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Analyzing learners' perceptions of engagement and learning interaction in gamified massive open online courses for TVET using SEM-PLS

Azizul Mohd Yusoff[1,2], Sazilah Salam[1], Siti Nurul Mahfuzah Mohamad[1], Rujianto Eko Saputro[3]
[1]Pervasive Computing & Educational Technology (PET) Research Group, Centre for Advanced Computing Technology (C-ACT), Fakulti Teknologi Maklumat dan Komunikasi, Universiti Teknikal Malaysia Melaka (UTeM), Melaka, Malaysia
[2]Kolej Komuniti Masjid Tanah, Melaka, Malaysia
[3]Faculty of Computer Science, Amikom University Purwokerto, Indonesia

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ABSTRACT

The introduction of gamified massive open online courses (G-MOOCs) represents a novel advancement in technical and vocational education and training (TVET). The use of gamification in education has been shown to increase engagement and motivation, which are crucial for effective learning. However, there is limited research on the specific impacts of G-MOOCs on learner outcomes in TVET. A key feature of G-MOOCs is the integration of gamification elements to enhance learner engagement and interest. This research employs structural equation modelling with partial least squares (SEM-PLS) to examine learners' perceptions of their participation and learning experiences in G-MOOCs for TVET. Specifically, the study aims to identify how gamification approaches such as fun, engagement, and learner interaction influence knowledge acquisition, skills development, satisfaction, and overall learning outcomes. The analysis reveals that G-MOOCs have a strong positive correlation (0.505) with learning engagement. Additionally, learning engagement significantly moderates learning outcomes (p=0.002). Interaction also has a significant impact (p=0.381) on learning outcomes. Overall, the findings indicate a significant positive relationship between learners' activities and their performance in G-MOOCs.

Corresponding Author:

Sazilah Salam
Pervasive Computing & Educational Technology (PET) Research Group, Centre for Advanced Computing Technology (C-ACT), Fakulti Teknologi Maklumat dan Komunikasi, Universiti Teknikal Malaysia Melaka (UTeM)
76100 Durian Tunggal, Melaka, Malaysia
Email: sazilah@utem.edu.my

1. INTRODUCTION

Massive open online courses (MOOCs) have been entirely transforming the accessibility and delivery of learning resources available across the globe and are now dominating the modern learning system [1]. MOOCs originally aimed at making education easily accessible for everyone with the use of online platforms that provided free access to numerous courses irrespective of one's residence and financial situation [2]. MOOCs are appealing when it comes to delivering educational content regarding fields like technical and vocational education and training (TVET) because they are flexible, well-scalable and can be personalized for everyone [3]. As numbers of enrolled learners in MOOCS continue to increase, researchers and educators are beginning to consider ways of increasing learners' interaction and success in these learning spaces.

Another approach that has been attracting a lot of attention is incorporating features of gamification into MOOCs design [4]. Gamification is the application of game like features such as badges, trophies, points, challenges among other items, in environments that are not generally associated with gaming with the intention of promoting engagement amongst the users [5]. In this regard, the application of gamification in MOOCs enables the retention, motivation, and interaction of the learners, through an appealing enjoyable environment that can capture a range of learners [6]. Gamification must therefore be able to determine the learning capability of its students with a view of satisfying their needs in a bid to master those skills on their own. It is mandatory that all the teaching and learning activities include features taken from game learning theories to enhance learner engagement [7]. It can be described as the strategy of adopting one or many of the features of the game, for instance, reward system, points and badges in a non-gaming environment to encourage learning interactions towards a particular behavior [8].

However, Malaysia's higher education cannot be complete without the integration of TVET, as it prepares learners to seek employment opportunities in different fields. The focus on practicality and the academic industry relation thrusts the learners into jobs [9]. This feedback has gone a long way in reinventing the landscape of Malaysia's higher education through integrating technical vocational training with online learning, which has given a new modernization process that is accessible, flexible, and scalable among other benefits attached to the use of internet tools [10]. Such integration might look more appropriate for distance learners aspiring to enhance their competencies [11]. By integrating e-learning systems with TVET, there could be enhanced learning flexibility and ease for the users whenever learning is happening [12]. However, this approach is very applicable in TVET MOOCs, given the focus to create learner engagement, and effective and positive learning spaces for TVET skills and knowledge achievement. Nevertheless, there is a lack of systematic research on its efficacy in TVET MOOCs, as well as the impact and perception resulting from gamification of the learning interactions among the learners. Also, as for Malaysia's higher education system, there is a trend toward further integration of TVET with online learning as more effective, flexible and accessible the relationship between the dynamics of gamification and TVET MOOCs remains an area of research significance.

This research paper contributes significantly because it systematically examines the complicated dynamics about how gamification has been integrated into MOOCs designed for TVET. The study uses structural equation modelling with partial least squares (SEM-PLS) to carry out an extensive analysis of learners' perceptions. In TVET, this helps to explain the interplay between engagement, gamified elements and learning outcomes that are complex. This study was meant to explore these relationships in order to enhance understanding of winning instructional design, hence offering instructors, decision-makers and instructional technologists' practical guidance on how they can improve the quality and influence of technical education provided through online platforms.

There are five sections in this study article. Section 2 (Related work) summarizes previous research on related subjects, emphasizing the knowledge gaps and importance of our study. In section 3 (Method), we describe the experimental design, which includes research participants, tools, and protocols. The quantitative results of the data analysis are presented in section 4 (Results), together with pertinent figures, tables, and SEM-PLS analyses. In section 5 (Discussion and implications), the findings are interpreted considering the study's goals, contrasted with earlier research, and potential reasons for the observed results are provided. Finally, the study's conclusion and future research options in this area are suggested in section 6 (Conclusion and future works).

2. RELATED WORK

Gamification has become more and more popular in educational settings as a way to increase learner engagement and boost learning objectives. As stated by Deterding *et al.* [13], gamification is the practice of adding game features into non-game settings to engage learners. Research done on the effects of gamification reveals that it has a positive effect on learning environments. For instance, elements such as leaderboards, points, and badges increase learners' engagement as reported in the literature by Hamari *et al.* [6]. The authors of the article by Landers and Callan [14], also underline that, through gamification, one can increase the learner's intrinsic motivation and sense of accomplishment. As Yang and Lee [15] and Puig *et al*. [16] also affirm, elements like scores, points, and badges would increase learner engagement and push. The design and facilitation of online learning are very important, and it is very important to foster the emotions and interests of the learners in the online course [17]. Digital learning design includes digital materials and teaching, a digital environment, digital interaction, and digital assessment [18]. This research contributes to what we know about using games: appropriately in learning environments. It especially targets MOOCs for TVET.

Technology, the use of game elements in other contexts known as gamification has been widely adopted in MOOCs to improve learners' engagement and participation especially in TVET. It has also been

evidenced that gamification has a positive effects on elements of MOOCs of learners' engagement, performance and motivation [19]. In order to enhance the learners' participation and increase the completion rate, the gamification elements, including challenges, a leader board, and badges, are integrated into the MOOC platforms [16]. However, despite the acknowledged efficiency, there is relatively little systematic literature on the use of gamification in the context of TVET MOOCs and its impact on learners' perception of engagement and learning interactions [4]. Pursuant to the integration of online learning in TVET MOOCs in Malaysia, analyzing the relationship and interaction between gamification and the existing TVET programs is significant to achieve better learner experience and overall learning performance [20]. This article shows how the elements of gamification have proven useful in MOOCs by helping learners complete courses and reducing drop-out rates [21]. Using of the relevant elements of gamification for performing the set goals remains critical in improving learner engagement in technical and vocational education [22]. Yusoff *et al.* [23] present a conceptual design for such online courses that involves various components of gamification such as skill points, rewards, badges, virtual goods and peer grading. The study also reveals that through linking these gamification mechanics to the educational goals it is possible to advance learning experiences as well as its outcomes.

According to Amini and Alimohammadlou [24], applying an analytical approach which is the SEM is useful in capturing intricate patterns of intersections between multiple factors. SEM has two types of factors, namely the exposed and the non-exposed ones. This technique helps researchers understand multiple factors impacting each other [25]. In the context of SEM, there is a technique known as PLS. This makes research more manageable especially when it involves complex models or smaller sample sets [26]. If your research cannot meet the multivariate normality assumption, PLS is particularly useful because it focuses on increasing explained changes in the dependent variables (DVs) [27]. Exploring for a good primer on the SEM-PLS approach is given by Hair *et al.* [28], who also highlight how adaptable and great for predictive modeling in various fields of study. Now, this study puts SEM-PLS into action in a new field. Gamified massive open online courses (G-MOOCs) are being investigated, particularly for TVET. The goal is to improve statistical methods when studying complex relationships in educational research.

Establishing a clear theory base is key for studies, especially in the complex areas of educational technology and TVET [29]. This research integrates vigorous critical assessment with firm theoretical framework and is interested in engagement, education interaction, gamification and TVET. According to Bouchrika *et al.* [30], incorporation of gamification in teaching context involves the following: active participation of learners, increased attention, interest, and engagement by the learners. Learning actions refer to the interface approaches that learners engage, relationship they foster with the instructors, peers, and educational materials [31]. Examining literature research by Zaric *et al.* [32] and Floris *et al.* [33] points to gamification. This term simply means trying to introduce features of games in areas that can hardly be described as games to incite people into further engagement. Technically, TVET contributes to frame a technical, skills-oriented segment that is so unique that it requires a separate focus. That is why Lai *et al.* [34] and Hamdan *et al.* [35], encourage enhancing its consideration due to its peculiarities of contingencies.

The integration of these modules presents the theoretical framework that allows to study the interdependent relationships of TVET, engagement, gamification, and learning interactions in G-MOOCs. That both the theoretical discourse in the research of education and the empirical analysis it facilitates are equally well enabled by this approach. In general, concerning the intentions of the given paper, it tries to establish a basis that can be used to have a good understanding of the current state while pointing out the gaps and areas that require further research concerning the MOOCs in TVET, based on the existing body of knowledge. This presents learning opportunity that enhances the understanding of how these innovative strategies unfold in the learning of learners in technical education with reference to the combined perspective of gamification and MOOCs in TVET. In conclusion, engaging, motivating and facilitating the interaction of the learners through gamification in TVET MOOCs is a significant and effective solution. However, more studies need to be conducted regarding the effects of gamification in the TVET interface and its effects on the educational outcomes, especially in the context of Malaysian higher education system.

3. METHOD

The purpose of this study was to determine the level of learning among the learners based on their G-MOOCs use. To enhance the understanding of the learner perceptions of the gamified effectiveness, the following questions will be answered in quantitative response on the issue area above. A group of 69 respondents (N=69) took part in twelve questionnaires which had been taken and modified by researchers [36]–[38]. Each survey questionnaire has five answers measured on Likert scale 1 to 5 (strongly disagree to strongly agreeable) which have been referred to and modified from Fotaris *et al.* [37] and Hew *et al.* [39]. The data which was collected from the questionnaire was captured and analyzed using SEM-PLS. SmartPLS is a statistical package specially designed by an academic software developer team in Germany [40]. This

statistical software conducts SEM analysis using common budgeting techniques, such as ordinary least square [41], [42], and is widely used by researchers to explore theories. The method's flowchart is shown in Figure 1.

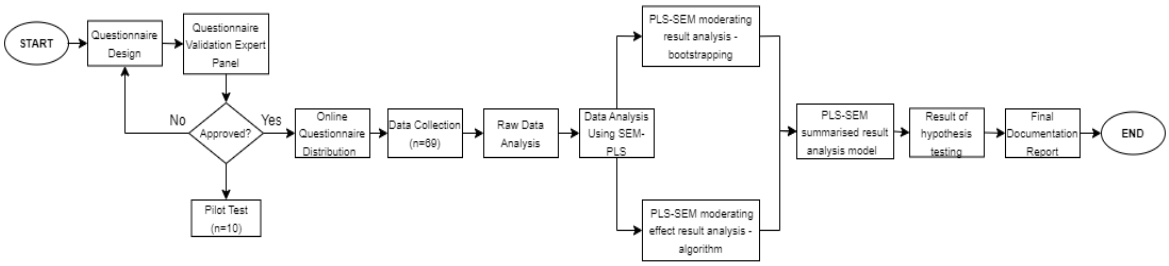

Figure 1. Flowchart for analyzing learner perception using SEM-PLS

The flowchart in Figure 1 indicates the research process utilizing SEM-PLS to examine the moderating effects. The process begins with the design of questionnaires and validation by five panel experts before the distribution of research questionnaires in accordance with the hypotheses, followed by data collection. All data were analyzed in their raw form, and SEM-PLS was employed to develop a structural model to assess the research hypotheses. Bootstrapping and algorithm aids in the evaluation of moderating effects, culminating in a last analysis accompanied by effects and the conclusions that can be drawn for your research question and followed up with a final report of the study. According to Hair *et al.* [28] there are five levels intended for applying SEM-PLS data analysis: i) PLS route model estimates; ii) accessing reflective and formative measurement models; iii) access the structure model iv) advanced analysis v) interpret the results and conclusions. Assessment model ratings include consistent reliability assessments, convergence legality, and discrimination validity. After that, as soon as the measurement model is reliable, an accessible structure model will be set up. Procedures in the assessment of structural models include estimating the path coefficients and measuring the variations described (R^2). Hair *et al.* [42] suggested that the approximate value for R^2, 0.700 is considered strong, the value around 0.500 as moderate, and the value of around 0.250 is weak. Using R^2 values to compare various designs frequently leads to issues. Greater expected accuracy is indicated by R^2 values in the range of 0 to 1.

4. RESULTS

Quantitative feedback on the above topics has been gathered and examined to provide answers to inquiries concerning learners' opinions of the efficacy of gamification. The twelve-questionnaire data were taken and analyzed at SPSS and data were analyzed using PLS. The panel of experts for the perception analysis data are lecturers with doctorate degrees from government agency departments and experts in SEM-PLS. The expert panel suggested that the analysis should be conducted for structured SEM-PLS models with moderating effects whether the difference in the p value ($p<0.05$) is significant or not.

4.1. SEM-PLS analysis with moderating effect

This SEM-PLS analysis involves a moderating effect. The data analysis includes research hypotheses based on measurements that have been set through a document review of existing research. The study model, which has been created and approved by an expert review group, serves as the foundation for the study's findings. The research model was analyzed using SEM-PLS to produce a structural SEM-PLS model for the algorithm and bootstrapping.

4.1.1. Data screening and the evaluation of measurement with moderating effect model

Several respondents (N=69) were involved in answering the questionnaire and all respondent responses were accepted for analysis. Two indicators were not involved as the outer loading factor is <0.708 [43]. Table 1 shows the measurement model of learner perceptions. Values greater than or equal to 0.708 are considered to represent strength, which means that the item under consideration has considerable potential for capturing the measure of the construct in question. These results show relatively great convergent validity because all factor loadings are above 0.7. Convergent validity refers to how well the items that are supposed to be measuring a particular construct reflect that construct.

Table 1. Measurement moderating effect model

Construct	Items	Convergent validity >0.708 Item loading	>0.5 AVE	Internal consistency >0.7 CR	>0.7 Cronbach α	Discriminant validity HTMT confident does not include 1
G-MOOC (Gamification element)	A3	0.765	0.699	0.902	0.856	Yes
	B3	0.770				
	C2	0.908				
	C3	0.892				
Learning engagement	B2	1.000	1.000	1.000	1.000	Yes
Learning engagement moderating	B2*G1	0.703	0.607	0.821	0.721	Yes
	B2*G2	0.804				
	B2*G3	0.939				
Learning interaction	G1	0.761	0.696	0.873	0.779	Yes
	G2	0.863				
	G3	0.875				
Learning outcomes	B1	0.880	0.678	0.807	0.733	Yes
	C1	0.762				

4.1.2. The construct, model, and hypothesis

Moderation in SEM refers to whether the strength of an independent variable (IV) and a DV depends on the presence or state of another variable known as a moderator. In the path model provided, there is no explicit third variable that mediates the association between learning engagement and learning outcomes. Thus, as any discussion regarding a moderating effect is founded upon the graph alone, less considerable equality cannot be argued. This indicates that the direct relationship between learning engagement and learning outcomes, which could entail a series of hypotheses to support that there is a positive relationship: H1, H2, H3. Figure 2 shows the result of the structural model with an R^2 value for learning engagement of 0.255 is considered as weak, while the path coefficient (H1) indicates (0.505) from EG-MOOC to learning engagement. The result of the structural model with R^2 value for learning outcome (0.553) is considered as moderate and the path coefficient (H2) indicates (0.296) from learning engagement to learning outcome while the path coefficient for H3 is 0.381. The PLS algorithm path was used to obtain coefficients. The bootstrapping technique with 5000 samples was used to check whether these paths were significant or not. Figure 3 shows the result for algorithm structural model for moderating effect.

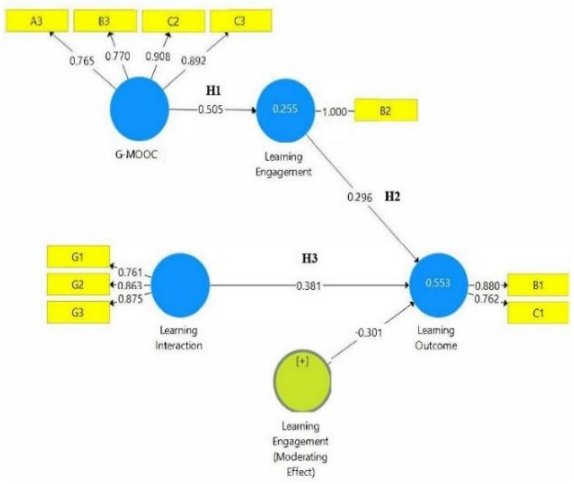

Figure 2. Structural model SEM-PLS moderating result–bootstrapping

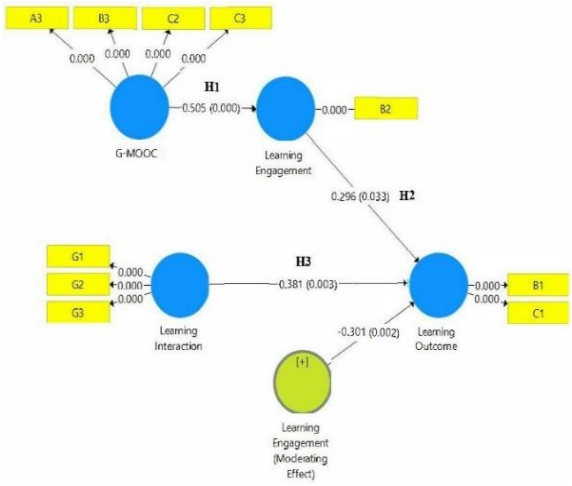

Figure 3. Structural model SEM-PLS moderating effect result–algorithm

Figure 4 shows the summarized result of the structural model SEM-PLS for the moderating effect. The coefficient that represents H1 path is 0.505, represents (0.000) the significance level of the coefficient that indicates that learning engagement has a positive and a direct effect on learning outcomes is statistically influential. Considering the value of 0.296 as the path coefficient of H2, and 0.002 as its significance level, one may conclude that there is indeed a positive and significant interaction effect. This implies that learning engagement has a direct and significant positive correlation with the learning outcomes by way of moderation by the learning interaction variable.

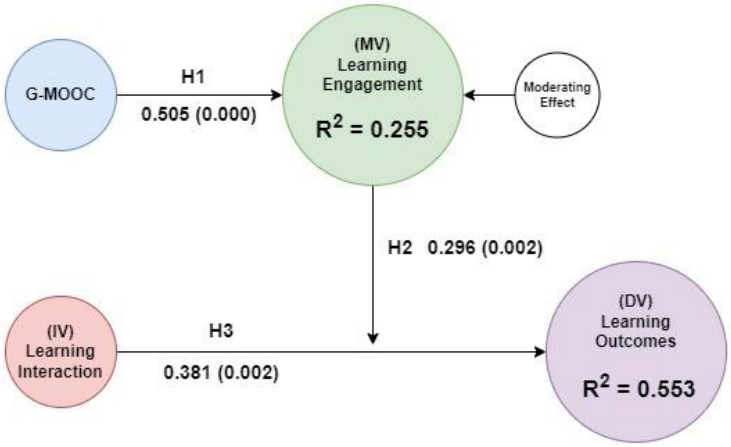

Figure 4. Summarized result of structural model SEM-PLS for moderating effect

There is a direct relation between degree of learning engagement and learning outcome, so a higher degree of learning engagement leads to better learning outcomes. In cases where the interaction term value appears as a positive sign, this means the reinforcing effect and therefore supports the relationship between interaction and learning outcomes with engagement. One can also say that the interaction and activity of learners can contribute to the best results of training. More studies need to be conducted to describe this relationship in detail. Based on Table 2, there were three (3) hypotheses that had been tested. All the hypotheses, which are H1 (p=0.000), H2 (p=0.002), and H3 (p=0.002), were significant. The result indicated that learning engagement has a significant moderating effect on learning outcomes, with a p value (p=0.002) below 0.05.

Table 2. Results of hypothesis testing

Hypothesis	Path coefficients	t value	p value	Significance (p<0.05)?
H1: G-MOOC →LE	0.505	4.728	0.000	YES
H2: LE →LO	0.296	3.066	0.002	YES
H3: LI →LO	0.381	3.060	0.002	YES

*H1: G-MOOC has a strong relationship (0.505) with learning engagement.
*H2: Learning engagement has a significant moderating effect (p=0.002) on learning outcomes.
*H3: Learning interaction has a significant effect (0.381) on learning outcomes.

5. DISCUSSION AND IMPLICATION

The main aim of these findings is to explore the effectiveness of gamified MOOC using SEM-PLS software to predict learners' perceptions of the teaching and learning process using gamification on the OpenLearning platform. This finding is designed to verify the impact of gamification on the process of teaching and learning online. In the context of gamification, which is the incorporation of elements of games in non-gaming environments has been shown to be a factor that is moderately effected. In the current study, Chung and Pan [44] use a mediation analysis to determine the moderated relationships between flow, social interaction, and engagement on the learner's learning experience in gamified learning environments. Overall, they reason that these elements improve learners' learning processes and achievements, with engagement being a moderator. In the same way, Ourdas and Ponis [45] recommended an analysis using SEM to analyze the impact of gamification on behavioral change. This article notes that their work supports the common evidence through demonstration of the impact of fun game elements on the users, as it is brought out by the fact that gamification enhances behavioral change due to the motivation elicited by the incorporation of well-designed games. They both again brought out the effectiveness of gamification in both educational and behavioral settings, stressing the tenets of engagement, social interaction, and flow.

The study's findings demonstrate that, as a moderating factor, gamification has a substantial impact on learning. Technology readiness is proven by Septiawan *et al.* [46], to be an important determinant on the successful implementation of the gamified system, an educational tool that has the potential to enhance the quality of learners learning outcomes. According to the study, to optimize technology enhanced learning through gamification, the learners in the educational institutions should be ready and prepared for it as well as the institutions must supply them with all the necessary technological skills and amenities. In contrast,

Alosaimi *et al.* [47] investigate the moderating role of teachers' experience and their biographical information on the use of games in teaching online activities. They also establish that teachers with many years of experience and those from diverse backgrounds are better placed to implement gamification strategies hence improving the gains in online education. Both studies suggest that indeed, the gamification approach in education has a great possibility. However, depending on the preparedness, and flexibility of teachers.

These findings enhance the understanding of researchers on the importance of gamification elements to stimulate learners' behavior in solving tasks and improve learner achievement through online learning. According to Shuhaiber *et al.* [48], share a best practice model in applying in information technology (IT) classrooms with the use of gamification. They discover that incorporating elements of game design with enhances students' engagement, cooperation, and readiness to learn practical applications. On the other hand, Prabowo *et al.* [49] examine the influence of the service quality on the level of engagement in online learning platforms with the help of the learning management system. Their conclusion is that quality of learning management system services such as response, reliability and user support helps in enhancing the learners' experience and satisfaction in online learning. Innovative approaches including the use of gamification and service quality in this case, is seen to have a very especial role in engaging the learners proactively and consequently enhance their performance.

Three hypotheses have been tested for the SEM-PLS structural model with moderating effect, as shown in Table 2, the results of the three (3) hypotheses (H1, H2, and H3) have a significant moderating effect. The findings support the H2 hypothesis by demonstrating that G-MOOC significantly affects the relation between learning engagement and learning outcomes (p=0.002). This is further evidenced by the moderate strength of the R^2 value correlations (0.553). According to Alkhwaldi *et al.* [50], the p-value for the SEM-PLS structural model with moderating effect is accepted. This conclusion is in accordance with the findings of the same field by Won *et al.* [51], which highlights the substantial results for moderating effects. It is also corroborated by findings in a different field by Ahmad *et al.* [52].

The findings of the SEM-PLS structural models clearly shows that learning engagement moderates learning outcome effectiveness. Since the guidelines for acceptable R^2 values vary on the complexity of the model and the research discipline, it is challenging to deliver higher prediction accuracy over the range of R^2 values from 0 to 1. The R^2 value is highly disciplined for consumer behavior, and researchers expect a higher value of 0.75 and up. Setting R^2 values of 0.75, 0.50, or 0.25 for endogenous latent variables that are recognized and classified as strong, medium, or weak is a common practice in scientific study on marketing challenges [53], [41].

6. CONCLUSION AND FUTURE WORKS

This research is designed to find out the impact of gamification elements on learning engagement in a MOOC environment and to validate the proposed G-MOOC model in the teaching and learning process for multimedia system subjects as an attraction and encouragement for learners to learn. The findings show that the gamification elements have significant effects on learning engagement through moderating interaction. These findings enhance our understanding of the importance of restructuring gamification elements based on dimensions of learning interaction to stimulate learner engagement in accomplishing their tasks through the OpenLearning platform. The results of the analysis and findings have been reported. The findings of this study suggest that the G-MOOC model can enhance learner engagement in MOOC environment. Analysis of the data reveals a notable difference in learners' achievement before and after utilizing G-MOOC. The findings also support proposed G-MOOC modelling mechanisms that have a significant positive impact on learning engagement in cognitive, behavioral, and affective components significantly. Technically, learners' engagement with the teaching and learning process has improved and has made a positive impact because of G-MOOCs. However, lecturers need to play an important role in determining activities that are appropriate with gamification elements to produce the best learning outcome. The creativity of lecturers in producing activity designs that are compatible with gamification elements and in parallel with learner engagement is very important in producing excellent outcomes.

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CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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BIOGRAPHIES OF AUTHORS

Azizul Mohd Yusoff is a senior lecturer at Kolej Komuniti Masjid Tanah, Kementerian Pengajian Tinggi. He graduated with a Bachelor of Engineering in computer system and communication from Universiti Putra Malaysia (2002), majoring in telecommunication. He obtained his Master of Science in information and communication technology from Universiti Teknikal Malaysia Melaka (UTeM) in 2020. In addition, he holds a diploma in education from Institut Perguruan Perlis (2008). He is currently a postgraduate learner at Universiti Teknikal Malaysia Melaka (UTeM). His current research focuses on E-learning, gamification, micro-credential and multimedia design. He can be contacted at email: azizulkksl@gmail.com.

Sazilah Salam is a Professor of Computer Science at the Faculty of Information and Communication Technology, UTeM. She is also currently a visiting professor at the Web Science Institute, Faculty of Engineering and Physical Sciences, University of Southampton, UK. She obtained her BSc. (Hons.) in computer science from Universiti Teknologi Malaysia (1987), Kuala Lumpur and Ph.D. from University of Southampton, UK (1997). She is the founder of the Pervasive Computing and Educational Technology Research Group, C-ACT, FTMK. Her current research focuses on MOOC observatory, semantic web, learning analytics, pervasive computing, and assistive technology. She can be contacted at email: sazilah@utem.edu.my.

Siti Nurul Mahfuzah Mohamad is a senior lecturer at the Faculty of Information and Communication Technology (FTMK), Universiti Teknikal Malaysia Melaka (UTeM). She graduated with a Bachelor of Information Technology (Hons) degree from Universiti Utara Malaysia (1998-2002), majoring in artificial intelligence. She obtained her MSc in computer science, in multimedia from Universiti Putra Malaysia (2007-2009). In 2014, she is awarded her PhD degree in interactive media from Universiti Teknikal Malaysia Melaka (UTeM). In addition, she holds a diploma in education from Institut Perguruan Perlis (2004-2006). She is a group member of Pervasive Computing and Educational Technology, Center for Advanced Computing Technology. She can be contacted at email: mahfuzah@utem.edu.my.

Rujianto Eko Saputro is a lecturer in the Faculty of Computer Science at Amikom University Purwokerto, Indonesia, since 2010. In 2021, he achieved a significant academic achievement by completing his doctoral program at Universiti Teknikal Malaysia Melaka. Currently, he serves as the head of the Bachelor of Information Technology Study Program. Outside of his academic role, Rujianto is the innovative thinker behind AMPU Studio, a multimedia, animation and game development lab at the Faculty of Computer Science at Amikom University Purwokerto. His research focuses in several areas including game design & development, gamification, persuasive technology, and HCI. He can be reached via email: rujianto@amikompurwokerto.ac.id.