding, the outcome of the survey of the respondents involved in the test shows the enthusiasm and determination to use the card games. As a result, it can be highlighted and applied to all students.

1. Introduction

Engineering science is one of the many courses that emphasizes the concept and law contained in Physics such as Zero-Thermodynamic Law, First Newton Law, Bernoulli’s Law and Ohm’s Law. There are many laws and concepts that need to be understood and memorized traditionally will cause students less interest in this engineering science. Infact, most of the law is interconnected with others such as as the First, Second and Third Newton Laws. Misunderstanding one of Newton’s Law will be resulted in no continuity between the three Newton Laws.

A study conducted on 1,400 students and a group of Physics teachers has agreed that Physics is cumulative which is if do not understand a concept or theory it is difficult to understand other concepts and theories e.g Newton’s theories of law. In fact, they also point out that there are too many things to learn and formulas to remember in Physics [1].

Thus, one of the activities that can be highlighted to encourage collaborative learning among engineering students is through games in education. Games in education are seen to have some positive features that can bring interest in learning in science. It is one way that can be used to remember and understand the basic facts and principles of science. It offers advantages over traditional learning.
approaches [2]. The spirit of learning also can be enhanced through games as well as exposing students to more creative and fun learning forms and reducing boredom in teaching and learning [3].

Game cards are widely used in science and engineering education. Referring to [4], card games are more effective than traditional methods and very helpful in improving memory and understanding. The study uses card games in biological education where the field is seen to have many complex concepts and vocabularies that need to be understood and remembered.

Meanwhile previous literature [5], also developed a card games named Voyager: Satellites since 2001 for school children aged between 9 and 13 years and also for general public. The card is used to convey information about Earth, space science and satellites in fun and entertaining way. The card games has received encouraging response from teachers and the community and a large number of Voyager card games: Satellites have been printed and circulated throughout the United Kingdom.

Along with technological advances, card games have also undergone a transformation where it has been created with the added use of technology. The advantages offered by the card games with this technology have gained attention in education such as web-based learning, android application, creative learning through Virtual Reality technology and the latest Augmented Reality (AR) technology along with the Industrial Revolution 4.0. The term Augmented Reality is defined in multiple ways and the most popular definition by Azuma proposed in 1997 that “Augmented reality is a field in which 3D virtual objects are integrated into a 3-D real environment in real time.” [6].

The study conducted by [7] shows that the use of interactive multimedia technology with AR technology in the subject of fitting skills in vocational colleges successfully enhances the learning process, helping students to perform practical tests and can be used as a teaching tool to generate active learning environment between teachers and students.

2. Methods

This study was divided into two phases. Phase 1 was the development of immersive card games and phase 2 was the evaluation of of effectiveness immersive card games as booster memory in Science Engineering. Figure 1 below shows the flow of methodology framework of this study. This framework was adapted from similar study [4,8].

![Figure 1. Flow of methodology framework.](image)

Referring to Figure 1, there are four steps involved to develop and evaluate the effectiveness of card games: instructional content and objectives, planning and conceptualization, game development and pilot testing and evaluation of the effectiveness of the card games.
2.1 Step 1: Input
Instructional content and objectives: Three main topics in Engineering Science were selected that are Force and Motion, Electricity and Electromagnet, Fluid, Heat and Thermodynamics. The card games must have features such as pocket size, easy to carry and play.

2.2 Step 2: Process
Planning and conceptualization: Research and studies, preparation of materials also other pertinent aspects were established in this step. Four important basic elements were considered to develop this immersive card games [9]:

- Mechanics: Action, Rules & Chance
- Story/Picture: Force & Motion, Electricity & Electromagnetism, Heat & Thermodynamics
- Aesthetics: Looks, Audio, Video & Feels
- Technology: Augmented Reality and Quizizz

Card design: In this project three important basic concept in Engineering Science were selected; Force and Motion, Electricity and Electromagnetism and Fluid, Heat and Thermodynamics, so there are 48 cards and each topic consists 16 cards as shown in Figure 2. The stable and suitable AR techniques to enhance the visual learning that is HP Reveal were choosen to equip the card games. This card games also have been linked to Quizizz to test students understanding and also can be use as booster memory.

![Sample of three cards from three topics](image)

Figure 2. Sample of three cards from three topics

2.3: Step 3: Output
In order to measure the effectiveness of the immersive card games usage, the data collection process is done through pre and post test execution. A total of 30 students of Mechanical Engineering Diploma semester 1 (DKM1A) from Tuanku Syed Sirajuddin Polytechnic, PTSS Session June 2018 were selected to undergo this test. The data obtained from this pre and post test will be quantitatively analyzed using paired sample t-test method. This t-test is intended to compare the abilities of students to answer questions before and after playing immersive card game.

2.3.1 Pre-Test
These DKM1A students take the Engineering Science course in the first semester. Force and Motion topics have been selected and conventional learning methods are used together with discussions. After completing this topic, students are given 7 days to make revision before pre-test. After 7 days, pre test was conducted among 30 students. The researchers found that marks obtained from pre-test were low and some were zero.

2.3.2 Post Test
After pre-test, researchers continue teaching and learning assisted by this card game. Students are given the opportunity to play this card game in several groups. Students are required to send scores obtained from the game together with pictures and videos as evidence. Post-test is done after completing the teaching and learning sessions.
2.3.3 t-Test
Reliable sample t-tests have been performed to see the effectiveness of card games usage on teaching and learning. Table 1 shows the experiment information carried out.

| Number | Item                          | Value |
|--------|-------------------------------|-------|
| 1      | Sample, n                     | 30    |
| 2      | Degree of Freedom, df         | 29    |

3. Results and Discussions
The data has been analyzed has been shown in Table 2 and Table 3 below.

|                          | Pre Test | Post Test |
|--------------------------|----------|-----------|
| Mean                     | 5.8667   | 7.2000    |
| N                        | 30       | 30        |
| Standard Deviation       | 1.38298  | 1.24291   |
| Std. Error Mean          | 0.25250  | 0.22692   |

Table 2 above shows the mean score of student performance before using the card games is 5.8667 and is smaller than the mean of performance after using card games of 7.200. This means that student performance before and after using cards games has a significant different.

| Perbezaan                |          |
|--------------------------|----------|
| Mean                     | -1.3333  |
| N                        | 30       |
| Standard Deviation       | 2.12267  |
| Std. Error Mean          | 0.38755  |
| t                        | -3.440   |
| df                       | 29       |
| Sig. (2-tail)            | 0.002    |

Likewise, based on Table 3, the t-values for student performance comparison before using card games and after using card games are $t = -3.440$ and significant level $p = 0.002$. This significant level is smaller than 0.05 ($p>0.05$). Therefore, the findings show that there is a significant difference between student performance before applying card games and after using card games.
4. Conclusions
The increment of scores in post-test after using this immersive card games shows that this card games can enhance students' understanding and memory in Science Engineering courses. This game card has been designed with the addition of Augmented Reality Technology elements where the advantages of this technology can enhance the player's visual memory in addition to the fun of play. The findings support the study by [10] as these students are Gen-A that to be among the most intelligent generation, highly materialistic and obsessed with technology. This card games also have been linked to Quizizz to test students understanding and also can be use as booster memory. In fact, this card games can be played with fellow students to help their independent learning time.

References
[1] Ornek F et al. 2008, *International Journal of Environmental and Science Education* **18** 165.
[2] Ellington H et al. “Games and Simulations in Science Education,” in *Games and Simulations in Science Education* 1981.
[3] Subramaniam R et al. 1999, *J Biol Educ* **33** 103.
[4] Gutierrez A F 2014 *CBE—Life Sciences Education* **13** 76.
[5] D. R. Smith et al. 2009, *Physics Education* **44** 479.
[6] Azuma R T 1997, *Presence: Teleoperators and Virtual Environments* **6** 355.
[7] Ismail M E et al. 2017 *Online Journal For Tvet Practitioners, Advanced Center for Technical and Vocational Education* **2** 2.
[8] Bulagang A F et al. 2017 *Indian Journal of Science and Technology*, **10** 39.
[9] S. Jesse 2008 ELSEVIER **41** 46.
[10] McCrindle M et al. 2014, *Understanding the Global Generations* **1** 12.