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Gamification Tools in Mathematics Course: Students' Acceptance

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ABSTRACT

Recently, many scholars have been drawn to the use of gamification in education to promote learners' engagement and improve their learning outcomes. Gamification is regarded as a novel technology-based teaching and learning tool that promotes learning in a fun and engaging manner. Using the modified technology acceptance model (TAM) as its theoretical foundation, the present study is designed to investigate the students' acceptance of the use of gamification to support their mathematical learning during open and distance learning (ODL). Free online gamification tools were designed for a mathematics course, namely, Further Differential Equations. A sample of 49 civil engineering degree students was selected to participate in this study for using gamification tools. The primary research methodology applied in this study was a quantitative approach based on a modified TAM survey questionnaire. The questionnaire results were analysed using descriptive statistics, independent samples t-test and correlation analysis. The analysis was focused on four proposed determinants, namely perceived usefulness, perceived ease of use, attitude towards using, and behaviour for intention to use. Findings revealed no statistical differences between male and female groups on all four determinants proposed in modified TAM's model. Also, the study discovered significant positive relationships among all of the model's determinants on gamification acceptance.

Keywords: gamification; modified TAM; Kahoot; Quizizz; further differential equations

INTRODUCTION

The pandemic of Covid-19 has ushered in a new era of online teaching and learning. Due to the rapid rise in the number of Covid-19 cases, all public and private educational organisations have temporarily closed. Miks & McIlwaine (2020) reported that over 1.6 billion children and teenagers are affected by the closure of schools and tertiary institutions. All students are required to attend their online and offline classes at home. As a result, almost every educator is struggling to come up with a better approach to their instructional methods or assessments to maintain the students' attention and engagement.

In the process of learning, students' engagement is often mentioned as paramount. Students' engagement consists of three important dimensions, namely cognitive engagement, behavioural engagement and emotional engagement. Handelsman et al. (2005) discovered that four factors, namely skill, emotion, participation or interaction and performance contribute to students'

engagement. Students would achieve great academic performances when they are highly motivated to learn.

Recently, gamification has become a well-known tool for capturing and inspiring learners' drive to achieve learning goals. Gamification has been applied in various disciplines in elementary and tertiary education, including computer science, mathematics, medicine, languages and other miscellaneous courses (Barna & Fodor, 2017; Chong, 2019; Li & Chu, 2021; Muhd & Jamilah, 2017; Yildrim, 2017). Moreover, free gamification tools such as Kahoot and Quizizz are embedded in Learning Management Systems (Google classroom, Moodle, Blackboard, WebCT) or open online courses (MOOC, Udemy). Numerous scholars, such as Kuo and Chuang (2016), Sanmugam et al. (2016), Hew et al. (2016), Barna & Fodor (2017) and Jones et al. (2019) have advocated that gamification can increase students' engagement.

Gamification is known as the use of game design features in non-game settings to stimulate users' active participation, and increase their engagement, thus enhancing the outcomes in learning. Utilising the game elements in the aforementioned method, all educators now have the opportunity to design their lesson plans or assessments via online platforms such as Kahoot, Quizizz, Socrative, Genially and Quizlet. Without jeopardising the nature of the curriculum, gamification could provide fun and excitement in learning. In a gamified environment, students are exposed to activities in which they are required to acquire a certain number of points or visit specific stations before moving on. The concept of games in learning facilitates a self-directed learning experience even more since students have complete control over their learning during the activities. For creative educators who are searching for alternative and fun ways to support the web-based learning for their classroom, it is highly recommended for free web-based games like Kahoot, Quizizz and Genially (Cheung & Ng, 2021; Jones et al., 2019; Suo et al., 2018;). This is because these games could provide meaningful and playful tools for them to diversify their teaching methods and assessments. It is also time-saving for educators to set up their platforms. Thus, this paper aims to investigate the students' acceptance towards the use of gamification for learning further differential equations using the modified Technology Acceptance Model (TAM). Further differential equations is the last mathematics subject taken by part-six civil engineering degree students at Universiti Teknologi MARA Penang Branch, Malaysia. Students usually lack motivation to actively participate in the learning activities during open and distance learning (ODL). Moreover, they also perceive that further differential equations is a challenging subject.

Following the introduction, the Literature Review section presents related studies on gamification and the TAM model. This is then followed by the Methodology section that elaborates on the conceptual framework, while the Results and Discussion section presents the results and analysis of this study. Finally, the Conclusion section concludes the paper.

LITERATURE REVIEW

Gamification of education is a method of increasing engagement by integrating game design elements into an educational environment (Dichev & Dicheva, 2017). Gamification can be applied to elementary education, primary education, secondary education and tertiary education. As a guideline for practitioners in gamification of education, Huang & Soman (2013) addressed a five-step process: (1) understanding the target audience and context, (2) defining the learning objectives, (3) studying the experience, (4) identifying the resources, and (5) applying gamification elements.

It is vital to understand the core concepts of games. Dickey (2005) mentioned three basic components in most games: goal-focused activity, reward mechanisms and progress tracking. "Gamification" (n.d.) separated game elements into two different components; game mechanics and game dynamics. Gamification mechanics are often classified by reward or process-tracking types such as leader boards, badges, points, feedback and prizes (Pedersen & Poulsen, 2016). Game dynamics, on the other hand, are game motivators like rewards, status, success, self-expression and competition.

Badges are referred to the use of logos or icons on a webpage that indicates the success of a user in completing a certain activity. Leaderboard refers to high-score tables that compare a

user's performance to that of other users ("Gamification", n.d.). This will increase user competitiveness to dethrone the existing leader. According to Table 1, badges and leaderboards are the top choice game elements used by researchers in gamification. Huang and Hew (2015) discovered that badges and leaderboards motivated 71.43% of learners in the treatment group to take part in a pre-course activity.

Table 1. Comparison of game elements used in previous studies

Game Mechanics	Li and Chu, 2021	Chong, 2019	Tsay et al. 2018	Yildrim, 2017	Kuo and Chuang, 2016
Badges	√		√	√	√
Leaderboard	√	√	√	√	√
Challenges			√		
Levels					√
Points	√	√		√	√
Online activity					√
Incentive					√

Indeed, the widespread use of gamification in the learning environment has gained attention from several researchers globally. The emerging free web-based gamification platforms that are frequently used are Kahoot and Quizizz. With over 50 million users, Kahoot becomes a worldwide recognised online learning platform based on a behavioural approach and is now user-centred (Plump & LaRosa, 2017). Kahoot is a gateway for educators to create quizzes including adding pictures or YouTube videos to the questions and editing quizzes made by others using a game-based method. Meanwhile, it also acts as a student response system. According to Wang and Lieberoth (2016), the combined effects of game elements such as audio and points in Kahoot have a more positive impact on students' engagement. Muhd & Jamilah (2017) reported that 113 first-year medical students highly perceived Kahoot as a fun, effective and better than e-learning portal for feedback.

Quizizz is also the favourite game-based tool with more than 50 million people around the world as it is a free, entertaining, multiplayer assessment tool that works on a computer, tablet or smartphone. Moreover, Quizizz contains game features such as avatars, themes, memes and music that provide a joyful atmosphere in learning. Suo et al. (2018) claimed that Quizizz keeps students engaged and focused on the content they are learning. Quizizz also applies in-class exercises in an introductory accounting class and is found to have a positive impact on students' engagement and learning outcomes in the class (Zhao, 2019).

The Technology Acceptance Model (TAM) is one of the most popular research models in a lot of studies, especially for technology acceptance. It was introduced by Davis in 1989 to predict the use and acceptance of information systems and technology by individual users. Davis also pinpointed that perceived ease of use and perceived usefulness are the two main fundamental determinants of user acceptance of technology. TAM has been successfully applied to a variety of technologies and across many cultures, including social media (Abrahim et al., 2019), virtual learning environments (Kurt & Tingöy, 2017), mobile and digital libraries (Rafique et al., 2020) and gamification (Ab. Rahman et al., 2018; Ghani et al., 2019; Malaquias et al., 2018).

METHODOLOGY

Based on literature reviews, the Technology Acceptance Model (TAM) by Davis (1989) is widely used in research to explain users' acceptance of ICT technology. In this study, a modified TAM model was applied to investigate the students' acceptance of the use of gamification for learning further differential equations. The reason is that because the experiment of gamification during the lesson was carried out by the lecturer, actual system usage of the technology is not relevant in this context. As such, this construct was excluded from the proposed TAM; therefore, the TAM model was modified to suit the purpose of this study, which focused on four determinants such as perceived usefulness (PU), perceived ease of use (PEOU), attitude towards using (ATU), and behaviour for intention to use (BFITU), as depicted in Figure 1 (e.g. Ghani et al., 2019; Noor Azli et al., 2021). The questionnaire used in the present study consisted of 15 items, which were adapted

from Ab. Rahman et al. (2018) and Noor Azli et al. (2021). The survey questionnaire consisted of four items for perceived usefulness (PU), four items for perceived ease of use (PEOU), four items for attitude towards using (ATU), and three items for behaviour for the intention to use (BFITU). These items were modified to suit the context of this study. All questionnaire items were measured on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Two professors in the fields of computer and mathematical sciences were consulted for help validating the 15 items listed in the questionnaire. Based on their advice, modifications to the language were then made.

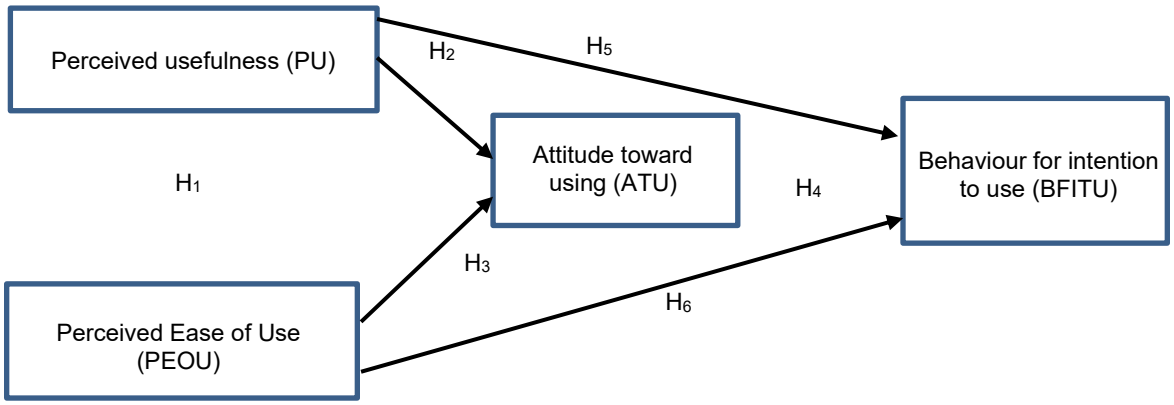

Figure 1. Conceptual framework

Based on the conceptual framework used in Figure 1, there were six hypotheses constructed as follow:

H1. There is a positive and significant relationship between Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) of using online gamification system.
H2. There is a positive and significant relationship between Perceived Usefulness (PU) and Attitude towards using (ATU) online gamification system.
H3. There is a positive and significant relationship between Perceived Ease of Use (PEOU) and Attitude towards using (ATU) online gamification system.
H4. There is a positive and significant relationship between Attitude towards using (ATU) and Behaviour for intention to use (BFITU) online gamification system.
H5. There is a positive and significant relationship between Perceived Usefulness (PU) and Behaviour for intention to use (BFITU) online gamification system.
H6. There is a positive and significant relationship between Perceived Ease of Use (PEOU) and Behaviour for intention to use (BFITU) online gamification system.

During the semester between March and June 2021, Kahoot and Quizizz were implemented three times as learning activities during open and distance learning (ODL). After certain topics of four chapters in further differential equations were delivered in the online lecture, students were assigned to answer ten questions designed in Kahoot and Quizizz based on the syllabus content in further differential equations. These gamification tools were easily integrated with Microsoft Teams, with a duration of about 30 minutes on average. Students could play Kahoot and Quizizz outside of the classroom using their smartphones, computers, or tablets for their self-directed learning. The questions developed using Kahoot and Quizizz are illustrated in Figure 2. The primary goal to employ the aforementioned gamification tools was to enhance their understanding of topics after the lesson. The students received individual feedback instantly on their questions in terms of correctness, the number of points and ranking through Kahoot and Quizizz.

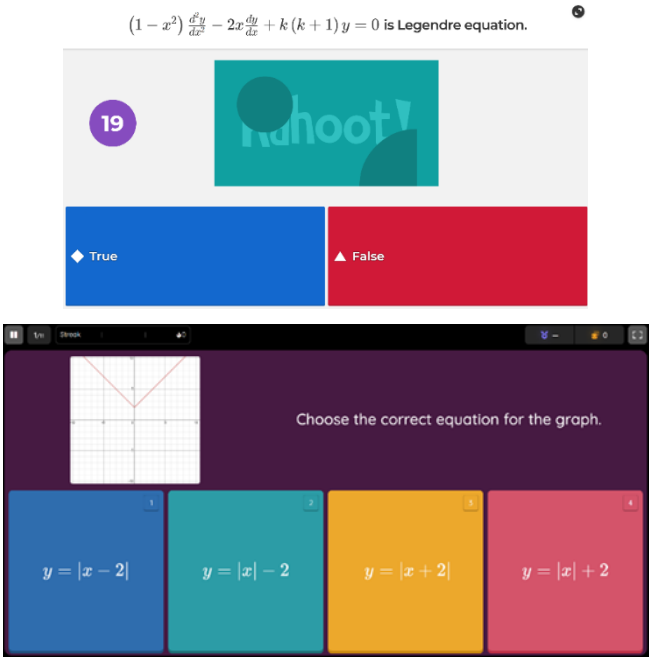

Figure 2. Screenshots from the questions in Kahoot! and Quizizz

Furthermore, Kahoot and Quizizz provide the functionality for lecturers to download the results from the quiz in an Excel spreadsheet. When the majority of the students received low grades, the instructors were able to pinpoint the students' weaknesses in the topic. At the end of the semester, an online questionnaire survey was administered to students through Google Form. Respondents in this survey were degree students of the Faculty of Civil Engineering, Universiti Teknologi MARA Penang Branch, Malaysia. They were given two weeks to answer and return the Google Form.

Quantitative data were analysed using Statistical Package for Social Sciences (SPSS) version 21 for Windows. Descriptive and inferential statistics such as mean, standard deviation and the Pearson Product Moment of Correlation analysis were employed to test the stated objectives.

RESULTS AND DISCUSSION

Based on literature reviews, the Technology Acceptance Model (TAM) by Davis (1989) is widely used in research to explain users' acceptance of ICT technology. In this study, a modified TAM model was applied to investigate the students' acceptance of the use of gamification for learning further differential equations. The reason is that because the experiment of gamification during the lesson was carried out by the lecturer, actual system usage of the technology is not relevant in this context. As such, this construct was excluded from the proposed TAM; therefore, the TAM model was modified to suit the purpose References should be listed at the end of the paper, should be arranged first alphabetically and then further sorted chronologically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters "a", "b", "c", etc., placed after the year of publication.

In this study, Cronbach's alpha was employed to test the internal consistency of questionnaires. Cronbach's alpha of the 15 items was 0.959, indicating a high-reliability value. The results showed the Cronbach's alpha of perceived usefulness of 0.872, suggesting that the internal consistency of questionnaires was good; perceived ease of use of 0.917, which was excellent; use attitude was 0.910, which was excellent; and of use intention that reached 0.912, which was also excellent. The reliability analysis is presented in Table 3.

Table 2. Demographic data for gender and age

Variables	Total (Percentage)
Gender	
Male	26 (53.1%)
Female	23 (46.9%)
Age	
22	2 (4.1%)
23	40 (81.6%)
24	4 (8.2%)
25	3 (6.1%)

Table 3. Summary of Cronbach's alpha reliability measurement scales

Variables	No items	Cronbach's Alpha
Perceived usefulness (PU)	4	0.872
Perceived ease of use (PEOU)	4	0.917
Attitude towards using (ATU)	3	0.910
Behaviour for intension to use (BFITU)	4	0.912

Perceived usefulness refers to students' perception of whether or not using the online gamification system could improve their performance. From Table 4, 59.4% of the respondents agreed on the usefulness of the online gamification system and another 22.4% of the respondents strongly agreed that the online gamification system was useful. The data showed that the online gamification system improved the students' learning performance (M=3.84, SD=0.717) and allowed them to identify mistakes in learning (M=3.96, SD=0.865). The interesting findings revealed that they agreed that the online gamification system motivated them to compete with peers in learning (M=4.00, SD=0.913). In Kahoot and Quizizz, students were motivated to see their names at the top of the leaderboard, and as a result, they were more attentive during lectures or discussions. Thus, this promotes healthy competition among the students.

Table 4. Mean and standard deviation of the items in perceived usefulness

	SD	D	N	A	SA	M	SD
1. The online gamification system improves my learning performance.	1 (2%)	1 (2%)	8 (16.3%)	34 (69.4%)	5 (10.2%)	3.84	0.717
2. The online gamification system allows me to identify my mistakes in my learning.	1 (2%)	1 (2%)	10 (20.4%)	24 (49.0%)	13 (26.5%)	3.96	0.865
3. The online gamification system motivates me to compete with my peers in learning.	1 (2%)	0 (0%)	14 (28.6%)	17 (34.7%)	17 (34.7%)	4.00	0.913
4. I find the online gamification system useful.	1 (2%)	0 (0%)	8 (16.3%)	29 (59.2%)	11 (22.4%)	4.00	0.764

Perceived ease of use denotes how students perceive that the use of the online gamification system for learning further differential equations only requires a minimum effort. There is no acquisition of skills when using gamification to learn further differential equations. In addition, the students were from Z-Generation and tech-savvy. From Table 5, 79.6% of the respondents agreed and strongly agreed that the online gamification system was easy to use. It was further supported by the high mean score for item 6 (M=4.00). They found that the online gamification system was flexible enough to be used (M=4.16) and that the interface and functionality of the online gamification system were clear and understandable (M=4.12). Since Microsoft Teams can integrate the application of Kahoot and Quizizz, the students did not face any difficulty in accessing both interactive online gamification systems using their laptops or smartphones.

Table 5. Mean and standard deviation of the items in perceived ease of use

Items No.	SD	D	N	A	SA	M	SD
5. I find the online gamification system to be flexible enough to be used.	1 (2%)	0 (0%)	6 (12.2%)	25 (51.0%)	17 (34.7%)	4.16	0.800
6. Interacting with the online gamification system is easy for me.	1 (2%)	0 (0%)	11 (22.4%)	23 (46.9%)	14 (28.6%)	4.00	0.842
7. The interface and functionality of the online gamification system are clear and understandable.	1 (2%)	0 (0%)	8 (16.3%)	23 (46.9%)	17 (36.7%)	4.12	0.832
8. Overall, I believe that online gamification system is easy to use.	1 (2%)	1 (2%)	8 (16.3%)	24 (49.0%)	15 (30.6%)	4.04	0.865

Attitude refers to students' positive or negative feelings about using the online gamification systems. Previous studies indicated that attitude is one of the most powerful predictors of the intentions to use technology (Malaquias et al., 2018). According to Table 6, the students' feedback on using the online gamification systems like Kahoot and Quizizz in their learning further differential equation was proven positive. Using the gamification tools, the students will not feel bored compared to the traditional approach. Perhaps those gamification systems provide a unique and refreshing learning environment.

Table 6. Mean and standard deviation of items in attitude towards using

Items No.	SD	D	N	A	SA	M	SD
9. It is a good idea to study using the online gamification system.	1 (2%)	0 (0%)	8 (16.3%)	30 (61.2%)	10 (20.4%)	3.98	0.750
10. I enjoy learning with the online gamification system.	1 (2%)	1 (2%)	6 (12.2%)	28 (57.1%)	13 (26.5%)	4.04	0.815
11. I look forward to those aspects of my learning that require the use of an online gamification system.	1 (2%)	0 (0%)	7 (14.3%)	26 (53.1%)	15 (30.6%)	4.10	0.797

In this study, the behavioural intention is the users' intention to use the online gamification system for learning further differential equations at present and in the future. Besides, perceived usefulness and perceived ease of use have a significant impact on the factor of behavioural intention to use. According to Table 7, there was a positive sign in the responses from the students. They were keen on using Kahoot and Quizizz to enhance fundamental topics (M=3.86, SD=0.890) and sharpen problem-solving skills (M=3.90, SD=0.848). They also intended to repetitively use the online gamification system as often as possible (M=4.04, SD=0.865). When students are excited about using Kahoot or Quizizz as a learning tool, they will become more motivated and attentive in online lessons.

Table 7. Mean and standard deviation of items in behaviour for intention to use

Items No.	SD	D	N	A	SA	M	SD
12. I intend to use the online gamification system to enhance fundamental topics.	1 (2%)	1 (2%)	14 (28.6%)	21 (42.9%)	12 (24.5%)	3.86	0.890
13. I intend to use the online gamification system to sharpen my skills at solving problems.	1 (2%)	1 (2%)	11 (22.4%)	25 (51.0%)	11 (22.4%)	3.90	0.848
14. I intend to use the online gamification system throughout this semester and the next semester.	1 (2%)	2 (4.1%)	13 (26.5%)	24 (49.0%)	9 (18.4%)	3.78	0.842
15. I intend to repetitively use the online gamification system as often as possible.	1 (2%)	1 (2%)	8 (16.3%)	24 (49.0%)	15 (30.6%)	4.04	0.865

Overall, Table 8 showed that there was no significant difference in four determinants namely PU, PEOU, ATU and BFITU between genders. Both male and female students like to use Kahoot! and Quizizz in learning further differential equations.

Table 8. *t*-test of overall four determinants in modified TAM model according to gender (n = 49)

					t-test for Equality of Means		
Variable	Gender	N	Mean	SD	t	Df	Sig. (2-tailed)
PU	Male	26	3.9808	0.81524	0.337	47	0.738
	Female	23	3.9130	0.54673			
PEOU	Male	26	4.1442	0.81906	0.620	47	0.539
	Female	23	4.0109	0.66776			
ATU	Male	26	4.1154	0.79410	0.762	47	0.450
	Female	23	3.9565	0.64592			
BFITU	Male	26	3.8654	0.88100	0.424	47	0.674
	Female	23	3.7717	0.62574			

This study used Pearson product-moment correlation statistics to show the relationship between two variables in the modified TAM model. Results in Table 9 indicated the correlation between the two variables was all positive. Pearson correlation coefficients (r) for two variables ranged from 0.713 to 0.830, and they were all significant at p<.0 l. Therefore, all six hypotheses (H_1, H_2, H_3, H_4, H_5 and H_6) were accepted. The relationship between PU, PEOU, ATU and BFITU that emerged from the data analysis is depicted in Figure 3. The students' acceptance towards the use of a gamification system in their mathematical learning based on four determinants in the modified TAM model became prominent.

Table 9. Correlation matrix for PU, PEOU, ATU and BFITU

Correlation					
		PU	PEOU	ATU	BFITU
PU	Pearson Correlation	1	.737**	.761**	.713**
	Sig. (2-tailed)		.000	.000	.000
	N	49	49	49	49
PEOU	Pearson Correlation	.737**	1	.830**	.718**
	Sig. (2-tailed)	.000		.000	.000
	N	49	49	49	49
ATU	Pearson Correlation	.761**	.830**	1	.733**
	Sig. (2-tailed)	.000	.000		.000
	N	49	49	49	49
BFITU	Pearson Correlation	.713**	.718**	.733**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	49	49	49	49

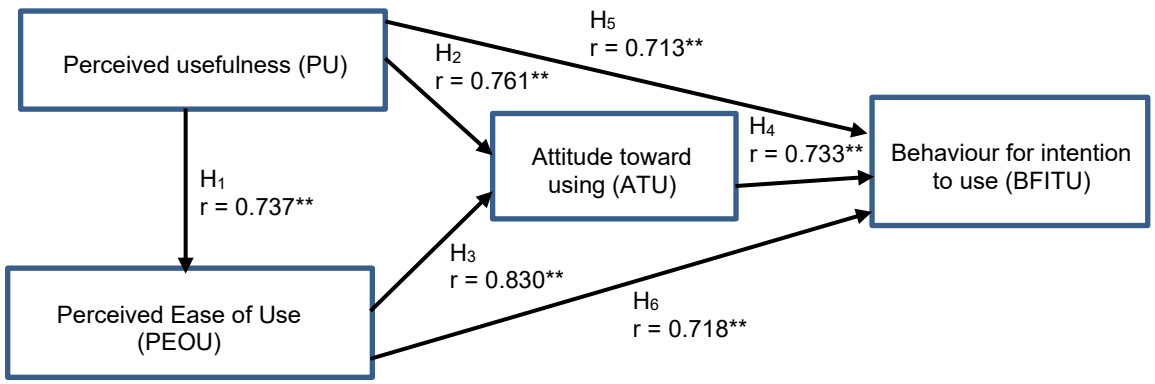

Figure 3. Results of hypothesis testing

CONCLUSIONS

In the 21st century, gamification has become one of the popular learning methods from the perspective of students as it allows them to monitor themselves and engage in fun and meaningful competitive environments. Apart from that, the educators could use the gamification tools in their teaching methods or assessment since students can learn topics and tackle difficult problems in a fun way. Additionally, the issue of lack of time for preparing content or quizzes in a gamified way could be overcome. Therefore, free online gamification systems such as Kahoot and Quizizz used in this study have shown promising results. Perhaps this study demonstrated alternative potentials of employing gamification in mathematics education.

This study explored how students perceived online gamification systems in learning further differential equations using the modified TAM model. It can be concluded that the intention of using online gamification systems such as Kahoot and Quizizz for degree civil engineering students in Universiti Teknologi MARA Penang branch is significantly affected by perceived usefulness, perceived ease of use and attitude towards using. The attitude towards using was affected by perceived ease of use and perceived usefulness. The perceived usefulness was also affected by the perceived ease of use.

The results of this study have the following implications. First, research findings indicate the acceptance level of using gamification among the UiTM students, which can be generalised to the perspective of the Malay students of Malaysia. Secondly, the findings support the usability of Kahoot and Quizizz as assessment tools for mathematics courses. Lastly, this study confirmed that the effect of gamification is not limited to primary or secondary schools; it is also appropriate for use in supporting higher level mathematic courses at universities, such as a further differential equations course.

For the convenience of sampling, the Universiti Teknologi MARA Penang branch was selected, which represents a limitation of this study. Therefore, studies should be carried out with a greater number of students from other institutions, so that the findings could be generalised.

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CONFLICT OF INTERESTS

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

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