Journal of Information Technology Education: Research

An Official Publication of the Informing Science Institute
InformingScience.org

JITEResearch.org

Volume 22, 2023

INVESTIGATING FACTORS THAT AFFECT THE CONTINUANCE USE INTENTION AMONG THE HIGHER EDUCATION INSTITUTIONS' LEARNERS TOWARDS A GAMIFIED M-LEARNING APPLICATION

Rosfuzah Roslan*	Faculty of Educational Study, Universiti Putra Malaysia (UPM), Selangor, Malaysia, and Centre for Diploma Studies (CeDS), Universiti Tun Hussien Onn Malaysia (UTHM), Pagoh, Johor, Malaysia	rosfuzah@gmail.com
Ahmad Fauzi Mohd Ayub	Faculty of Educational Study, Universiti Putra Malaysia (UPM), Selangor, Malaysia	afmy@upm.edu.my
Norliza Ghazali	Faculty of Educational Study, Universiti Putra Malaysia (UPM), Selangor, Malaysi	alezg@upm.edu.my
Nurul Nadwa Zulkifli	Faculty of Humanities, Management, & Science, Universiti Putra Malaysia (UPM), Sarawak, Malaysia	nurulnadwa@upm.edu.my
Siti Noor Haslina Md Latip	Faculty of Educational Study, Universiti Putra Malaysia (UPM), Selangor, Malaysia	sitinoorhaslina@gmail.com
Siti Syuhada Abu Hanifah	Faculty of Educational Study, Universiti Putra Malaysia (UPM), Selangor, Malaysia	gs58835@student.upm.my

* Corresponding author

Accepting Editor Justin Filippou | Received: October 31, 2022 | Revised: December 27, 2022; January 28, February 5, 2023 | Accepted: February 6, 2023.
Cite as: Roslan, R., Mohd Ayub, A. F., Ghazali, N., Zulkifli, N. N., Md Latip, S. N., H., & Abu Hanifah, S. S. (2023). Investigating factors that affect the continuance use intention among the higher education institutions' learners towards a gamified m-learning application. *Journal of Information Technology Education: Research, 22,* 97-128. https://doi.org/10.28945/5080

ABSTRACT

Aim/Purpose	The main purpose of this study is to identify the factors affecting the continuance use intention of gamified m-learning applications by Higher Education Institution (HEI) learners in Malaysia.
Background	Mobile learning (m-learning) has been a popular choice among learners in HEIs due to its convenient 'on-the-go' concept. On the other hand, embedding gamification elements in m-learning applications help in increasing the users' interest in continuous use. Therefore, many HEIs have invested in producing their own m-learning products apart from utilizing existing m-learning applications that are widely available online. One of the challenges faced by HEIs is the low technology usage rates towards the 'in-house' developed applications, which affect the receptiveness of education stakeholders in investing or maintaining educational applications. Meanwhile, the lack of continuous usage had given a negative impact on their academic-related tasks and performance. Hence, it is important to understand the significant factors that influence learners' intentions in continuance usage of a gamified m-learning application. This will serve as an insight to the HEIs management regarding the needs and design that better suits their users' expectations.
Methodology	This study employed a correlational cross-sectional research design using an online survey. The participants of the final survey involved first-year students from one of the Malaysian public universities. For the final analysis, 269 responses were analysed using the partial least square-structural equation modelling (PLS-SEM) technique, which is a powerful multivariate analysis mechanism. The Expected Confirmation Model (ECM), which is a post-acceptance model, was extended with the pre-acceptance model named Extended Unified Theory of Acceptance and Use of Technology (UTAUT2), to form the research proposed model that describes the continuance intention in using a gamification-based m-learning application.
Contribution	This research contributes to the body of knowledge and helps better understand users' continuance intention in the post-acceptance phase of the gamified m-learning application. It exposes information at the individual level, regarding the continuance intention of using an m-learning tool that is equipped with gamification elements. This will mostly benefit the educational resource developers in the HEIs in producing effective 'in-house' learning tools.
Findings	This research develops a theoretical enhancement of the Expectation Confirmation Model (ECM) that affects the HEIs' m-learning resource developers and management, dealing with IT-related behaviour. Moreover, a solid continuance usage intention conceptual model, which incorporated two important models, was also introduced. Out of all ten hypotheses, only two were not supported that are related to factors facilitating conditions and social influence. Those two factors negatively influence the HEI learners' continuance use intention. Meanwhile, the core factors for satisfaction, which are perceived usefulness and confirmation, were found to be significant. Lastly, satisfaction was proven to mediate the positive path between perceived usefulness and the continuance intention of using the gamified m-learning application.
Recommendations for Practitioners	This study offers insights into strategies that the HEIs' management should perform in securing continuance usage of the 'in-house' developed m-learning products. One of the strategies could be organising technology workshops that

will prepare their educators in implementing the institutions' gamified teaching and learning tools. Another highlighted issue is regarding the need for faculties to design an effective approach to entice educators and learners towards applying new learning technologies.

Recommendations for Researchers — This study contributes to the micro-level analysis of the continuance use intention of gamification-based m-learning applications by fostering the understanding of the phenomenon at the individual level. It is recommended that other researchers extend the research model by incorporating other theories, as this study was only based on two models (i.e., ECM and UTAUT2). Additionally, a longitudinal study could be another approach that enables researchers to collect much richer data that includes a wide array of background characteristics or control variables. Another suggestion would be applying related factors that may contribute to the discovery of effective gamified m-learning application designs.

Impact on Society — The findings of the study show the importance of confirmation made by the applications' users towards usefulness and usage satisfaction. Confirmation and perceived usefulness also have an increasingly similar impact on users' satisfaction with the application and their subsequent continuance use intention. It is also revealed that easy-to-use products are commonly expected nowadays, as users might be reluctant to spend much time on them. On the other hand, for a specific gamification-based product, it is also expected by the users for it to be capable of giving an 'enjoyable' experience, hence motivating continuance usage. As a result, an effective gamified m-learning application or product will be able to be used by Malaysian HEI learners if the developers and stakeholders develop and evaluate the usage of their products with the consideration of the information provided by this research.

Future Research — Future studies could include respondents from other diploma programmes, resulting in an in-depth analysis. It is needed to support the generalizability of the findings in this study by considering larger populations from all different programmes. In addition, similar research can be done based on different circumstances; for instance, use of the gamified m-learning application during the in-campus physical classes instead of virtual classes (online), which might influence the users' perception in terms of the social influence and facilitating condition.

Keywords — gamified m-learning, gamification, expected confirmation model, extended unified theory of acceptance and use of technology, continuance use intention

INTRODUCTION

In accordance with the current demands of the twenty-first century, Higher Education Institutions (HEIs) have faced a vast transformation in teaching and learning systems and approaches. It is now a trend for m-learning applications to include gamification concepts that incorporate play and fun elements (Ishaq et al., 2021), in which the product will become a 'gamification-based' m-learning application or also mentioned as a 'gamified' m-learning application. Gamification refers to a game-like experience provided to users by applying gamification elements or mechanisms (Koivisto & Hamari, 2019). Among the gamified m-learning applications that have been used in the teaching and learning of Malaysian HEIs are e-quiz (Ismail et al., 2019), Mobile-Assisted Language Learning (MALL) (Ishaq et al., 2021), course learning (Ramle et al., 2019), Learning Management System (LMS) mobile versions such as the Moodle application (Annamalai et al., 2021), and the Edmodo application (Suka & Hamid, 2020). Using these gamified m-learning applications has increased learners' intrinsic and

extrinsic motivation in using the learning tool, which eventually fostered and reinforced their learning (Benben & Bug-os, 2022; Lin et al., 2018). Specifically, the usage of those applications in Malaysian HEIs has helped the learners significantly in terms of knowledge reinforcement and retention (Lin et al., 2018; Mohamad, et al., 2020). It also promotes the 'learning on-the-go' concept, where learners have the luxury of flexibility in accessing their courses' content from their mobile devices anytime and anywhere (Lozanova, 2022).

Acquiring approval or acceptance of the new technology is much easier than retaining the HEI learners' interest in continuance use (Tam et al., 2020). The low technology usage rates among the learners affected the receptiveness of education stakeholders in investing or maintaining educational applications (Ahmad, 2020). In other words, lack of sustained usage of an application leads to difficulties for the developers to solicit users' responses to eventually improve the technology (Chiu et al., 2020), as well as gaining financial benefits if there are any, such as revenue that comes from various sources (e.g., advertisements, 'in-app' purchases, subscriptions, sponsorship, etc.) (Higgins, 2016). From the learners' outlook, lacking continued usage of m-learning applications may negatively affect their academic-related tasks and performance. This notion was based on Cho (2016), who found that users' discontinuance of a fitness and health application had caused negative impacts on the users' health. Therefore, it is necessary for HEIs to be aware of the applications' design that suits their users' expectations even at the start of the development phase.

In terms of the trend of research related to digital learning, most studies have concentrated on recognising the effect on learners' performance, engagement, and motivation (e.g., Zainuddin et al., 2020) as well as the acceptance of the product (e.g., Lestari & Nugraha, 2021; Md Yunus et al., 2021). Meanwhile, studies related to 'continuance use intention' on product use of e-learning (e.g., Al Amin et al., 2022), Massive Open Online Courses (MOOC) (e.g., Shanshan & Wenfei, 2022), Learning Management Systems (LMS) (e.g., Ashrafi et al., 2022; Widjaja & Widjaja, 2022) and m-learning application (e.g., Khlaif et al., 2022; Tam et al., 2020) were already done; however, studies on continuance use intention mainly on a gamified m-learning application is scarce (Roslan et al., 2021a; Wirani et al., 2022), making this a critical literature gap.

The current work proposes an extended version of the Expectation Confirmation Model (ECM) by Bhattacherjee (2001), a post-acceptance model that integrates elements of the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh et al. (2012), a pre-acceptance model, to examine the factors that influence the users' continuance intention to use a gamified m-learning application. Firstly, this study identifies relevant determinants from the UTAUT2 which represents the explanatory elements and combines them with the exploratory elements from the ECM model (Bhattacherjee, 2001). Secondly, by investigating the determinants of learners' continuance intention to use the gamified m-learning application, a contribution can be made to the broader body of knowledge related to this topic. This is critical because the majority of earlier educational information technology (IT) studies mainly focused on the initial acceptance, while this study focuses on investigating the post-acceptance phase of gamified m-learning applications' usage.

THEORETICAL BACKGROUND

This section presents the theoretical basis of this study. The Expected-Confirmation Model (ECM) proposed by Bhattacherjee (2001) and the Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh et al. (2012) are explained together with the relevant literature for a broader understanding of the role of technology, IT usage, and user intention. Lastly, the incorporated model of ECM and UTAUT2 proposed by this research are also discussed leading to the formulation of ten hypotheses.

Expected Confirmation Model (ECM)

Post-acceptance behaviour study using the Expected Confirmation Model (ECM) has been a popular choice (Tam et al., 2020; Yang et al., 2022). The robustness of the ECM is due to the foundation theories derived, which were from the Expectation Confirmation Theory (ECT) and Technology Acceptance Model (TAM). Bhattacherjee (2001) adapted the ECT and TAM to produce ECM in Figure 1, which supports three variables to predict and explain the individuals' continuous intention of technology usage. The variables are satisfaction, confirmation of expectations, and perceived usefulness. In the confirmation stage, users evaluate whether their initial expectations have been adequately met after accepting and using the technology. The level of their confirmation affects their satisfaction with the technology and their perception of its usefulness. As a result, perceived usefulness and satisfaction jointly determine their intention to continue using the technology. Continuance use of intention as a construct is being used to measure whether a user (learner) is accepting a new technology or approach beyond the initial satisfaction as well as an indicator of future behaviours.

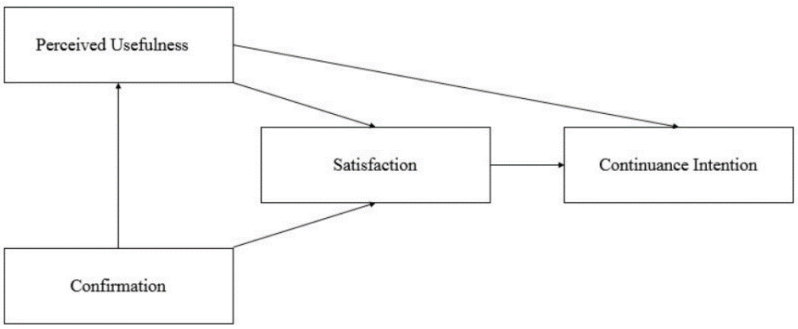


Figure 1. Expected Confirmation Model (ECM) by Bhattacherjee (2001)

A few recent m-learning application studies that also incorporated ECM in their proposed frameworks are by Tam et al. (2020), Alhumaid (2021), and Alzaidi and Shehawy (2022). First, Tam et al. (2020) applied ECM with the addition of UTAUT2 factors in their continuance use intention study of mobile applications among university students in Lisbon. They discovered that the students were directly and meaningfully influenced by their satisfaction and performance expectancy (i.e., perceived usefulness) of mobile application usage. Later, Alhumaid (2021) proposed an integrated model using theoretical models such as the Theory of Planned Behavior (TPB), the TAM, and the ECM and discovered that attitude was the best predictor for using the m-learning system. In recent research, Alzaidi and Shehawy (2022) proposed a conceptual framework for the continued intentions of learners to use m-learning during the COVID-19 outbreak expanding the UTAUT and the ECM under different cultural contexts. These previous studies proved the validity of ECM modification by incorporating several other explanatory constructs derived from the pre-acceptance model, for example, variables from the UTAUT or UTAUT2.

Extended Unified Theory of Acceptance and Use of Technology (UTAUT2)

In the pre-acceptance or pre-adoption domain, the Unified Theory of Acceptance Use of Technology (UTAUT), inspired by Venkatesh et al. (2003) suggested that the acceptance of technology is primarily driven by performance expectancy or perceived usefulness, effort expectancy, also known as perceived ease of use, social influence, and facilitating conditions. Additionally, these relationships are moderated by gender, age, experience, and voluntariness of use. The Extended Unified Theory of Acceptance Use of Technology (UTAUT2) by Venkatesh et al. (2012) in Figure 2, which is an extended version of UTAUT, was formulated in order to better adapt it to the consumer use framework, and it introduces three new variables, which are hedonic motivation, price value, and habit. While hedonic motivation and price value are solely related to intentions to use, habit is related to

both intentions to use and actual usage. Moreover, UTAUT2 includes a new relationship between the facilitating conditions and the intention to use. Since consumption in the consumer environment is always voluntary, UTAUT2 eliminates voluntariness of use as a moderating variable. Instead, it introduces experience as a moderator in the relationship between intentions to use and usage.

Based on the previous finding, most of the studies that implemented the UTAUT model as the theoretical framework used only part of the variables, while moderators are excluded in most of the studies due to low applicability use (Al-Mamary, 2022; Li & Zhao, 2021; Marchewka et al., 2007). For instance, Marchewka et al. (2007) showed that the moderating role of gender and age are irrelevant in online learning systems for college students. Meanwhile, because the samples in Li and Zhao's (2021) study were all college students of similar age and background and had high consistency of samples, the four moderators in the UTAUT model were not applied. On the other hand, Al-Mamary (2022) did not bother to include any moderators as those were not the aim of his research interest.

In recent years, both the UTAUT and UTAUT2 have been applied to examine the acceptance of mobile-based technologies and other technology contexts (Castanha et al., 2021; N. Singh et al., 2020; Tamilmani et al., 2021). UTAUT2 was also used to investigate technology continuance use intention. For example, research by Tam et al. (2020) on mobile application among learners in Lisbon, Portugal, and the latest by Osei et al. (2022) which focused on the e-learning adoption during the COVID-19 pandemic era among the learners of tertiary education in Ghana. In conclusion, the constructs from the pre-acceptance model, UTAUT2, are a valid addition to a post-acceptance model to uncover technology continuance use intention contributors.

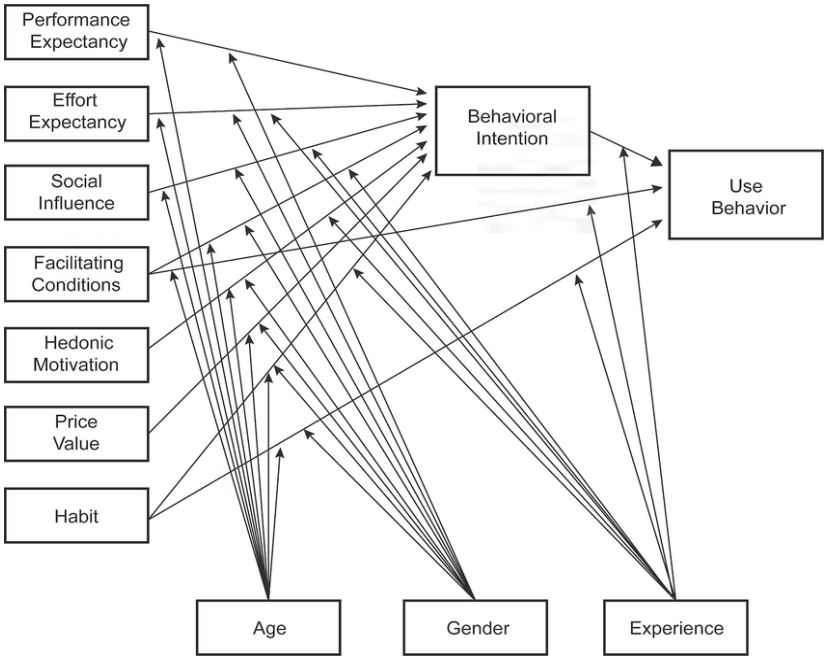


Figure 2. Extended Unified Theory of Acceptance and Use of Technology (UTAUT2) by Venkatesh et al. (2012)

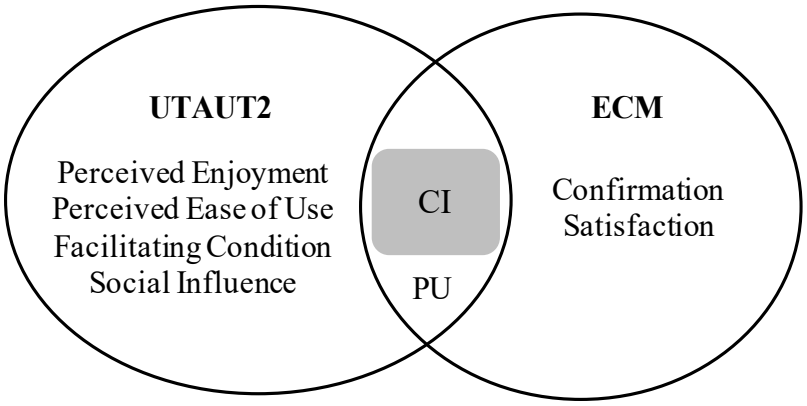
Incorporated Model of ECM and UTAUT2

Motivated by the fact that there is a lack of research on learners' continuance use intention, specifically in a 'gamification-based' or 'gamified' m-learning application, this study applied a robust post-usage model (i.e., ECM) as the base model. In order to reveal more information or, in other words, increase the explanatory power of this continuance use of intention research, more variables were incorporated into Bhattacherjee's (2001) ECM model. The variables were derived from the

technology pre-acceptance or pre-adoption model, namely the UTAUT2 from Venkatesh et al. (2012). Behavioural intention and use behaviour are typically associated with the pre-acceptance stage of technology (Venkatesh et al., 2003), whereas continuance use intention encompasses the post-acceptance stage of a technology (Bhattacherjee, 2001). Of the nine constructs from UTAUT2, only five are related to the technological product used in this study, which are: (i) facilitating condition (FC), (ii) social influence (SI), (iii) effort expectancy/perceived ease of use (PEOU), (iv) hedonic motivation/perceived enjoyment (PENJ), and (v) performance expectancy/perceived usefulness (PU).

For factor price value (PV), it can be included in the proposed model if this research focuses on the perspective of the educator (i.e., educators as the population); however, this research focused on the student as the type of user, or in other words, student module. Therefore, the price value factor is not applicable due to payment or purchase not being imposed on students' accounts. In the case of another two unselected UTAUT2 variables (i.e., behaviour intention, use behaviour), those variables indicate the pre-adoption research, which is an assessment related to technology pre-adoption or pre-acceptance, while this research focuses on the post-adoption or post-acceptance phase (i.e., continuance use intention). On the other hand, the habit (H) factor is not included due to two reasons: (i) sufficient time has not elapsed for users to trigger habit at the early stage of technology adoption, and (ii) habit usually occurs more naturally under voluntary settings, while experience on the usage of the product is usually acquired under mandatory settings. Similarly, Tamilmani et al. (2018) also mentioned these same reasons for not including the habit (H) factor in their study as well.

This study was conducted during the COVID-19 outbreak which witnessed the instant shift to virtual or online learning tools leading to increased levels of stress as a result of escalated on-screen time (Mheidly et al., 2020). Moreover, more independent learning hours had to be spent to complete the learners' academic tasks which left the learners with limited resting hours (Azlan et al., 2020). Hence, the learners were most unlikely to develop a habit towards the use of the technological product (i.e., Kingdom Quizzes) as it requires a lot of time and attention, and the usage of the product is usually for the mandatory situation. Meanwhile, ECM contains four constructs (i.e., perceived usefulness, confirmation, satisfaction, continuance use intention), and all the constructs are related to the technological product used in this study. Considering that this research involves the use of an online learning system (i.e., m-learning), all the participants are first-year diploma students (i.e., 19 years of age), and are in their second semester which means that all of them had experienced using various educational systems in that institution, hence the moderators associated with the UTAUT2 were deemed irrelevant to be included in this study. The theoretical framework is shown in Figure 3.



Note. PU (Perceived Usefulness); CI (Continuance Use Intention)

Figure 3. The theoretical framework adopted from ECM and UTAUT2

Hypotheses

Ten hypotheses are presented based on the proposed model in Figure 4. The first and second hypotheses are related to the confirmation of expectations which implies the degree of the perceived congruence between the expectations of the IT product/service and its actual performance (Bhattacherjee, 2001; Chiu et al., 2020). Users who validate their prior assumptions regarding a particular IT solution might immediately see its advantages. Meanwhile, users' confirmation of expectations managed to obtain the expected benefits through their IT usage, thereby leading to a positive effect of perceived usefulness and satisfaction with the IT product (Han & Conti, 2020; S. Singh, 2020; F. Zhou et al., 2021). Therefore, this study will view confirmation as the HEI learners' perception of the similarity between their expectation of the usage of gamified m-learning application with the actual operation. In other words, the actual learners' experience while using the application, has to confirm the learners' initial expectations. Therefore, the following hypotheses are posed:

H1a: Confirmation (C) has a positive effect on satisfaction (S) in using gamified m-learning applications.

H1b: Confirmation (C) has a positive effect on the perceived usefulness (PU) of gamified m-learning applications.

The third and fourth hypotheses are related to the construct of perceived usefulness, reflecting that a person believes using a specific system would boost job performance (Davis, 1989). Perceived usefulness is an essential factor that is also referred to as performance expectancy (Tam et al., 2020). It is commonly explored to verify the products' level of usability, leading to satisfaction, and is widely considered in continuance usage intention studies (e.g., Kim & Nam, 2019; S. Singh, 2020). Therefore, in this study, the users will be satisfied upon using the gamified m-learning application if their expectation of the application's ability to perform their academic tasks faster with mobility's advantage is fulfilled. Hence, the basis for hypothesis H2a.

On the other hand, Premkumar and Bhattacherjee (2008) confirmed perceived usefulness as the predictor of intention in TAM and a dependable predictor of continuance use intention. The application in this study is expected to be the automated version of the traditional (paper-based) process and able to be used on mobile devices. Therefore, hypothesis H2b was formulated based on the users' belief that using the gamified m-learning application is very useful to them, especially when they are 'on the go' regardless of their physical location, which triggers their interest in continuous use of the product. Drawing on the above cases, it is suggested that:

H2a: Perceived usefulness (PU) has a positive effect on satisfaction (S) in using the gamified m-learning application.

H2b: Perceived usefulness (PU) has a positive effect on gamified m-learning application continuance use intention.

The next hypothesis is related to the construct of perceived enjoyment. Perceived enjoyment is considered as a form of intrinsic motivation that can lead to emotional arousal and stipulates the extent to which fun can be acquired from using IT or IS (Chao, 2019). Sharifi Fard et al. (2019) and Akdim et al. (2022) highlighted that perceived enjoyment is also referred to as hedonic motivation. Numerous studies have proved that enjoyment is a particularly powerful predictor of usage decisions for technologies, for example, the MOOC (Tao et al., 2022), online education platforms (L. Zhou et al., 2022), virtual reality (Zhang et al., 2022), augmented reality (Alsharhan et al., 2022), and m-learning application (Al-Bashayreh et al., 2022).

The fifth hypothesis is based on reliable evidence confirming the link between perceived enjoyment, which is the hedonic aspect of technology, with continuance use intention (Akdim et al., 2022). As the technological product for this research consists of all three MDA gamification elements (i.e., mechanic, dynamic, aesthetic) and offers an interconnected strategy game, it is assumed that a learners'

perceptions about the hedonic aspect of a gamified m-learning application will have a positive impact on their willingness to continuance using the product. Therefore, the following hypothesis is posed:

H3: Perceived enjoyment (PENJ) has a positive effect on gamified m-learning application continuance use intention.

The construct perceived ease of use, referred to as effort expectancy, is the degree of belief that using a specific technology will be free of effort (Davis, 1989). According to Tam et al. (2020), when users strongly believe that a mobile application is indeed practical, therefore they may also believe that the application is difficult to use, which contributed to the idea that the benefits of using it are offset by the effort to use the application. An assumption is that the simple and user-friendly functionalities of the gamified m-learning application will likely make the learner perceives it as easy to use and useful during the execution. If the application is relatively helpful and easy to use, learners will be more willing to learn about the features and finally have the intention to continue use (L. Y. Wang et al., 2019). Hence, the next hypothesis is posed:

H4: Perceived ease of use (PEOU) has a positive effect on gamified m-learning application continuance use intention.

According to Venkatesh et al. (2003, 2012), facilitating conditions are the degree to which the individual perceives the existence of resources and support to use a specific technology whenever necessary. Previously, Nysveen and Pedersen (2016) stated that a consumer who has access to a favourable set of facilitating conditions is more likely to have a greater intention to use technology. Furthermore, a recent study by Kamarozaman and Razak (2021) related to e-campus continuance use intention found that facilitating condition plays an essential contributor. Therefore, the formation of the seventh hypothesis is based on the more facilitation conditions associated with using the gamified m-learning application, the more a user will continue to use them. Therefore, the following hypothesis is posed:

H5: Facilitating condition (FC) has a positive effect on gamified m-learning application continuance use intention.

For social influence, Venkatesh et al. (2003) described social influence as the degree to which a person perceives that important people around them believe that everyone should use the new. Generally, the perception of others influences the intentions to use a particular technology. This is an important factor in determining the acceptance and continuance use of technology. Likewise, Wu and Chen (2017) stated that when an individual observes that others use the technological application and perceive the benefits of its implementation, that individual will become more willing to use the application, which can increase both present and future usage of the technology. Vanduhe et al. (2020) established that when a user observes that his/her peers are using gamification and acknowledged the benefits of its use, that individual will be inspired to implement gamification for training in the present and the future. For this study, it is expected that social influence entails the learners' perception of usefulness from others and plays a vital role in driving attitudes toward using the gamified m-learning application. Hence, the following hypothesis is posed:

H6: Social influence (SI) has a positive effect on gamified m-learning application continuance use intention.

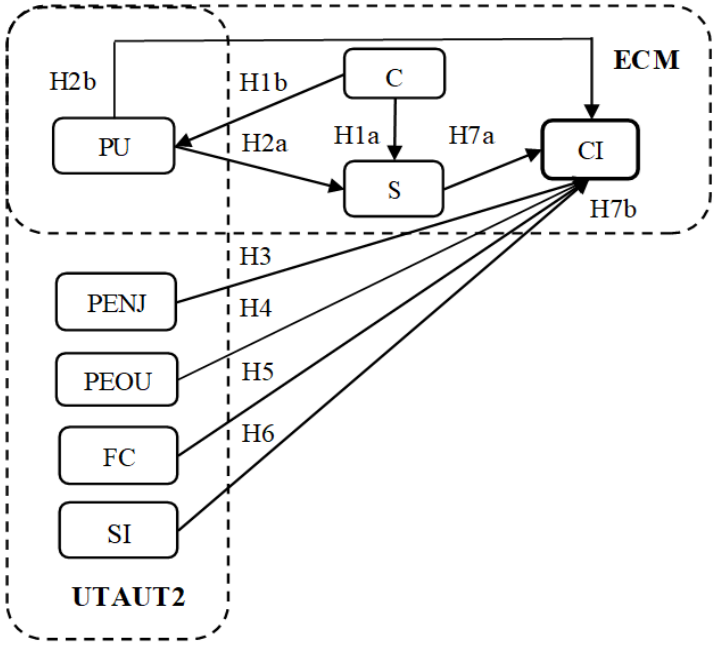
In the application context, consumer or user satisfaction is the state of satisfaction that comes from the performance that meets expectations (Phuong et al., 2020). Studies by Bagaskara et al. (2021) and Yang et al. (2022) have reported that satisfaction is significant towards the continuance usage intention. The students' expectations of the performance of learning technology are indeed interconnected with their satisfaction, and then later affect their intention to continue implementing technology blended learning (Yang et al., 2022). Meanwhile, Bagaskara et al. (2021) confirmed that due to Google Classroom's easy-to-use features, students felt satisfied with their user experience, hence having the intention to continue using the LMS. Therefore, the formulation of hypothesis H7a in this

study revolves around the users feeling content with the gamified m-learning applications' services and pleasing experience, which is an important aspect in securing their intention to use the product again.

In another case, Yang et al. (2022) also found that satisfaction mediates the impact of beginners' perceived usefulness towards continuance use intention of blended learning in HEI. Previously, Islam and Azad (2015) confirmed satisfaction as a mediating factor between the usefulness and continuance use of an e-learning system. It is said that both the students and educators expressed positive views on the usefulness of the Learning Management System (LMS), which triggered their satisfaction to continually use the LMS. Following that, Joo et al.'s (2017) study also found that satisfaction played a mediating role in linking perceived usefulness and continuance use intention towards digital textbooks. Therefore, in this study, satisfaction is also predicted to influence the mediating effect between perceived usefulness and continuance use intention due to the expectation that users need to be satisfied with the impact of the gamified m-learning usage and the ability to complete their academic tasks. Thus, the formation of hypothesis H7b is as follows:

H7a: Satisfaction (S) has a positive effect on gamified m-learning application continuance use intention.

H7b: Satisfaction (S) positively mediate the relationship between perceived usefulness (PU) and continuance use intention of the gamified m-learning application.



Note. PU (Perceived Usefulness); PENJ (Perceived Enjoyment); FC (Facilitating Condition); PEOU (Perceived Ease of Use); SI (Social Influence); C (Confirmation); S (Satisfaction); CI (Continuance Use Intention)

Figure 4. Research model

In conclusion, the incorporation of UTAUT2 and ECM allows capturing of data relating to two use perceptions, pre- and post-usage perceptions of the gamified m-learning application. However, the original continuance usage intention model (i.e., ECM) cannot fully explain the post-acceptance influencing factors of the application without the introduction of certain modifications, such as embedding constructs that also represent the expected behaviours of learners.

METHOD

RESEARCH CONTEXT AND PARTICIPANTS

This study was conducted in one of Malaysia's public universities, specifically at the Centre for Diploma Studies (CeDS), Universiti Tun Hussein Onn Malaysia (UTHM). Diploma programmes are considered post-secondary education or tertiary education, generally receiving enrolment from students aged 18 years old. In CeDS, UTHM, the diploma study is conducted for two and a half years (i.e., five semesters), and the last semester is dedicated to industrial training, meaning there would be no teaching and learning sessions. The gamified m-learning application involved in this study is an android-based e-quiz mobile application called Kingdom Quizzes and developed by UTHM. The Kingdom Quizzes application offers more than just a quiz module, it also offers an interconnected game module (i.e., tower defence strategy game). The types of activities that the learners can perform are: (i) executing quizzes, (ii) revision, and (iii) gameplay. Furthermore, the gamification items employed by Kingdom Quizzes are: (i) points, (ii) leaderboard, (iii) performance list, (iv) virtual gifts, (v) level and challenges, and lastly, (vi) avatar/personalised image. Figure 5 displays the activities in Kingdom Quizzes done by the learners.

Figure 5. Activities done using the Kingdom Quizzes application

This study employed a correlational cross-sectional research design using an online survey. The participants of the final survey are the first-year students of diploma programmes: Civil Engineering, Animation, and Information Technology, who are 'active' Kingdom Quizzes users. The 'active' status refers to students who had completed more than 50% of the total published quizzes during that semester. This restriction is enforced based on the perception that inactive users may not be able to give reliable answers to the questions posed in the survey due to their low involvement with the product. The usage of Kingdom Quizzes, consisting of all the aforementioned activities, was done for eight weeks in a semester, and the number of quizzes published for each course is at least three sets. Details of the procedure are stated in Table 1.

Table 1. Research procedure performed in one semester (14 weeks)

Week	Activity/Task
1–3 (3 weeks)	• Discussion with participating educators • Finalized quiz content, schedule, list of students • Quiz setup and testing
4–5 (2 weeks)	• Briefing on the Kingdom Quizzes usage to the students • Application download, installation, and testing
6–13 (8 weeks)	• Quiz publishing by educator • Quiz execution, quiz revision, game playing (i.e., interconnected strategy game) by students • Quiz marks and grade compilation by educator
14 (Survey week)	<u>Before the survey session</u> • Preparation of 'active' and 'inactive' students' listing by educator <u>During the survey session</u> • At the start of the session, students' attendance was collected and checked to ensure the participants are the targeted participants (i.e., 'inactive' students are dismissed) • Briefing on the Kingdom Quizzes application and survey that will be conducted • A Google Form link is given in the chat section. Respondents are reminded to turn on their web camera while answering the survey and encouraged to ask any questions regarding the items posed in the survey • After the survey completion, respondent will acknowledge the educator on their exit so that the number of completed responses can be cross-validated or cross-checked

At the end of the semester, the Google Form link containing the research survey was distributed to the 'active' students (i.e., students who had completed more than 50% of overall published quizzes throughout the semester) in a Google Meet session (Figure 6). Due to conducting an online survey, it is important that the survey link is given to the eligible person (i.e., UTHM Diploma students who used the Kingdom Quizzes application to perform authorized quizzes, throughout the whole semester). This is to prevent any form of abuse (e.g., unauthorized respondents or unknown responses, multiple insertions) towards the data collection done through an open link (i.e., Google form link). Hence, it is important for educators to identify all the students that are in the Google Meet session at the time.

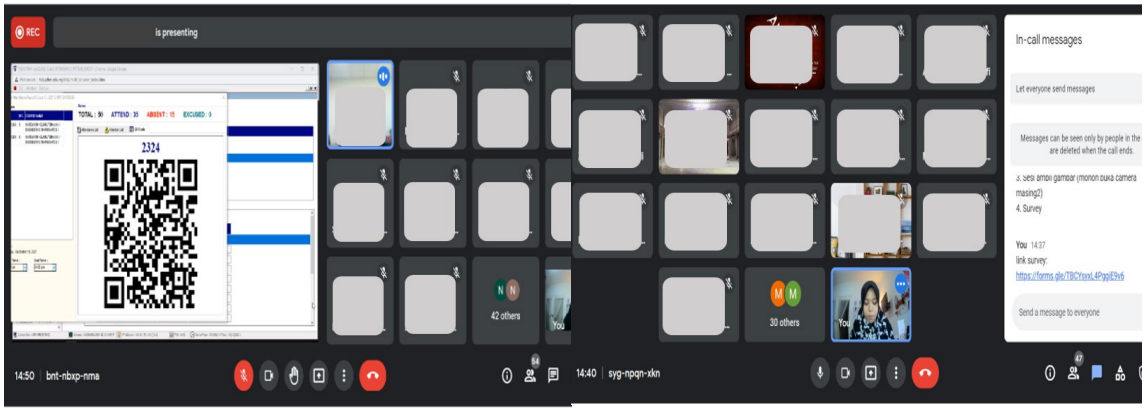


Figure 6. Google Meet survey session

A total of 317 questionnaires were collected during the survey session. Subsequently, 48 responses were excluded due to the existence of extreme cases identified from Mahalanobis's multivariate outlier test (Leys et al., 2018). In conclusion, 269 valid responses remained for further analysis. Overall, the responses consisted of 129 (48%) female and 140 (52%) male respondents, and the programme distributions are: 103 out of 240 students of civil engineering (38.3%), 44 out of 100 students of animation (16.4%) and 122 out of 220 students of IT (45.3%).

MEASURES

The instrument used in this research is based on reliable existing instruments that were adapted and modified to fit the aim and context of this study. Table 2 presents the final items with the source of the instrument. All items were measured using the Likert scale of 5 – points ranging from strongly disagreed (1), disagreed (2), somewhat agreed (3), agreed (4), to strongly agreed (5). Prior to data collection, a pre-test was carried out in which the survey items were evaluated by five experts in the field of educational technology. Subsequently, a pilot test with 60 first-year students from the previous cohort of student enrollment was performed to ascertain the reliability of items at the preliminary stage. The Cronbach's Alpha (α) values of each construct based on the result of the pilot study are also presented in Table 2. Based on Hair et al. (2014), the reliability score of .70 or higher is the ideal threshold for obtaining suitable reliability of an instrument and the Cronbach's Alpha (α) values for each construct are displayed as .70 and above. Meanwhile, the average value of Cronbach's Alpha (α) for the whole instrument is .770, which shows that the instrument is acceptable and reliable for this research. Hence, the instrument is declared fit to be used in the actual study. The full items or instrument is presented in the Appendix.

Table 2. Details on the instrument including reliability test (Cronbach's Alpha) based on the pilot study

Construct	Number of Items	Source	Cronbach's Alpha (α)
Perceived Usefulness (PU)	5	Bhattacherjee (2001); Venkatesh et al. (2012)	.818
Perceived Ease of Use (PEOU)	5	Venkatesh et al. (2012)	.760
Social Influence (SI)	5	Venkatesh et al. (2012)	.701
Facilitating Conditions (FC)	5	Venkatesh et al. (2012)	.713
Perceived Enjoyment (PENJ)	4	Venkatesh et al. (2012)	.707
Satisfaction (S)	6	Bhattacherjee (2001)	.831
Confirmation (C)	6	Bhattacherjee (2001)	.855
Continuance Use Intention (CI)	5	Bhattacherjee (2001)	.776
Total	41	Average (α)	.770

DATA ANALYSIS

Prior to evaluating the model, the 269 final data were examined for multivariate normality using a multivariate coefficient. The multivariate coefficient is one of the techniques that is used to assess multivariate normality, as demonstrated in Mardia (1970). Based on Mardia's coefficient procedure, the kurtosis coefficient ($\beta = 103$) was above the threshold score of 20, indicating data being non-normally distributed (Byrne, 2013; Kline, 2015). For this reason, partial least square-structural equation modeling (PLS-SEM) is more appropriate to be applied through the use of a non-parametric inferential technique (i.e., bootstrapping) (Sarstedt et al., 2021). The final data, which is 269, complied with the minimum sample size that is proposed in PLS-SEM (i.e., $n > 160$) (Kock & Hadaya, 2018).

Before proceeding to the first data analysis procedure to verify the measurement model, Common Method Bias (CMB) is tested. It is said that the CMB can overemphasise the strength of the relationships among the variables in the model due to all the responses were gathered from a similar source.

The CMB is assessed through two types of approaches: (i) Harman's Single Factor (HSF) (Podsakoff, 2003), and (ii) full collinearity assessment (Kock & Lynn, 2012). According to the recommendation of Podsakoff (2003), the HSF results illustrated that the largest variance explained by an individual factor was 30.23% (< 50%). Furthermore, the assessment of full collinearity produced a variance inflation factor (VIF) below 3.30 (Kock & Lynn, 2012), as shown in Table 2. This concludes that this study has no issue related to CMB.

Starting with the first data analysis step, which is assessing the measurement model with the purpose of checking the reliability and validity of the construct, this involves (i) an internal reliability test, (ii) a convergent validity test, and (iii) a discriminant validity test (Hair et al., 2011), which will reveal how well the observed variables represented the latent variables. The internal reliability is acceptable when the composite reliability value is .70 or higher (Bagozzi & Yi, 1988). Meanwhile, for convergent validity, the threshold value of the average variance extracted (AVE) is above .50 (Nunnally & Bernstein, 1994). Lastly, discriminant validity is being checked using the Heterotrait-Monotrait ratio of correlations (HTMT) due to its superior performance based on Ghasemy et al. (2020). The threshold value below .90 (Gold et al., 2001) is selected in this study to identify the discriminant validity of the variables involved.

Next, the validation of the structural model was conducted to find the relationships among the variables set in this study. All the constructs in this research were measured using reflective measurement models as each set of the observed variables (indicators) can be classified as manifestations of the underlying constructs. The evaluation was done using five steps: (i) the lateral collinearity (VIF) (Becker et al., 2015), (ii) the path coefficients, (iii) the coefficient of determination (R^2) (Hair et al., 2019), (iv) the effect size (f^2) (Cohen, 1988), and (v) the predictive accuracy (Q^2) (Geisser, 1975; Shmueli et al., 2016, 2019; Stone, 1974).

RESULTS

This section provides a report on the measurement model and structural model analyses based on the finalized data set and preliminary data examination performed in the previous section. In the end, analysis based on the original ECM was also conducted as a comparison measure in order to prove the relevance of the proposed research model.

VERIFICATION OF THE MEASUREMENT MODEL

For the measurement model, the convergent validity can be assessed based on (i) outer loading and (ii) average variance extracted (AVE). Outer loading value that is high means that the indicators most likely belong to the construct. As recommended by Hair et al. (2021), the outer loadings that should be achieved are .708 and above to indicate that the construct is capable in explaining at least 50% of the indicator's variance. In contrast, the outer loadings with a value less than .40 should be discarded (Bagozzi et al., 1991; Hair et al., 2021). However, the items with outer loadings more than .40 can be accepted if the construct has achieved .50 and above for the AVE score (Hulland, 1999; Ramayah et al., 2016).

In addition, seven items (i.e., SIN1 = .357; FCO1R = .323; FCI2 = .514; CU1R = .264; PEOUE1 = .697; SIE2R = .558; SS1R = .561) were removed due to low loading, which is less than .708 (Hair et al., 2019); however, one of the satisfactions' items (SD1R= .521), one of the facilitating conditions' items (FCO2= .634) and two of the continuance use intentions' items (CIU4R = .510, CIR2 = .697) were retained as the AVE of each construct is already greater than .50. The values of AVE ranged from .523 to .647 and the composite reliabilities were greater than .70, indicating sufficient internal reliability and convergent validity. The internal and convergent validity results are in Table 3. The next assessment is associated with discriminant validity using the Heterotrait-Monotrait ratio of correlations (HTMT), displayed in Table 4. The HTMT values were below the conservative threshold limit of .90 (Gold et al., 2001), thereby establishing discriminant validity.

Table 3. Full collinearity, internal reliability, and convergent validity results

Latent Variable	Item	Loading	Random Dummy Variable (VIF)	Cronbach's Alpha (α)	Composite Reliability (> .7)	AVE (> .5)
Perceived Usefulness (PU)	PUP1 PUT2 PUT3 PUU2 PUU3	0.801 0.740 0.808 0.794 0.824	1.170	.854	.895	.631
Perceived Ease of Use (PEOU)	PEOUI2 PEOUI3 PEOUI4 PEOUI5	0.786 0.727 0.763 0.727	1.149	.743	.838	.564
Social Influence (SI)	SIE1 SIO1 SIO2	0.729 0.885 0.837	2.158	.755	.859	.671
Facilitating Conditions (FC)	FCK1 FCO2 FCT1	0.777 0.634 0.750	1.336	.543	.766	.523
Perceived Enjoyment (PENJ)	PENJE1R PENJE2R PENJF1R PENJI1	0.727 0.728 0.814 0.700	1.474	.750	.831	.553
Satisfaction (S)	SD1R SD2 SI1 SS2 SS3	0.521 0.752 0.828 0.783 0.797	1.060	.795	.859	.554
Confirmation (C)	CP1 CP3 CS1 CS1a CS2	0.836 0.808 0.776 0.791 0.808	2.731	.863	.901	.647
Continuance Use Intention (CI)	CIR1 CIR1a CIR2 CIU1 CIU4R	0.861 0.861 0.697 0.826 0.510	2.632	.809	.871	.582

Table 4. HTMT results for discriminant validity assessment

	1	2	3	4	5	6	7	8
1. Confirmation								
2. Continuance Use Intention	0.896							
3. Facilitating Condition	0.883	0.744						
4. Perceived Ease of Use	0.888	0.845	0.883					
5. Perceived Enjoyment	0.529	0.716	0.447	0.608				
6. Perceived Usefulness	0.898	0.856	0.888	0.885	0.538			
7. Satisfaction	0.863	0.889	0.769	0.802	0.751	0.797		
8. Social Influence	0.814	0.761	0.892	0.859	0.568	0.833	0.843	

Note. HTMT < 0.90

VERIFICATION OF THE STRUCTURAL MODEL

To evaluate the structural model, the study begins with examining the lateral collinearity (VIF) between the latent variables. Table 5 shows that VIF values were between 1 and 2.789, which is below the cut-off score of 3 (Becker et al., 2015), indicating the problem of multicollinearity issue is not a concern. Next, the hypotheses in the structural model were tested by using a bootstrap re-sample technique with an iteration of 5,000 sub-sample. Table 5 presents the corresponding results, while Figure 7 illustrates the path coefficients calculated from t-statistics and R^2 of the proposed model.

Table 5. Hypotheses testing and structural model assessment results

	β	Indirect Effect	Confidence Interval	*t*-value	*p*-value	Inner VIF	R^2	f^2	Q^2	Result
H1a: C -> S	.524		(.428, .630)	8.484**	.000	2.523	.577	.257	.305	S
H1b: C -> PU	.777		(.735, .821)	29.652**	.000	1.000	.604	1.523	.368	S
H2a: PU -> S	.277		(.162, .386)	4.092**	.000	2.523		.072		S
H2b: PU -> CI	.314		(.189, .416)	4.587**	.000	2.789	.660	.104	.372	S
H3: PENJ -> CI	.182		(.080, .278)	3.032**	.001	1.598		.061		S
H4: PEOU -> CI	.149		(.056, .243)	2.607*	.005	2.458		.026		S
H5: FC -> CI	- .014		(-.095, .078)	.264	.396	1.775		.000		NS
H6: SI -> CI	.026		(-.074, .133)	.421	.337	2.343		.001		NS
H7a: S -> CI	.298		(.191, .420)	4.357**	.000	2.524		.104		S
H7b: PU -> S -> CI		.083	(.036, .142)	3.040*	.002					S

*Note. * p < .01, **p ≤ .001; S (Supported); NS (Not supported); PU (Perceived Usefulness); PENJ (Perceived Enjoyment); FC (Facilitating Condition); PEOU (Perceived Ease of Use); SI (Social Influence); C (Confirmation); S (Satisfaction); CI (Continuance Use Intention); VIF (Variance Inflation Factor)*

Confirmation (H1a: β = .524, t = 8.484, p = .000) and perceived usefulness (H2a: β = .277, t = 4.092, p = .000) have direct positive effect on satisfaction. Meanwhile, confirmation positively influenced perceived usefulness (H1b: β = .777, t = 29.652, p = .000). The result proved that most of the relationships have a positive effect on continuance use intention, which involved perceived usefulness (H2b: β = .314, t = 4.587, p = .000), perceived enjoyment (H3: β = .182, t = 3.032, p = .001), perceived ease of use (H4: β = .149, t = 2.607, p = .005) and satisfaction (H7a: β = .298, t = 4.357, p = .000). However, two relationships which are the facilitating conditions with continuance use intention (H5: β = -0.014, t = .421, p = .396) and social influence with continuance use intention (H6: β = .026, t = .421, p = .337) were not statistically significant. Additionally, the mediation effect using Preacher and Hayes' (2004) bootstrapping approach was applied and confirmed that satisfaction was found to mediate the relationship between perceived usefulness towards continuance use (H7b: β = .083, t = 3.040, p = .002).

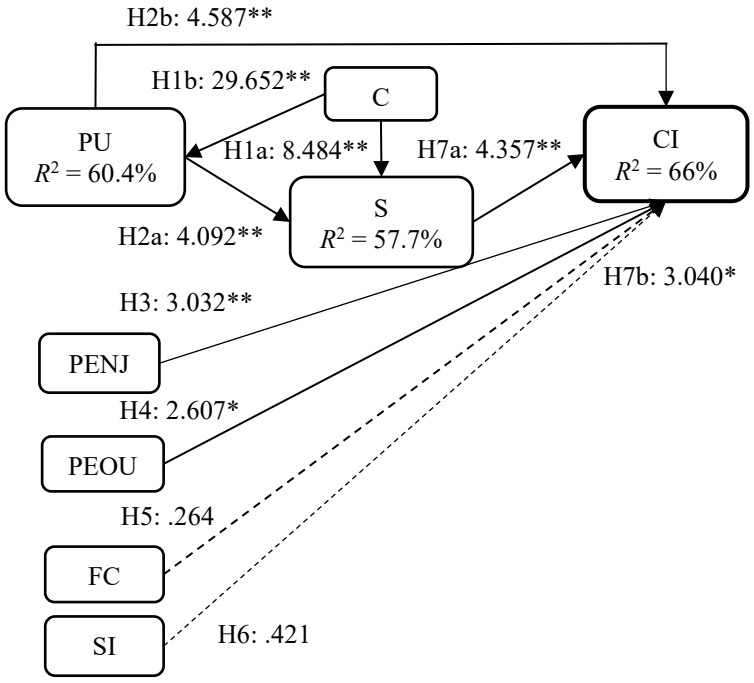
The next step involved the assessment of the coefficient of determination (R^2) which represents the in-sample predictive power. According to Hair et al. (2011), the strength of R^2 values is ideally categorised as greater than .25 equals weak, greater than .50 equals moderate, and greater than .75 can be measured as substantial. The results revealed that 66% of the variance in continuance use intention is explained by satisfaction, perceived usefulness, perceived ease of use, perceived enjoyment, facilitating condition, and social influence; 60.4% of the variance in perceived usefulness is explained by confirmation; and 57.7% of the variance in satisfaction is explained by perceived usefulness and confirmation (see Table 5).

Therefore, the in-sample predictive power (R^2) of this model is considered as moderate as all the endogenous variables showed R^2 values greater than .50. In addition, when compared with the R^2 of continuance use intention from the original or base model of ECM (Bhattacherjee, 2001) using the same research sample (R^2 = .622) as displayed in Figure 8, the results proved that the proposed research model displays increment of 3.8% (R^2 = .660). Meanwhile, the other two endogenous variables remain at the same values. This proved that extending the variables in the original ECM, it added

more value, meaning that it has more explanatory power on continuance use intention than the original ECM.

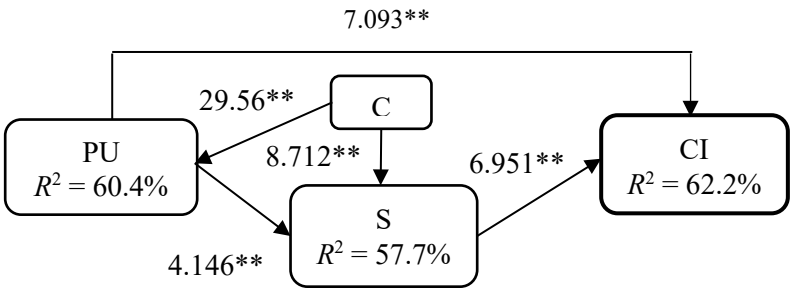
Subsequently, the effect size of the construct was assessed using Cohen's (1988) f^2, which are effect size (f^2) values above .02, .15, and .35 represent small, medium, and large effects. By looking at the f^2 values in Table 4, it can be observed that confirmation (f^2 = .257) and perceived usefulness (f^2 = .072) demonstrated moderate and small effect size in generating R^2 for satisfaction, respectively, whereas confirmation (f^2 = 1.523) portrayed a large effect size in generating R2 for perceived usefulness. On the other hand, the perceived usefulness, perceived enjoyment, perceived ease of use, and satisfaction reflect a small effect size in generating R^2 for continuance use intention. Furthermore, the facilitating condition does not exert any effect, while the social influence effect size is considered trivial with only f^2 = .001.

The last step is identifying the predictive accuracy of the structural model based on the blindfolding approach of the Geisser Stone–Geisser test criterion (Q^2). When the Q2 value exceeds the threshold of 0 for all the endogenous variables, it supports the predictive relevance of the model (Stone, 1974). However, this study enhanced the explanation of Q^2 by determining its effect using Cohen's (1988) rule of thumb where Q^2 greater than 0.02 signifies small or low, Q^2 greater than 0.15 signifies medium or moderate, while Q^2 greater than 0.35 represents large or strong predictive power (Suhan et al., 2018). As illustrated in Table 5, two endogenous variables (i.e., perceived usefulness = .368 and continuance use intention = .372) exhibited strong predictive accuracy (Q^2 value > .35), while one endogenous variable (i.e., satisfaction = .305) exhibited moderate predictive accuracy. In all, the model represents a strong predictive model for investigating the factors of gamified m-learning continuance use intention.



*Note. *p < .01; **p ≤ .001; Dashed line/arrow: hypothesis not supported; PU (Perceived Usefulness); PENJ (Perceived Enjoyment); FC (Facilitating Condition); PEOU (Perceived Ease of Use); SI (Social Influence); C (Confirmation); S (Satisfaction); CI (Continuance Use Intention)*

Figure 7. Summary of the research structural model



*Note. **p ≤ .001; PU (Perceived Usefulness); C (Confirmation); S (Satisfaction); CI (Continuance Use Intention)*

Figure 8. Original ECM structural model

DISCUSSION

KEY FINDING

Based on the results, two additional variables from the pre-acceptance model (i.e., UTAUT2), which are the perceived ease of use and perceived enjoyment, were the ones that impacted the continuance use intention of HEI learners. This finding is also consistent with the previous studies that found the significance of both variables among HEI learners towards technology continuance use intention (Kim & Nam, 2019; Roslan et al., 2021b; Ye et al., 2020). In contrast, variables facilitating condition and social influence failed to exert a positive influence, which corresponds to hypotheses H5 and H6, respectively. This is mainly because the research was conducted during the COVID-19 outbreak which heavily influenced both variables. The COVID-19 pandemic had served a different condition than usual; in Malaysia, for instance, during the outbreak which started at the end of 2019 and continued until 2021, distance learning had to take place with instant enforcement of online learning, utilising web-based and mobile-based educational tools.

In sum, out of the ten hypotheses, eight were supported (i.e., H1a, H1b, H2a, H2b, H3, H4, H7a, H7b), while the other two were rejected (i.e., H5, H6). Hypothesis H1a involves the influence of confirmation of expectation towards satisfaction in gamified m-learning usage. Indeed, the result of the finding showed that the satisfaction of Malaysian HEI learners is strongly affected by confirmation of the features and functions of the product. As the learners discover that their expectations of the product are being met, their level of satisfaction increases. This is in accordance with the findings of previous studies by Kumar et al. (2018) and Poromatikul et al. (2019). On the other hand, results related to another confirmation of expectation hypothesis (i.e., H1b) revealed that users' level of confirmation is positively associated with their perceived usefulness which is in accordance with Ouyang et al. (2017). Thus, it can be concluded that, as learners' expectations of gamified m-learning increase, their perception of the usefulness of the application may also increase. This signifies that when learners confirm the expected benefits from the gamified m-learning, they will believe it is worth using and tend to expect more from it in their future use.

The supported hypothesis H2a is related to the effect of the perceived usefulness of the gamified m-learning application usage toward the users' satisfaction. The result is in line with Ouyang et al. (2017) and Wilson et al. (2021). As the learners felt that there was an 'added value' that they could get, or when they felt that their academic performance would be improved by using the technological product (i.e., Kingdom Quizzes), then it could increase their satisfaction with the product, or even towards the HEI which produced it. Meanwhile, the finding of this research is in support of H2b, which also reflects the results of Alshurideh et al.'s (2020) and Tam et al.'s (2020) studies on continuous intention to use the mobile application in HEI. This confirms that the usefulness of an m-

learning product for the purpose of completing the learners' academic task is highly expected as it is usually the users' goal in the first place.

Additionally, perceived enjoyment is also found to be one of the antecedents of continuance use intention among HEI learners on a gamified m-learning application, as it was found to have a positive influence, supporting hypothesis H3. This also agrees with the finding by Yan et al. (2022), which proved that perceived enjoyment has a significant positive influence on the student's intention to participate in an online gamified classroom. Each participation will boost their desire for further usage. Another antecedent of gamified m-learning application continuance use intention is perceived ease of use, which supported hypothesis H4 in this research. The result was also in line with Saeed Al-Maroof et al.'s (2021) study which confirmed the significant role of perceived enjoyment towards continuous intention to use technology in HEI. Meanwhile, Fathema et al. (2015) also mentioned that perceived usefulness and perceived ease of use are the most influential factors in users' continuance use intentions. However, Cai et al. (2019) have proven that perceived usefulness is more effective than perceived ease of use when one wants to deal with the use of technology.

On the contrary, hypothesis H5 was not supported in this study, which corresponds with Marandu et al.'s (2022) research related to continuance use intention for online learning among HEI learners in the post-COVID-19 pandemic. Marandu et al. (2022) revealed that the facilitating condition has a negative influence. This is because the learners had already felt that online learning could be managed on their own or already self-facilitated during the pandemic. Similarly, the negative effect of facilitating conditions in this research is also due to the learners having been used to incorporating internet usage to support daily academic tasks and applying smartphones to their daily routines. This had provided the ideal conditions for online and mobile learning usages; hence they give no importance to the issue of the facilitating conditions.

For hypothesis H6, the finding showed that social influence negatively affected the continuance use intention on gamified m-learning applications which is similar to Dramani et al. (2022), where they found that social influence also displayed insignificance towards continuance use intention of the e-learning system in the Ghana HEI during the COVID-19 pandemic. Their study predicted that the reason for its insignificance is due to social influence only influences the behavioural intention of IT users in the early stages of adoption. In the case of this research, the sudden order for virtual learning limited the institution and educators' active involvement in encouraging and influencing the learners during the usage of the Kingdom Quizzes application. It also degraded the interactions among peers, affecting Kingdom Quizzes' usage influence from their circle of friends.

Another antecedent of the continuance use intention for gamified m-learning applications that was confirmed through the finding in this study is satisfaction, which reflects hypothesis H7a. Rohan et al.'s (2021) research found that satisfaction is the most significant predictor of continuance use intention among HEI learners in Thailand and is parallel with the finding of this study. They found that achievement-related gaming elements have a positive effect on user need satisfaction and feeling of fun while using the MOOC, resulting in higher time spent in the specific related course. This situation may also have occurred during the usage of Kingdom Quizzes, the gamification-based m-learning application used in this research. Evidently, the predicted variable satisfaction proved to mediate the link between perceived usefulness and continuance use intention, hence hypothesis H7b is supported. This verifies the need of the learners to feel satisfied with the benefits of the gamified m-learning application and to develop a future desire to continue using the m-learning product. This is also in accordance with Cheng et al.'s (2020) and Akel and Armağan's (2021) studies.

In the end, it can be concluded that the findings from this study show that less effort in using the effective educational product is very much sought after. Additionally, embedding progressive game and gamification items increase the sense of entertainment gained through the usage of m-learning. Hence, educators should take the opportunity in utilizing the characteristics of game elements in designing effective activities that will increase the enjoyment of online learning.

Contributions

Theoretically, this research contributes to the body of knowledge in three different aspects. First, it extended the use of the ECM by Bhattacherjee (2001), in the context of a gamified m-learning application. This is in line with recent studies that had successfully proven the significance in extending the ECM, in the context of exploring the users' continuance use intention towards a gamified mobile application. For example, T. Wang et al. (2021) combined ECM with self-determination theory (SDT) for a gamified mobile health (mHealth) application, while Ünal and Güngör (2021) implemented the ECM with the Theory of Planned Behavior (TPB) to learn English through a mobile-assisted language learning (MALL) using the gamified m-learning application, namely, Duolingo.

Second, the present study expanded the literature by revealing the critical role of technology pre-acceptance mechanisms or, in other words, explanatory elements on the continuance use intention of a technological product. In support of the previous work by Tam et al. (2020), which also implemented Venkatesh et al.'s (2012) UTAUT2 model as supplementary factors for post-acceptance influences discovery, it was also proven in this study that it can unfold the link between the features of initial adoption that may influence the continuance intention to use a gamified mobile application. However, it is revealed that the additional variables selected should be applied depending on the nature of the technological product used, research situation or time frame, population background, and culture. Lastly, due to the revelation of mediating effect in this study, it also offers a comprehensive understanding of the mechanism that enriches the m-learning application usage apart from complementing prior studies, such as Y. T. Wang and Lin (2021), Ünal and Güngör (2021) and Chang (2022), that simply focus on the direct links of variables without highlighting the role of satisfaction as mediator.

In terms of the managerial contribution aspect, the study may provide insight into the HEI's academic development and management. The academic development and management department usually consist of the products' developers, designers, content administrators, and decision-makers. They may be able to implement gamification elements into the m-learning application which correspond to the mechanics, dynamic and aesthetic aspects (i.e., MDA gamification framework) accordingly, corresponding to van Elderen and van der Stappen's (2019) literature review study. This will enhance learning strategies for education, learners' achievement, participation, and motivation as suggested by Carrión Candel and Colmenero (2022).

Parallel to the results of this study, the digital learning department should refine its gamified m-learning application in terms of: (i) gamification items, (ii) products' ability or functionality, and (iii) user-friendly operation. In the quest to provide a holistic approach towards ensuring the success of the m-learning application in the institution, the developers should also consider the availability of the application in all operating systems (OS) or platforms (e.g., iOS). Although this reflects the factor of facilitating condition, which was discovered as insignificant in this study, earlier studies of technology acceptance by Seethamraju et al. (2018) and technology continuance use by Kamarozaman and Razak (2021) demonstrated its importance.

Limitations and Future Research Directions

The research suffers from three limitations. First, due to performing a correlational cross-sectional study, there is a lack of complete understanding of the dynamics among individuals' perceptions. Therefore, it is recommended that such research perform longitudinal studies instead, which enable researchers to better grasp the dynamics of the constructs over time. Second, the sample used in this research was limited to three types of diploma programmes in one university (i.e., UTHM), which did not include the other programmes (e.g., mechanical engineering, science, and electrical engineering). In that case, it is recommended to include respondents from other diploma programmes, resulting in an in-depth analysis. The last limitation concerns the sample size, or the final number of responses analysed. Further research is needed to support the generalizability of the findings in this study by considering larger populations from all programmes.

An additional suggestion would be applying factors to the prediction model that are related to gamification design elements or features of the product (e.g., object, mechanics, interface) which may contribute to the discovery of effective gamified m-learning application designs. The next suggestion would involve institutional leaders should provide 'transfer-of-technology' workshops that will prepare their educators to implement the institutions' gamified teaching and learning tools and protocols for guided use of mobile devices in learning activities. Finally, should there be a seasonal cycle of COVID-19 as there is with many other viruses, the greater the need for faculties to design an effective approach to entice educators and learners towards applying new learning technologies?

CONCLUSION

During the COVID-19 outbreak, educational applications have supported many learners in their academic journeys (Butler et al., 2021; Crompton & Burke, 2018). Enabling them access to online learning and engaging in synchronous conversations with other individuals (Camilleri & Camilleri, 2021, 2022). This shows the importance of online approaches in connecting educators with learners. Now, in the post-pandemic era, scholars are beginning to wonder about the existing learners' interest in continuing to use the digital learning tools they had previously used during the pandemic times. Therefore, a continuance use intention topic is essential in the quest to encourage the students to continue acquiring knowledge and for educational platforms to retain users. Based on the integration of ECM and UTAUT2, this study established a theoretical model of gamified m-learning application continuance use and validated the proposed research model.

As expected, continuance use intention is positively influenced by explanatory elements from the pre-acceptance model, excluding social influence and facilitating condition factors that were heavily influenced by the COVID-19 pandemic situation in Malaysia at the time this research was conducted. Due to that situation, where teaching and learning sessions were ordered to be performed virtually or online, students were not able to be influenced by their peers, educators, and institution, as well as having to depend entirely on themselves to facilitate the condition of mobile application usage. Dovetailing with the previous literature, satisfaction has been found to mediate perceived usefulness with the continuance use intention. This phenomenon is seen to be consistent with the characteristics of users in general, where there is a need for them to feel satisfied with the benefits acquired from product usage. Apart from that, some of the limitations have been highlighted, as well as providing suggestions for future research related to m-learning.

Overall, this study has successfully identified the determinants that impacted gamification-based m-learning application continuance use intention among Malaysian HEI learners. Hence, the information may benefit the m-learning developers and stakeholders in the HEI to produce effective gamified learning resources. The m-learning application should now be the ultimate focus in HEIs as it is not just a piece of technology but an indispensable tool that allows educators to interact with the learners. Compared to other e-learning resources, a mobile application is considered to have more advantages as it plays the role of a "connection generator". This is because it provides portable, convenient, and interactive opportunities that allow learners to interact with the institutions' academic content on an ongoing basis.

REFERENCES

Ahmad, T. (2020). Student perceptions on using cell phones as learning tools. *PSU Research Review, 4*(1), 25–43. https://doi.org/10.1108/PRR-03-2018-0007

Akdim, K., Casaló, L. V., & Flavián, C. (2022). The role of utilitarian and hedonic aspects in the continuance intention to use social mobile apps. *Journal of Retailing and Consumer Services, 66*, 102888. https://doi.org/10.1016/j.jretconser.2021.102888

Akel, G., & Armağan, E. (2021). Hedonic and utilitarian benefits as determinants of the application continuance intention in location-based applications: The mediating role of satisfaction. *Multimedia Tools and Applications, 80*(5), 7103–7124. https://doi.org/10.1007/s11042-020-10094-2

Al Amin, M., Razib Alam, M., & Alam, M. Z. (2022). Antecedents of students' e-learning continuance intention during COVID-19: An empirical study. *E-Learning and Digital Media.* https://doi.org/10.1177/20427530221103915

Al-Bashayreh, M., Almajali, D., Altamimi, A., Masa'deh, R. E., & Al-Okaily, M. (2022). An empirical investigation of reasons influencing student acceptance and rejection of mobile learning apps usage. *Sustainability, 14*(7), 4325. https://doi.org/10.3390/su14074325

Alhumaid, K. (2021). Developing an educational framework for using mobile learning during the era of COVID-19. *International Journal of Data and Network Science, 5*(3), 215. https://doi.org/10.5267/j.ijdns.2021.6.012

Al-Mamary, Y. H. S. (2022). Understanding the use of learning management systems by undergraduate university students using the UTAUT model: Credible evidence from Saudi Arabia. *International Journal of Information Management Data Insights, 2*(2), 100092. https://doi.org/10.1016/j.jjimei.2022.100092

Alsharhan, A., Salloum, S. A., & Aburayya, A. (2022). Technology acceptance drivers for AR smart glasses in the middle east: A quantitative study. *International Journal of Data and Network Science, 6*(1), 193–208. https://doi.org/10.5267/j.ijdns.2021.9.008

Alshurideh, M., Al Kurdi, B., & Salloum, S. A. (2020). Examining the main mobile learning system drivers' effects: A mix empirical examination of both the Expectation-Confirmation Model (ECM) and the Technology Acceptance Model (TAM). *Advances in Intelligent Systems and Computing, 1058*, 406–417. https://doi.org/10.1007/978-3-030-31129-2_37

Alzaidi, M. S., & Shehawy, Y. M. (2022). Cross-national differences in mobile learning adoption during COVID-19. *Education + Training, 64*(3), 305–328. https://doi.org/10.1108/ET-05-2021-0179

Annamalai, N., Ramayah, T., Kumar, J. A., & Osman, S. (2021). Investigating the use of Learning Management System (LMS) for distance education in Malaysia: A mixed-method approach. *Contemporary Educational Technology, 13*(3), ep313. https://doi.org/10.30935/cedtech/10987

Ashrafi, A., Zareravasan, A., Rabiee Savoji, S., & Amani, M. (2022). Exploring factors influencing students' continuance intention to use the learning management system (LMS): A multi-perspective framework. *Interactive Learning Environments*, *30*(8), 1475–1497. https://doi.org/10.1080/10494820.2020.1734028

Azlan, C. A., Wong, J. H. D., Tan, L. K., Huri, M. S. N. A., Ung, N. M., Pallath, V., Tan, C. P. L., Yeong, C. H., & Ng, K. H. (2020). Teaching and learning of postgraduate medical physics using Internet-based e-learning during the COVID-19 pandemic – A case study from Malaysia. *Physica Medica, 80*, 10–16. https://doi.org/10.1016/j.ejmp.2020.10.002

Bagaskara, B., Yohana, C., & Fidhyallah, N. F. (2021). The effect of perceive ease of use and satisfaction to continuance intention Learning Management System. *International Journal of Current Economics & Business Ventures, 1*(2), 115–127.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science, 16*(1), 74–94. https://doi.org/10.1007/BF02723327

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative Science Quarterly*, *36*(3), 421–458. https://doi.org/10.2307/2393203

Becker, J. M., Ringle, C. M., Sarstedt, M., & Völckner, F. (2015). How collinearity affects mixture regression results. *Marketing Letters, 26*(4), 643–659. https://doi.org/10.1007/s11002-014-9299-9

Benben, V. Y., & Bug-os, M. A. A. C. (2022). Physics students' academic achievement and motivation in a gamified formative assessment. *American Journal of Educational Research, 10*(6), 385–390. https://doi.org/10.12691/education-10-6-2

Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. *MIS Quarterly, 25*(3), 351–370. https://doi.org/10.2307/3250921

Butler, A., Camilleri, M. A., Creed, A., & Zutshi, A. (2021). The use of mobile learning technologies for corporate training and development: A contextual framework. In M. A. Camilleri (Ed.), *Strategic corporate communication in the digital age* (pp. 115–130). Emerald Publishing Limited. https://doi.org/10.1108/978-1-80071-264-520211007

Byrne, B. M. (2013). *Structural equation modeling with AMOS: Basic concepts, applications, and programming.* Routledge. https://doi.org/10.4324/9781410600219

Cai, J., Yang, H. H., Gong, D., MacLeod, J., & Zhu, S. (2019). Understanding the continued use of flipped classroom instruction: A personal beliefs model in Chinese higher education. *Journal of Computing in Higher Education, 31*, 137–155. https://doi.org/10.1007/s12528-018-9196-y

Camilleri, M. A., & Camilleri, A. C. (2021). The acceptance of learning management systems and video conferencing technologies: Lessons learned from COVID-19. *Technology, Knowledge and Learning*, *27*, 1311–1333. https://doi.org/10.1007/s10758-021-09561-y

Camilleri, M. A., & Camilleri, A. C. (2022). Remote learning via video conferencing technologies: Implications for research and practice. *Technology in Society, 68*, 101881. https://doi.org/10.1016/j.techsoc.2022.101881

Carrión Candel, E., & Colmenero, M. J. R. (2022). Gamification and mobile learning: innovative experiences to motivate and optimise music content within university contexts. *Music Education Research*, *24*(3), 377–392. https://doi.org/10.1080/14613808.2022.2042500

Castanha, J., Pillai, S. K. B., & Indrawati. (2021). What influences consumer behavior toward information and communication technology applications: A systematic literature review of UTAUT2 model. In M. Tuba, S. Akashe, & A. Joshi (Eds.), *ICT Systems and Sustainability: Advances in Intelligent Systems and Computing.* Springer. https://doi.org/10.1007/978-981-15-8289-9_30

Chang, C. C. (2022, August). Factors affecting m-learning continuance–From the perspectives of flow theory and stimulus-organism-response theory. *Proceedings of the 23rd European Conference on Knowledge Management*, *23*(2), 1396–1402. https://doi.org/10.34190/eckm.23.2.710

Chao, C. M. (2019). Factors determining the behavioral intention to use mobile learning: An application and extension of the UTAUT model. *Frontiers in Psychology, 10*, 1652. https://doi.org/10.3389/fpsyg.2019.01652

Cheng, S., Liu, L., & Li, K. (2020). Explaining the factors influencing the individuals' continuance intention to seek information on Weibo during rainstorm disasters. *International Journal of Environmental Research and Public Health, 17*(17), 6072. https://doi.org/10.3390/ijerph17176072

Chiu, W., Cho, H., & Chi, C. G. (2020). Consumers' continuance intention to use fitness and health apps: An integration of the expectation-confirmation model and investment model. *Information Technology & People, 34*(3), 978–998. https://doi.org/10.1108/ITP-09-2019-0463

Cho, J. (2016). The impact of post-adoption beliefs on the continued use of health apps. *International Journal of Medical Informatics, 87*, 75–83. https://doi.org/10.1016/j.ijmedinf.2015.12.016

Cohen, J. (1988). *Statistical power analysis for the Behavioral Sciences* (2nd ed.). Academic Press

Crompton, H., & Burke, D. (2018). The use of mobile learning in higher education: A systematic review. *Computer & Education, 123*, 53–64. https://doi.org/10.1016/j.compedu.2018.04.007

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*, 319–339. https://doi.org/10.2307/249008

Dramani, I. E., Tang, Z., & Coffie, C. P. K. (2022). Usage intention of e-learning systems in Ghanaian tertiary institutions: A case study of the university for development studies. *Sustainability, 14*(12), 7360. https://doi.org/10.3390/su14127360

Fathema, N., Shannon, D., & Ross, M. (2015). Expanding the Technology Acceptance Model (TAM) to examine faculty use of Learning Management Systems (LMSs) in higher education institutions. *Journal of Online Learning and Teaching*, *11*, 210–232.

Geisser, S. (1975). The predictive sample reuse method with applications. *Journal of the American Statistical Association, 70*(350), 320–328. https://doi.org/10.1080/01621459.1975.10479865

Ghasemy, M., Teeroovengadum, V., Becker, J.-M., & Ringle, C. (2020). This fast car can move faster: A review of PLS-SEM application in higher education research. *Higher Education, 80*, 1121–1152. https://doi.org/10.1007/s10734-020-00534-1

Gold, A., Malhotra, A., & Segars, A. (2001). Knowledge management: An organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185–214. https://doi.org/10.1080/07421222.2001.11045669

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2014). *Multivariate data analysis* (7th ed.). Prentice-Hall.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). *A primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (3rd ed.). Sage. https://doi.org/10.1007/978-3-030-80519-7

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

Hair, J. F., Sarstedt, M., & Ringle, C. M. (2019). Rethinking some of the rethinking of partial least squares. *European Journal of Marketing, 53*(4), 566–584. https://doi.org/10.1108/EJM-10-2018-0665

Han, J., & Conti, D. (2020). The use of UTAUT and post acceptance models to investigate the attitude towards a telepresence robot in an educational setting. *Robotics, 9*(2), 34. https://doi.org/10.3390/robotics9020034

Higgins, J. P. (2016). Smartphone applications for patients' health and fitness. *The American Journal of Medicine, 129*(1), 11-19. https://doi.org/10.1016/j.amjmed.2015.05.038

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal, 20*(1), 195–204. https://doi.org/10.1002/(SICI)1097-0266(199902)20:2%3C195::AID-SMJ13%3E3.0.CO;2-7

Ishaq, K., Zin, N. A. M., Rosdi, F., Jehanghir, M., Ishaq, S., & Abid, A. (2021). Mobile-assisted and gamification-based language learning: A systematic literature review. *PeerJ Computer Science, 7*, e496. https://doi.org/10.7717/peerj-cs.496

Islam, A. N., & Azad, N. (2015). Satisfaction and continuance with a Learning Management System: Comparing perceptions of educators and students. *The International Journal of Information and Learning Technology, 32*(2), 109–23. https://doi.org/10.1108/IJILT-09-2014-0020

Ismail, M. A. A., Ahmad, A., Mohammad, J. A. M., Fakri, N. M. R. M., Nor, M. Z. M., & Pa, M. N. M. (2019). Using Kahoot! as a formative assessment tool in medical education: A phenomenological study. *BMC Medical Education, 19*(1), 1–8. https://doi.org/10.1186/s12909-019-1658-z

Joo, Y. J., Park, S., & Shin, E. K. (2017). Students' expectation, satisfaction, and continuance intention to use digital textbooks. *Computers in Human Behavior, 69*, 83–90. https://doi.org/10.1016/j.chb.2016.12.025

Kamarozaman, Z., & Razak, F. Z. A. (2021). The role of facilitating condition in enhancing user's continuance intention. *Journal of Physics: Conference Series, 1793*(1), 012022. https://doi.org/10.1088/1742-6596/1793/1/012022

Khlaif, Z. N., Sanmugam, M., & Ayyoub, A. (2022). Impact of technostress on continuance intentions to use mobile technology. *The Asia-Pacific Education Researcher*, 1–12. https://doi.org/10.1007/s40299-021-00638-x

Kim, J., & Nam, C. (2019, June). Analyzing continuance intention of recommendation algorithms. *Proceedings of the 30th European Conference of the International Telecommunications Society, Helsinki, Finland.* https://www.econstor.eu/bitstream/10419/205190/1/Kim-Nam.pdf

Kline, R. B. (2015). *Principles and practice of structural equation modelling* (4th ed.). Guilford Publications.

Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal, 28*(1), 227–261. https://doi.org/10.1111/isj.12131

Kock, N., & Lynn, G. (2012). Lateral collinearity and misleading results in variance-based SEM: An illustration and recommendations. *Journal of the Association for Information Systems, 13*(7). https://doi.org/10.17705/1jais.00302

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management, 45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Kumar, R. R., Israel, D., & Malik, G. (2018). Explaining customer's continuance intention to use mobile banking apps with an integrative perspective of ECT and self-determination theory. *Pacific Asia Journal of the Association for Information Systems, 10*(2), 79–112. https://doi.org/10.17705/1pais.10204

Lestari, P., & Nugraha, J. (2021). Analysis of using quizizz to the students of grade XII SMK N 1 Surabaya using the technology acceptance model. *Jurnal TAM (Technology Acceptance Model), 12*(2), 123–134. https://doi.org/10.56327/jurnaltam.v12i2.1047

Leys, C., Klein, O., Dominicy, Y., & Ley, C. (2018). Detecting multivariate outliers: Use a robust variant of the Mahalanobis distance. *Journal of Experimental Social Psychology, 74*, 150–156. https://doi.org/10.1016/j.jesp.2017.09.011

Li, Y., & Zhao, M. (2021). A study on the influencing factors of continued intention to use MOOCs: UTAUT model and CCC moderating effect. *Frontiers in Psychology, 12*, 528259. https://doi.org/10.3389/fpsyg.2021.528259

Lin, D. T. A., Ganapathy, M., & Kaur, M. (2018). Kahoot! It: Gamification in higher education. *Pertanika Journal of Social Sciences and Humanities, 26*(1), 565–582. https://doi.org/10.3390/su12124822

Lozanova, L. (2022). Readiness for self-learning through m-learning of pedagogy students. *Journal of Psychology and Pedagogy Research in Modern Realities, 1*(1). https://a-publish.com/ojs/index.php/jpprmr/article/view/15

Marandu, E. E., Mathew, I. R., Svotwa, T. D., Machera, R. P., & Jaiyeoba, O. (2022). Predicting students' intention to continue online learning post-COVID-19 pandemic: extension of the unified theory of acceptance and usage technology. *Journal of Applied Research in Higher Education*. https://doi.org/10.1108/JARHE-02-2022-0061

Marchewka, J. T., Liu, C., & Kostiwa, K. (2007). An application of the UTAUT model for understanding student perceptions using course management software. *Communication IIMA, 7*(2), 93–104. https://scholarworks.lib.csusb.edu/cgi/viewcontent.cgi?article=1038&context=ciima

Mardia, K. V. (1970). Measures of multivariate skewness and kurtosis with applications. *Biometrika, 57*(3), 519–530. https://doi.org/10.2307/2334770

Md Yunus, M., Ang, W. S., & Hashim, H. (2021). Factors affecting Teaching English as a Second Language (TESL) postgraduate students' behavioural intention for online learning during the COVID-19 pandemic. *Sustainability, 13*(6), 3524. https://doi.org/10.3390/su13063524

Mheidly, N., Fares, M. Y., & Fares, J. (2020). Coping with stress and burnout associated with telecommunication and online learning. *Frontiers in Public Health*, *8*, 574969. https://doi.org/10.3389/fpubh.2020.574969

Mohamad, M., Arif, F. K. M., Alias, B. S., & Yunus, M. M. (2020). Online game-based formative assessment: Distant learners post graduate students' challenges towards Quizizz. *International Journal of Scientific and Technology Research, 9*(4), 994–1000. http://www.ijstr.org/final-print/apr2020/Online-Game-based-Formative-Assessment-Distant-Learners-Post-Graduate-Students-Challenges-Towards-Quizizz.pdf

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychological theory*. McGraw-Hill

Nysveen, H., & Pedersen, P. E. (2016). Consumer adoption of RFID-enabled services: Applying an extended UTAUT model. *Information Systems Frontiers, 18*(2), 293–314. https://doi.org/10.1007/s10796-014-9531-4

Osei, H. V., Kwateng, K. O., & Boateng, K. A. (2022). Integration of personality trait, motivation and UTAUT 2 to understand e-learning adoption in the era of COVID-19 pandemic. *Education and Information Technologies*, *27*, 10705–10730. https://doi.org/10.1007/s10639-022-11047-y

Ouyang, Y., Tang, C., Rong, W., Zhang, L., Yin, C., & Xiong, Z. (2017, January). Task-technology fit aware expectation-confirmation model towards understanding of MOOCs continued usage intention. *Proceedings of the 50th Hawaii International Conference on System Sciences, Manoa, Hawaii,* 174–183. https://doi.org/10.24251/HICSS.2017.020

Phuong, N. N., Luan, L. T., Van Dong, V., & Le Nhat Khanh, N. (2020). Examining customers' continuance intentions towards E-Wallet usage: The emergence of mobile payment acceptance in Vietnam. *Journal of Asian Finance, Economics and Business, 7*(9), 505–516. https://doi.org/10.13106/jafeb.2020.vol7.no9.505

Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Poromatikul, C., De Maeyer, P., Leelapanyalert, K., & Zaby, S. (2019). Drivers of continuance intention with mobile banking apps. *The International Journal of Bank Marketing, 38*(1), 242–262. https://doi.org/10.1108/IJBM-08-2018-0224

Preacher, K. J., & Hayes, A. F. (2004). SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behavior Research Methods, Instruments, & Computers, 36*(4), 717–731. https://doi.org/10.3758/BF03206553

Premkumar, G., & Bhattacherjee, A. (2008). Explaining information technology usage: A test of competing models. *Omega, 36*(1), 64–75. https://doi.org/10.1016/j.omega.2005.12.002

Ramayah, T., Cheah, J., Chuah, F., Ting, H., & Memon, M. A. (2016). *Partial least squares structural equation modeling (PLS-SEM) using SmartPLS 3.0: An updated and practical guide to statistical analysis*. Pearson Malaysia Sdn Bhd.

Ramle, R., Nathan, S. S., & Berahim, M. (2019). Digital game-based learning of stack data structure using question prompts. *International Journal of Interactive Mobile Technologies, 13*(7), 90–102. https://doi.org/10.3991/ijim.v13i07.10778

Rohan, R., Pal, D., Funilkul, S., Chutimaskul, W., & Eamsinvattana, W. (2021). How gamification leads to continued usage of MOOCs? A theoretical perspective. *IEEE Access, 9*, 108144–108161. https://doi.org/10.1109/ACCESS.2021.3102293

Roslan, R., Mohd Ayub, A. F., Ghazali, N., & Zulkifli, N. N. (2021a). The development of a collaborated gamified e-quiz and strategy game mobile application to increase students' motivation and continuance usage intention. *ANP Journal of Social Science and Humanities, 2*(2), 74–81.

Roslan, R., Mohd Ayub, A. F., Ghazali, N., & Zulkifli, N. N. (2021b). The influence of perceived ease of use, perceived usefulness, social influence, and perceived enjoyment towards continuance intention in using a gamified e-quiz mobile application. *Journal of Institutional Research (South East Asia), 19*(2), 283–310. http://www.seaairweb.info/journal/articles/JIRSEA_v19_n02/JIRSEA_v19_n02_Article12.pdf

Saeed Al-Maroof, R., Alhumaid, K., & Salloum, S. (2021). The continuous intention to use e-learning, from two different perspectives. *Education Sciences, 11*(1), 6. https://doi.org/10.3390/educsci11010006

Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In C. Homburg, M. Klarmann, & A. Vomberg (Eds.), *Handbook of market research* (pp. 587–632). Springer. https://doi.org/10.1007/978-3-319-57413-4_15

Seethamraju, R., Diatha, K. S., & Garg, S. (2018). Intention to use a mobile-based information technology solution for tuberculosis treatment monitoring – Applying a UTAUT model. *Information Systems Frontiers, 20*(1), 163–181. https://doi.org/10.1007/s10796-017-9801-z

Shanshan, S., & Wenfei, L. (2022). Understanding the impact of quality elements on MOOCs continuance intention. *Education and Information Technologies*, *27*, 10949–10976. https://doi.org/10.1007/s10639-022-11063-y

Sharifi Fard, S., Alkelani, A. M., & Tamam, E. (2019). Habit as a moderator of the association of utilitarian motivation and hedonic motivation with purchase intention: Implications for social networking websites. *Cogent Social Sciences, 5*(1). https://doi.org/10.1080/23311886.2019.1674068

Shmueli, G., Ray, S., Velasquez Estrada, J. M., & Chatla, S. B. (2016). The elephant in the room: Predictive performance of PLS models. *Journal of Business Research, 69*(10), 4552–4564. https://doi.org/10.1016/j.jbusres.2016.03.049

Shmueli, G., Sarstedt, M., Hair, J. F., Cheah, J. H., Ting, H., Vaithilingam, S., & Ringle, C. M. (2019). Predictive model assessment in PLS-SEM: Guidelines for using PLSpredict. *European Journal of Marketing, 53*(11), 2322–2347. https://doi.org/10.1108/EJM-02-2019-0189

Singh, N., Sinha, N., & Liébana-Cabanillas, F. J. (2020). Determining factors in the adoption and recommendation of mobile wallet services in India: Analysis of the effect of innovativeness, stress to use and social

influence. *International Journal of Information Management, 50*, 191–205. https://doi.org/10.1016/j.ijinfomgt.2019.05.022

Singh, S. (2020). An integrated model combining ECM and UTAUT to explain users' post-adoption behaviour towards mobile payment systems. *Australasian Journal of Information Systems, 24*, 1–27. https://doi.org/10.3127/ajis.v24i0.2695

Stone, M. (1974). Cross-validation and multinomial prediction. *Biometrika, 61*(3), 509–515. https://doi.org/10.1093/biomet/61.3.509

Suhan, Samartha, V., & Kodikal, R. (2018). Measuring the effect size of coefficient of determination and predictive relevance of exogenous latent variables on endogenous latent variables through PLS-SEM. *International Journal of Pure and Applied Mathematics, 119*(18), 39–48. https://acadpubl.eu/hub/2018-119-18/1/4.pdf

Suka, I. E., & Hamid, N. A. (2020). The implication of attitude towards Educational Support System (ESS) use in education. *Research in Management of Technology and Business, 1*(1), 233–244. https://publisher.uthm.edu.my/periodicals/index.php/rmtb/article/view/516

Tam, C., Santos, D., & Oliveira, T. (2020). Exploring the influential factors of continuance intention to use mobile apps: Extending the Expectation Confirmation Model. *Information Systems Frontiers, 22*(1), 243–257. https://doi.org/10.1007/s10796-018-9864-5

Tamilmani, K., Rana, N. P., & Dwivedi, Y. K. (2018). Use of 'habit' is not a habit in understanding individual technology adoption: A review of UTAUT2 based empirical studies. In A. Elbanna, Y. Dwivedi, D. Bunker, & D. Wastell (Eds.), *Smart working, living and organising* (pp. 277–294). Springer. https://doi.org/10.1007/978-3-030-04315-5_19

Tamilmani, K., Rana, N., Wamba, S., & Dwivedi, R. (2021). The extended unified theory of acceptance and use of technology (UTAUT2): A systematic literature review and theory evaluation. *International Journal of Information Management, 57*, 102269. https://doi.org/10.1016/j.ijinfomgt.2020.102269

Tao, D., Fu, P., Wang, Y., Zhang, T., & Qu, X. (2022). Key characteristics in designing massive open online courses (MOOCs) for user acceptance: An application of the extended technology acceptance model. *Interactive Learning Environments, 30*(5), 882–895. https://doi.org/10.1080/10494820.2019.1695214

Ünal, E., & Güngör, F. (2021). The continuance intention of users toward mobile assisted language learning: The case of DuoLingo. *Asian Journal of Distance Education, 16*(2), 197–218. https://doi.org/10.5281/zenodo.5811777

Vanduhe, V. Z., Nat, M., & Hasan, H. F. (2020). Continuance intentions to use gamification for training in higher education: Integrating the Technology Acceptance Model (TAM), social motivation, and Task Technology Fit (TTF). *IEEE Access*, *8*, 21473–21484. https://doi.org/10.1109/ACCESS.2020.2966179

van Elderen, J., & van der Stappen, E. (2019, June). The potential impact of gamification elements on the acceptance of technology in the context of education: A literature review. *Proceedings of the 32nd Bled eConference, Humanizing Technology for a Sustainable Society, Bled, Slovenia.* https://doi.org/10.18690/978-961-286-280-0.10

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27*(3), 425. https://doi.org/10.2307/30036540

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology. *MIS Quarterly, 36*(1), 157–178. https://doi.org/10.2307/41410412

Wang, L. Y., Lew, S. L., Lau, S. H., & Leow, M. C. (2019). Usability factors predicting continuance of intention to use cloud e-learning application. *Heliyon, 5*(6). https://doi.org/10.1016/j.heliyon.2019.e01788

Wang, T., Fan, L., Zheng, X., Wang, W., Liang, J., An, K., Ju, M., & Lei, J. (2021). The impact of gamification-induced users' feelings on the continued use of mHealth apps: A structural equation model with the self-determination theory approach. *Journal of Medical Internet Research, 23*(8), e24546. https://doi.org/10.2196/24546

Wang, Y. T., & Lin, K. Y. (2021). Understanding continuance usage of mobile learning applications: The moderating role of habit. *Frontiers in Psychology, 12*, 736051. https://doi.org/10.3389/fpsyg.2021.736051

Widjaja, A., & Widjaja, Y. G. (2022). The influence of interaction, learner characteristics, perceived usefulness, and perceived satisfaction on continuance intention in e-learning system. *International Journal of Research in Business and Social Science, 11*(2), 381–390. https://doi.org/10.20525/ijrbs.v11i2.1665

Wilson, N., Keni, K., & Tan, P. H. P. (2021). The role of perceived usefulness and perceived ease-of-use toward satisfaction and trust which influence computer consumers' loyalty in China. *Gadjah Mada International Journal of Business, 23*(3), 262–294. https://doi.org/10.22146/gamaijb.32106

Wirani, Y., Nabarian, T., & Romadhon, M. S. (2022). Evaluation of continued use on Kahoot! as a gamification-based learning platform from the perspective of Indonesia students. *Procedia Computer Science, 197*, 545–556. https://doi.org/10.1016/j.procs.2021.12.172

Wu, B., & Chen, X. (2017). Continuance intention to use MOOCs: Integrating the Technology Acceptance Model (TAM) and Task Technology Fit (TTF) model. *Computers in Human Behavior, 67*, 221–232. https://doi.org/10.1016/j.chb.2016.10.028

Yan, H., Zhang, H., Su, S., Lam, J. F., & Wei, X. (2022). Exploring the online gamified learning intentions of college students: A technology-learning behavior acceptance model. *Applied Sciences, 12*(24), 12966. https://doi.org/10.3390/app122412966

Yang, H., Cai, J., Yang, H. H., & Wang, X. (2022). Examining key factors of beginner's continuance intention in blended learning in higher education. *Journal of Computing in Higher Education*, 1–18. https://doi.org/10.1007/s12528-022-09322-5

Ye, P., Liu, L., Gao, L., & Mei, Q. (2020). Factors affecting woman's continuance intention for mobile games. *International Journal of Information and Communication Technology Education, 16*(4), 48–67. https://doi.org/10.4018/IJICTE.2020100104

Zainuddin, Z., Shujahat, M., Haruna, H., & Chu, S. K. W. (2020). The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system. *Computers and Education, 145*, 103729. https://doi.org/10.1016/j.compedu.2019.103729

Zhang, M., Shu, L., Luo, X., Yuan, M., & Zheng, X. (2022). Virtual reality technology in construction safety training: Extended technology acceptance model. *Automation in Construction, 135*, 104113. https://doi.org/10.1016/j.autcon.2021.104113

Zhou, F., Mou, J., & Kim, J. (2021). Toward a meaningful experience: an explanation of the drivers of the continued usage of gamified mobile app services. *Online Information Review, 46*(2), 285-303. https://doi.org/10.1108/OIR-10-2020-0464

Zhou, L., Xue, S., & Li, R. (2022). Extending the Technology Acceptance Model to explore students' intention to use an online education platform at a University in China. *SAGE Open, 12*(1). https://doi.org/10.1177/21582440221085259

APPENDIX

SURVEY INSTRUMENT

Construct	Code	Item
Perceived Usefulness (PU)	PUP1	The Kingdom Quizzes application increases my academic productivity.
	PUT2	The use of Kingdom Quizzes application enables me to solve academic assessment (quiz) faster.
	PUT3	The Kingdom Quizzes application assists me to study efficiently.
	PUU2	The Kingdom Quizzes application enables me to improve my chance in completing academic tasks (e.g., quick formative assessment, self-assessment, peer assessment, revision) due to the concept of portability.
	PUU3	Overall, the Kingdom Quizzes application is advantageous for my learning due to the mobility concept in executing quizzes.
Perceived Ease of Use (PEOU)	PEOUI2	I interact smoothly with the Kingdom Quizzes application while playing the strategy games.
	PEOUI3	I easily understand how to interact with the Kingdom Quizzes application when performing quick formative assessment (quiz).
	PEOUI4	I easily understand how to interact with the Kingdom Quizzes application when playing the strategy game.
	PEOUI5	I do not have the need to think too much on ways to use the Kingdom Quizzes application due to the user-friendly attributes of the application (e.g., application navigation, functions provided).
	PEOUE1	It is easy for me to learn using the Kingdom Quizzes application.
Social Influence (SI)	SIE1	Lecturers/Educators are helpful in the usage of the Kingdom Quizzes application.
	SIO1	My learning institution encourages the use of the Kingdom Quizzes application.
	SIO2	In general, my learning institution agrees with the use of the Kingdom Quizzes application.
	SIN1	I use the Kingdom Quizzes application because my coursemates are using it.
	SIE2R	Lecturers/educators do not agree with the use of the Kingdom Quizzes application for my learning.

Construct	Code	Item
Facilitating Conditions (FC)	FCK1	I have the required knowledge to use the Kingdom Quizzes application due to the provided user guide video and document.
	FCO2	When facing with technical difficulties that are related to my current mobile device, the Kingdom Quizzes application is also supported by other medium of operation (e.g., android tablet, personal
	FCT1	computer or notebook supported with third party software).
	FCI2	I can seek technical assistance from my lecturer/educator or applications' administrator when experiencing difficulties while accessing the Kingdom Quizzes application.
	FCO1R	The learning institution prepares mobile network/internet that supports (e.g. stable, sufficient) the usage of Kingdom Quizzes application to be accessed around the campus or college.
		The Kingdom Quizzes application is not compatible with technologies (e.g. OS Android, device) that I am currently using.
Perceived Enjoyment (PENJ)	PENJE1R	I do not enjoy the quiz module in the Kingdom Quizzes application.
	PENJE2R	I do not enjoy the game module (tower defence game) in the Kingdom Quizzes application.
	PENJF1R	It is not enjoyable to use the Kingdom Quizzes application.
	PENJI1	I feel that the elements such as rules, rewards, score, rank in the leaderboard, virtual prize in the quiz module of Kingdom Quizzes application is interesting.
Satisfaction (S)	SD1R	I am not satisfied with the limited game level on the tower defence game in the Kingdom Quizzes application.
	SD2	I am satisfied with the flexibility of the time span given in completing the questions in the quiz module in the Kingdom Quizzes application.
	SI1	I feel positive towards the use of the Kingdom Quizzes application.
	SS2	I am satisfied with the output (e.g., completed quiz, revision session, mark and ranking of the students' progress, game session)
	SS3	achieved when using the Kingdom Quizzes application.
	SS1R	My lecturer/educator had made the right decision choosing the Kingdom Quizzes application as a tool for students to perform quick formative assessment.
		I am unsatisfied with the overall experience of using the Kingdom Quizzes application.
Confirmation (C)	CP1	The benefits delivered by the Kingdom Quizzes application are better than I expected.
	CP3	Overall, my expectations throughout using the Kingdom Quizzes application are fulfilled.
	CS1	The quiz module in the Kingdom Quizzes application is better than expected.
	CS1a	The game module in the Kingdom Quizzes application is better than expected.
	CS2	The functions provided in the Kingdom Quizzes application were carefully thought by the product developer as expected.
	CU1R	The experience while using the Kingdom Quizzes application is worse than expected.

Construct	Code	Item
Continuance Use Intention (CI)	CIR1	I recommend others to use the quiz module in the Kingdom Quizzes application for peer assessment throughout their learning.
	CIR1a	I recommend others to use the quiz module in the Kingdom Quizzes application for self-assessment throughout their learning.
	CIR2	I recommend others to also play the game module in the Kingdom Quizzes application for fun.
	CIU1	I intend to proceed with using the Kingdom Quizzes application for future quizzes or on other subjects.
	CIU4R	I do not intend to frequently use the Kingdom Quizzes application in the future.

AUTHORS

Rosfuzah Roslan is a PhD candidate currently studying at the Faculty of Educational Studies, Universiti Putra Malaysia (UPM), Selangor. She is an IT lecturer at the University Tun Hussein Onn Malaysia (UTHM). She has been working there since 2013. Previously she served as a System Analyst at the Malaysian Ministry of Education for 4 years, working on educational system development. With the background of computer science, she is interested in research and development related to gamified system and application with the implementation of IoT, virtual and augmented reality.

Fauzi Mohd Ayub is a professor at the Faculty of Educational Studies, Universiti Putra Malaysia (UPM), Selangor. His research interests include information technology and educational technology. His expertise encompasses multimedia and information technologies in education.

Norliza Ghazali is a senior lecturer at Faculty of Educational Studies, Universiti Putra Malaysia (UPM), Selangor. Her research interests include online learning and instrument development. Testing and assessment are among her areas of expertise.

Nurl Nadwa Zulkifli is a senior lecturer at Faculty of Humanities, Management, & Science, Universiti Putra Malaysia, Malaysia (UPM), Bintulu Campus, Sarawak. Her research interests are online learning, blended learning, multimedia, virtual and augmented reality, peeragogy, STEM learning and collaborative learning.

Siti Noor Haslina Md Latip is a PhD candidate currently studying at the Faculty of Educational Studies, Universiti Putra Malaysia (UPM) with the Ministry of Education (MOE) HLP scholarship. She started her English teaching career in 2003 with the Malaysian Ministry of Education and has an English teaching experience of 19 years in Japan and Malaysia. She researches mobile-assisted language learning (MALL) as part of teaching and learning English for Second language Learners (ESL).

Siti Syuhada Abu Hanifah has just graduated from her Masters in Educational Technology from Educational Studies, Universiti Putra Malaysia (UPM), Selangor. She serves as a teacher in one of Malaysia's public secondary schools. Her research interests are in digital competence and technology utilization.