

Non-Major Students' Perception on the Application of Gamification and Simulation in Electrical and Electronics Engineering Courses at Universities in Malaysia

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Article history

Received
8 June 2022
 Received in revised form
21 September 2022
 Accepted
22 September 2022
 Published online
20 December 2022

Abstract

In the field of electrical and electronics (E&E) technology that is evolving rapidly, the Ministry of Higher Education Malaysia emphasizes universities to ensure that the expected non-major E&E engineering graduates are fully equipped with the skills to fulfil market needs. However, it is challenging for non-major students to understand the topics taught to them through the methods as they are conventionally being delivered. Therefore, gamification and simulation such as Kahoot, Quizizz, Multisim and CircuitMod have been applied in the university to facilitate formative assessment in order to enhance interest and understanding, and also accomplish learning more effectively among non-major students. Hence, this research aims to examine the non-major students' perception of the implementation of gamification and simulation in class for face-to-face and online settings. To achieve this, a set of questionnaires was adapted with some modifications for the purpose of data collection. It was distributed to the students from random public universities in Malaysia who are currently enrolled in E&E engineering courses at their respective universities which majority of them are from a mechanical engineering background. Research questions concentrate on the advantages and students' perceptions of gamification and simulation in E&E engineering courses. The collected data has been analyzed using descriptive statistical analysis. Based on the perceptions of the participating non-major E&E engineering students, the majority of the respondents agreed that gamification and simulation provide a better learning experience with the highest score mean of 4.22. Moreover, gamification and simulation boost students' ability to learn, motivate them, increase their understanding, promote their well-being, and increase their achievement academically. Students hold a positive perception with 4.20 mean score, stating that it is suitable for application in the learning process as it is easy to use, fun, motivating, and more efficient. The results provided would encourage educators in Malaysian universities to better meet the needs of teaching non-major students with their lessons.

Keywords: Gamification, Simulation, Engineering Education, Teaching Method, Electrical and Electronics Engineering

Introduction

According to the Eleventh Malaysia Plan, Malaysia recorded an unemployment rate of 3.3% in 2019 (Semouk, 2019). Therefore, the Malaysian government has given special attention in the Twelfth Malaysia Plan towards enhancing the capability of individual employment and providing a large pool of highly skilled workers across various demanding industries, especially electronics technology in the field of electrical engineering (Lelchumanan, Ismail, & Sulaiman, 2019; Yong, 2019). Hence, this aspiration has created a new enthusiasm for universities as a part of the technical and vocational education and training to ensure that career needs can be accommodated by their expected engineering graduates such that their talents are not wasted.

Most of the electrical schools at the universities in Malaysia offer one or two introductory service courses in electrical and electronics (E&E) engineering to non-major students. For instance, Fundamental of Electrical Engineering and Electronics courses served as the introduction in the E&E engineering course at

Universiti Teknologi Malaysia (UTM), Principle of Electric and Electronics, and Electric courses at Universiti Tun Hussein Onn Malaysia (UTHM) and Electronics Technology at Universiti Teknikal Malaysia Melaka (UTeM). The Electronic course offered by the School of Electrical Engineering, UTM for instance, is mainly intended to introduce non-major students to semiconductor devices and basic concepts in analogue electronics. The mapped course content includes the basic structure of electronic devices, their characteristics, circuit analysis and applications. The goal is to develop an excellent understanding of the operation of the device among non-major students to be applied in analogue and digital circuit design that may be required of the workforce according to the industrial trend. Other than that, the students will make relation with all relevant information, which was obtained during class conducted for Constructivism Learning Technique. Apart from that, they prefer to apply that information as their experiences to be applied in a reality. Based on this, the Constructivism Learning Technique has been embedded successfully which they can use all those information obtained

during the class conducted. Then, they will be preferred to apply that information as their experiences to be applied in a reality (Matsumoto, Amagai, & Yuminaka, 2020).

However, a growing concern has been raised regarding non-major students' difficulties in coping with the topics taught in E&E engineering courses during the teaching and learning process. It was based on the fact that the mapped course contents were impractical and irrelevant to their field which has led to a learning barrier (Hajjar & Sobahi, 2012). This situation was further exacerbated by the severe impact of the Covid'19 pandemic which limited the students' ability to adapt and pay attention to the lesson. Consequently, there are methodological and effective strategies that are being implemented by the majority of the educators in lieu of traditional teaching methods (online lessons or in-presence), to get non-major students interested with their lessons to achieve the learning objectives effectively (Buckley & Doyle, 2016; Leung & Pluskwik, 2018; Majuri, Koivisto, & Hamari, 2018; Moccozet, Tardy, Opprecht, & Léonard, 2013; Nieto-Escamez & Roldán-Tapia, 2021; Wiggins, 2016) for example cooperative learning, competitive and innovative learning (gamification) (Matsumoto, Amagai, & Yuminaka, 2020), Project-Based Learning (PBL) and simulation learning.

Accordingly, the present paper aims to scrutinize the non-major students' perception of the gamification and simulation approaches at universities in Malaysia as a part of their learning journey in E&E engineering courses. This paper is divided into five sections. Section II gives a brief overview of related works on gamification and simulation approaches to teaching non-major students the E&E engineering courses, advantages of such teaching methods in class and tools of gamification and simulation as a part of teaching strategies whether it is face-to-face or online setting. The methodology of this research is briefly described in Section III, while the discussion on the results is presented in Section IV. The conclusions of this research are drawn in the final section.

Literature Review

According to Kapp, "gamification" is defined as games or activities that include fun elements to promote learning (Kapp, 2012). Kapp have identified nine elements of games and standard features which are shown in Figure 1. Brief explanation on each element can be found in (Kapp, 2012). Numerous studies have attempted to explain the advantages and usefulness of gamification in comparison to the traditional methods due to its potential in learning results (Buckley & Doyle, 2016; Furdu, Tomozei, & Kose, 2017; Kapp, 2012; Kapp, 2013; Leung & Pluskwik, 2018; Majuri et al., 2018; Moccozet et al., 2013; Nieto-Escamez & Roldán-Tapia, 2021; Wiggins, 2016). The implementation of gamification with a proper learning structure encourages and motivates

the learners through an interesting way with enjoyment and satisfaction (Kapp, 2013). In other words, it assists the students to acquire skills and knowledge in a better environment through the reward.

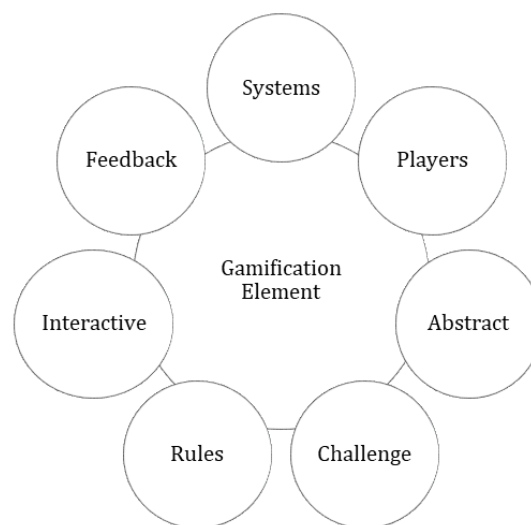


Figure 1: The element of gamification (Kapp, 2012).

In the same vein, Mullin in their recent research noted that the elements in gamification teaching strategy can develop both emotional and cognitive skills (Mullins & Sabherwal, 2020). Accordingly, gamification has become one of the popular teaching methods in higher education for competitive and innovative learning incorporated with project-based learning. The gamification strategy has been shown to be effective by the researchers through several studies in which the gamification strategy has been integrated in curricular for teaching higher education levels across the world. These include "computer science" (Ahmad et al., 2020), "microcontroller and microprocessor" (Ristov, Ackovska, & Kirandziska, 2015), "computer architecture" (Tlili, Essalmi, & Jemni, 2015) subjects.

Apart from gamification, simulation is also one of the teaching and learning approaches that is commonly used with distance learning concepts (Jamshidi & Milanovic, 2022; Kang & Temkin, 2022). It is similar to a virtual laboratory which is a holistic experiential learning process with more realistic user experience, multiple access, and high flexibility. Accordingly, it allows the students to reflect with critical analysis and foster the students' engagement creatively so the students can take initiative and learn from mistakes. With simulation, the concept of a complex system can be demonstrated, which allows engagement and interaction between the simulated equipment and the user for better practical understanding (Almasri, 2022; DeCoito & Estaiteyeh, 2022). In fact, several studies have found that the deployment of the simulation

benefits the learning process (Campos, Nogal, Caliz, & Juan, 2020; Juan, Loch, Daradoumis, & Ventura, 2017).

Game-based education that is commonly used for teaching and learning application tools at universities in Malaysia are Kahoot and Quizizz. Both are technological online games that allow the educators to design interactive and incredible content and formative assessment with the aim to improve the impact of effective teaching and digital learning experiences. On the other hand, Multisim and CircuitMod are among the circuit simulators that are being applied for teaching and learning process, especially if it is related to the fundamental and analysis of the electrical circuit. Considerably, introducing gamification and simulation as part of the teaching method in a higher education curricular is anticipated to have the potential to replace the traditional method in enhancing students' understanding (Vlachopoulos & Makri, 2017).

Methodology

In this study, the questionnaires are adapted from Sunarti et al. (2022) with some modifications and disseminated through online google form for quantitative research due to its low cost, easy administration, and ability to represent a large population. The sample size was determined by selecting a random sample among non-major Electrical and Electronics (E&E) engineering students from public universities in Malaysia such as Universiti Teknologi Malaysia (UTM), Universiti Tun Hussein Onn (UTHM), Universiti Teknikal Melaka (UTeM) dan Universiti Teknologi Mara (UiTM) who are currently enrolled to the E&E engineering courses that served as a service course. A total of 380 students participated in this survey with a 100% response rate using convenient sampling method. Out of the total, 350 (92.1%) respondents are from Mechanical Engineering background and 30 (7.89%) respondents are from Naval Arch and Offshore Engineering background.

The advantages aspect of the gamification and simulation in E&E engineering courses were measured with seven (7) items including knowledge understanding, motivation towards lesson, learning experience and environment, instant feedback, flexibility to learn and academic performance. Meanwhile, another aspect in this study is the student's perception towards the application of gamification and simulation by which it is measured with five (5) items including importance of gamification and simulation during learning process, ease of use, interactive learning experience, effective learning process, interest, and motivation during the learning process. The 5-point scale question was used for each item in the questionnaire, which ranged from 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) to 5 (strongly agree). Besides that, one multiple question is included in the survey to compare the students' preference application between gamification and

simulation in E&E engineering courses learning. On top of that, this item of the questionnaire required the respondents to give an explanation on their preference application.

Result and Discussion

There were seven (7) advantages of the application of gamification and simulation in electrical and electronics (E&E) engineering courses that have been listed out in this research. From the results, it is found that the majority of those who responded to these items felt that the implementation of gamification and simulation in E&E engineering course benefits their study. The detailed mean for every items that measured the advantages of gamification and simulation that give benefits to the non-major students is shown in Table 1.

Table 1: Advantages of Gamification and Simulation in Learning E&E Engineering Course

Advantages	Mean
Gamification and simulation increased understanding in comparison to the traditional teaching method	4.19
Gamification and simulation are motivating	4.09
Gamification and simulation provided a better learning experience	4.22
Gamification and simulation in provided a better learning environment	4.16
Gamification and simulation provided instant feedback	4.11
Gamification and simulation allowed the students freedom to fail so that they can learn from failure	4.17
Gamification and simulation provided an advantage in academic performance	4.00

From the results, it can be seen that the aspect of "Gamification and simulation provided a better learning experience" recorded the highest mean with a 4.22 score followed by the aspects of "Gamification and simulation increased understanding in comparison to the traditional teaching method" and "Gamification and simulation allowed the students freedom to fail so that they can learn from failure" with 4.19 and 4.17 mean scores, respectively. This is in line with the research undertaken by Furdu, Tomozei and Kose in 2017 which stated that the combination of fun and learning in the class will make learning more enjoyable and attractive compared to the traditional method and hence, increase students' understanding of their studies. In fact, the students' engagement through the gamification and simulation may improve retention and memory (Furdu et al., 2017). Besides that, the

implementation of gamification and simulation allowed the students to accept their mistakes thus leading towards the students' desire to learn (Doppelt & Schunn, 2008).

Meanwhile the fourth aspect the respondents agreed upon the most is the "Gamification and simulation is believed to provide better learning environment" with 4.16 mean score. According to Doppelt et al., a positive learning environment is one of the vital aspects that influences the learning outcome (Doppelt & Schunn, 2008). "Gamification and simulation provided instant feedback", "Gamification and simulation are motivating" and "Gamification and simulation provided an advantage in academic performance" are the three lowest means as selected by the respondents with 4.11, 4.09 and 4.00 mean scores, respectively.

According to students' perceptions, the students agreed that the implementation of gamification and simulation in E&E engineering course will be fun for learning process and can improve the process of learning effectively. The students also suggested that the application of gamification and simulation should be implemented in class so that it can enhance the students' motivation. Table 2 the shows the outcomes of the analysis which indicate the mean scores under students' perception.

Table 2: Students' Perception Towards Gamification and Simulation

Students' Perception	Mean
Gamification and simulation are vital to be implemented in the learning process	4.17
Gamification and simulation are easy to use	4.07
Gamification and simulation in class will be fun for the learning process	4.20
Gamification and simulation can improve the learning process effectively	4.17
Gamification and simulation can give motivation to students	4.14

On the other hand, the students' preference application to be used in E&E engineering courses is shown in Figure 2. From the results, it indicated that majority of the respondents (56.6%) opt to apply simulation over gamification in E&E Engineering courses. Some of the comments are "I would prefer to use simulation like Multisim in this course as it represents the real-world application", "For me, simulation could indicate the problem if the simulation went wrong", "Simulation gives a clear picture of how the processes take place for better understanding", "it is suitable to learn theory through simulation" and "it is easy to use with clear instructions". On top of that, a minority of participants (43.4%) indicated that they

prefer gamification in E&E Engineering courses based on the fact that gamification could stimulate the brain and is exciting. Some of the comments are "Gamification in this course enhance my motivation to learn the subject effectively", "Gamification like Kahoot platform is always used by my lecturer and I found it was fun" and "I feel more excited to learn while using gamification approach". Therefore, this finding highlights the usefulness of gamification and simulation as teaching tools for non-major E&E engineering students. This is in good agreement with previous research (Buckley & Doyle, 2016; Leung & Pluskwik, 2018; Majuri et al., 2018; Moccozet et al., 2013; Nieto-Escamez & Roldán-Tapia, 2021; Wiggins, 2016).

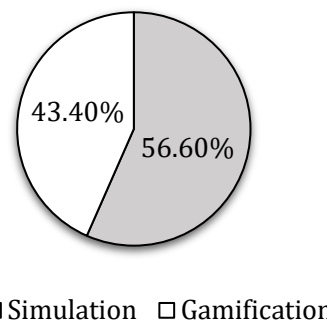


Figure 2: Non-major Students' Preferences of Teaching Tools

Conclusion

This paper has investigated the non-major students' perception on the application of gamification and simulation in electrical and electronics (E&E) engineering courses at universities in Malaysia. The research's outcomes might signal that the implementation of gamification and simulation may assist non-major students to enhance their understanding on the syllabus taught for E&E engineering service courses.

This study indicated both applications can be perceived as good alternatives compared to the traditional method. These applications motivate the students in achieving the learning objectives by providing better learning experience and environment, instant feedback, and a freedom to fail that gives advantages in academic performance.

Particularly, gamification is a more fun method that can induce a sense of accomplishment, healthy competition and happy emotions which will have a greater impact in memorization. Simulation on the other hand, is more formal, which can be applied to all range of students since gamification rewards the fastest and the skilled, instant visualization and results are key to create a better understanding of a component/system, and safe and better learning environment. Further data collection would be needed to determine exactly how effective the gamification

and simulation influence the students' competency and comprehension in E&E engineering course.

Overall, this research provides the insight to the educators on the needs of teaching and learning process of E&E engineering course especially to non-major students to achieve the learning outcomes.

Acknowledgement

The authors would like to thank the students for completing this survey. The project is fully supported by School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Johor Bahru.

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