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Predictive Model for Factors Influencing Students' Continuance Usage Intention on a Gamified Formative Assessment Application

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Abstract: Formative assessments help students identify their strengths and weaknesses as well as the target areas that need work. Meanwhile, the success of gamification implementation in mobile learning (m-learning) applications has been proven by many research associated with technology acceptance. However, studies on the technology post-acceptance phase are scarce. Deploying gamification concepts in competency-based education and assessment method, aim to diversify the game dynamics usage in new and practical areas such as technical and vocational education. Therefore, this study focused on the development of a predictive model for a gamified m-learning application that extends the Expectation Confirmation Model (ECM) with perceived enjoyment. This study applied a correlational research design on the students of Technical and Vocational Education and Training (TVET) based diploma programmes in one of Malaysian public university. An online survey was conducted, and garnered 269 responses, which were used in the final analysis based on the Partial Least Square-Structural Equation Modelling (PLS-SEM). The findings showed that all the factors in the model, which are the confirmation of expectation, satisfaction, perceived usefulness and perceived enjoyment, appeared to be significantly influencing the students' continuance usage intention towards the gamified m-learning application as well as jointly explained 64.6% (R^2) of the changes. The addition of variable perceived enjoyment provided an increment of 2.7% compared to the R^2 value of the original ECM model. Most importantly, the proposed extended ECM proved to be a reliable prediction model when the Q^2 values for continuance use intention and perceived usefulness displayed strong predictive accuracy, having 0.368 (Q^2) for both variables, while satisfaction showed moderate strength with the value of 0.305 (Q^2). Therefore, the predictive model is reliable to be used to investigate future usage and effective designs of gamified m-learning products among the technical and vocational education students in other Higher Education Institution (HEI).

Keywords: Mobile learning, gamification, continuance usage intention, expectation confirmation model

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1. Introduction

Mobile learning (m-learning) application is currently a widely used media in education other than e-learning. Malaysia is known to have a solid wireless network infrastructure which benefits university students with ready access to various mobile services (Al-Rahmi et al., 2022; Razali et al., 2022). The m-learning application promotes the 'learning on-the-go concept, where students have the luxury of flexibility in accessing their courses' content from their mobile devices anytime and anywhere. The current trend of m-learning applications is to include gamification concepts because it promotes play and fun elements. According to Werbach and Hunter (2015), the gamification design concentrates on rewards as the core of 'pleasure'. A player's competence can be verified via external rewards, such as a 'badge'; this will trigger positive behaviour and create intrinsic motivation. Meanwhile, Park and Kim, (2021) confirmed that 'leaderboard', which is an assessment of learners' interaction and achievement, contributes to the learners' exposure to goal setting, competition and feedback. 'Leaderboard' influences learners' motivation more than other game mechanics such as progress bars, end prizes, and awarded badges (Park & Kim, 2021). Therefore, gamification implementation in teaching and learning tools encourages the students to return to the tools. It is also an alluring method in strengthening relations between the learners and the educational tools. Malaysian students like the idea of technology adoption in the classroom; however, they are unwilling to invest much time and energy in it, which is attributed to how the technology is used or selected (Su Luan et al., 2003; Thang et al., 2016). Therefore, Lin et al. (2018) proposed the gamification elements as the solution to enhance Malaysian students' attention and encourage sustained learning. Furthermore, the experiential nature of a game concept, allows learners to be fully involved in the learning cycle. This also means that gamification is able to garners learners' full attention and stimulate knowledge retention due to its 'play nature'. Lin et al. (2018) showed that one of the ways to measure the successfulness of sustained learning or knowledge is through the implementation of formative assessment which also refers to the concept of 'testing effect' or 'retrieval practices' among learners proven by Rowland (2014) study.

In recent years, many Higher Education Institutions (HEIs) in Malaysia have been producing their m-learning resources following the growth of online learning and the high usage of mobile phones among HEIs students. Examples of such m-learning applications are 'Ethoshunt' for teaching and learning ethics (Zakaria et al., 2020) and 'Safety and Health' application for the occupational safety and health (OSH) course (Ismail et al., 2018), developed by Universiti Putra Malaysia (UPM) and 'MobiEko' application for microeconomics module developed by Universiti Kebangsaan Malaysia (UKM) (Muslimin et al., 2017). On the other hand, Universiti Tun Hussein Onn Malaysia (UTHM) produced a programming course application (Ramle et al., 2019) and a gamified e-quiz (Roslan et al., 2021a). However, despite the rise of mobile applications, the rate of continuance usage behaviours among users is relatively low. Ceci (2023) reported that education applications presented the lowest retention rate with, 2% after 30 days of installation compared to other mobile applications categories such as news (11%), shopping (5%) and entertainment (3%). Gaining new users and retaining them is fundamental for the promising growth of a mobile application, and developers can expand their potential users by utilising tools, for example gamification as an engagement agent.

Acquiring users' loyalty toward using a specific mobile application is a challenge. Continued usage of information technology (IT) or information system (IS) products is said to be far more critical than its initial adoption, based on prior literature (Xavier & Zakkariya, 2021). Before the year 2011, research on continuance usage intention primarily involved websites. However, in 2019, studies related to mobile applications increased more than website-based studies (Yan et al., 2021). Continuance usage intention is the users' decision to keep using a specific IT or IS that an individual has already been using. By examining factors contributing to users' continuance usage intention, application developers can later effectively produce a new or enhanced application that meets the users' needs and expectations (Roslan et al., 2021b).

Numerous prominent theories such as expectation-confirmation theory (ECT) by Oliver (1980), expected confirmation model (ECM) based on Bhattacherjee, (2001) study, and technology continuance theory (TCT) by Liao et al. (2009) have explored users' post-adoption behaviour towards continuous usage of IS. In recent research by Mishra et al. (2023), they discovered that the IS continuance model has extensively been used, but with mixed results, whereby the strength of various relationships proposed in a model are highly dependent on the specific IS context. Therefore, following the suggestion and implementation by Mishra et al. (2023) study, this study selected the basic and most prominent post-adoption model, which is the ECM by Bhattacherjee, (2001) as the base model and integrating it with a factor that appeals to hedonic technology, such as gamified m-learning application. In conclusion, this study aims to create a predictive model that reflects the continuance use intention of a gamification-based m-learning applications in the Malaysian HEI student context.

1.1 Expected Confirmation Model (ECM)

The expected confirmation model (ECM) by Bhattacherjee (2001), illustrated in Fig. 1, was the primary reference model that many had used to predict the technology continuance usage by users (Singh, 2020). A user's intention to continue using technology is influenced by three factors as follows; (i) perceived usefulness which refers to the extent to which a person believes that using a particular IS will enhance their job performance, (ii) confirmation of expectation is the users' perceptions of the congruence between the expectation of technology usage and its actual performance, and (iii) satisfaction which reflects users' effect with feelings about the prior use of the technology. 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.

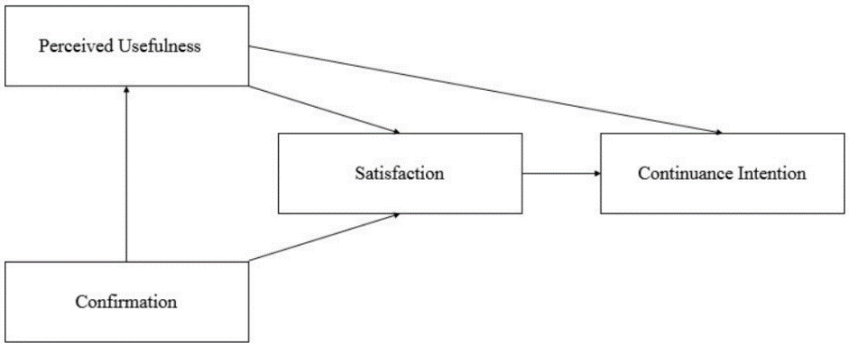

Fig. 1 - Expected Confirmation Model (ECM)

1.2 Perceived Enjoyment (PENJ)

Perceived enjoyment is an intrinsic motivation that specifies how fun can be derived from using IT, or an IS (Chao, 2019). In recent years, construct perceived enjoyment has been added to most of the research models, especially for a product that is gamification based. It is the most critical determinant of mobile game adoption that influences users' intention to continue using a service (Faqih, 2022). Al Amri and Almaiah (2020) finding also confirmed that perceived enjoyment is associated with mobile gamification technology and triggers motivation in future usage among HEI students. Following that, perceived enjoyment in this study signifies the extent to which fun can be acquired from using the gamified m-learning applications and offering fun experience.

1.3 Proposed Research Model

Section Six hypotheses are presented based on the proposed model in Fig. 2, which introduced the integration of ECM and constructed perceived enjoyment. This study will view confirmation of expectation, or in other words, as the HEI students' perception of the similarity between their expectation of the usage of gamified m-learning application with the actual operation. Therefore, the following hypotheses are posed:

H1a: Confirmation significantly affects satisfaction in using the gamified m-learning application.

H1b: Confirmation significantly affects the perceived usefulness of the gamified m-learning application.

It is commonly explored that a product level of usability will lead to satisfaction and is widely considered in continuance usage intention studies (Singh, 2020). Therefore, the following hypothesis (i.e., H2a) in this study involves the users' satisfaction upon using the gamified m-learning application if they expect the application's ability to perform their academic tasks faster with the mobility's advantage. Meanwhile, hypothesis H2b was formulated based on the users' belief that using the gamified m-learning application is very useful, especially when they are 'on the go' regardless of their physical location, which triggers their interest in continuous use of the product.

H2a: Perceived usefulness significantly affects satisfaction in using the gamified m-learning application.

H2b: Perceived usefulness significantly affects gamified m-learning application continuance use intention.

The following hypothesis is based on Akdim et al. (2022), which confirmed the link between perceived enjoyment, the hedonic aspect of technology, and continuance use intention. It is assumed that students' perceptions about the hedonic aspect of a gamified m-learning application will positively impact their willingness to continue using the product. Therefore, it is suggested that;

H3: Perceived enjoyment significantly affects gamified m-learning application continuance use intention.

Lastly, the sixth hypothesis involves constructing satisfaction, which revolves around the users feeling content with the gamified m-learning applications' services and the pleasing experience, essential in securing their intention to use the product again. Hence, the following hypothesis is posed:

H4: Satisfaction significantly affects gamified m-learning application continuance use intention.

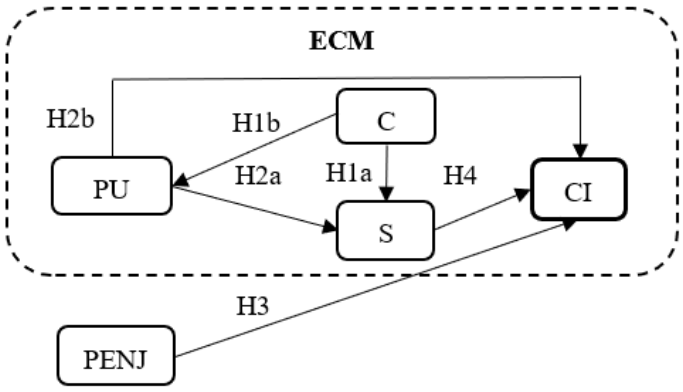

Fig. 2 - Proposed model

Note: PU (Perceived Usefulness), PENJ (Perceived Enjoyment), C (Confirmation), S (Satisfaction), CI (Continuance Use Intention)

2. Method

2.1 Research Design, Technological Product, and Participants

This study employed a cross-sectional, correlational research design through an online survey. Meanwhile, the technological product involved is an android-based formative assessment mobile application called Kingdom Quizzes, developed by Universiti Tun Hussein Onn Malaysia (UTHM). The Kingdom Quizzes application offers more than just a quiz module. It also provides an interconnected game module (i.e., a tower defense strategy game). The type of activities that the students can perform is (i) executing quiz, (ii) revision, and (iii) gameplay. Furthermore, the gamification items employed by Kingdom Quizzes are; points, a leaderboard, a performance list, virtual gifts, levels and challenges, and an avatar/personalised image. Fig. 3 displays the activities that can be performed in the application.

This research was conducted at one of the Malaysian HEIs, Universiti Tun Hussein Onn Malaysia (UTHM) which offers Technical and Vocational Education and Training (TVET) diploma programmes consisting of Diploma of Chemical Engineering Technology, Diploma of Mechanical Engineering, Diploma of Civil Engineering, Diploma of Electrical Engineering, Diploma of Information Technology, and Diploma of Animation Technology. However, the population of this study is taken at 560, based on the existing user of the gamified m-learning application (i.e., Kingdom Quizzes), who are the first-year students from session 2021/2022 of the following programmes; Civil Engineering (240 students), Information Technology (220 students) and Animation (100 students). Meanwhile, the samples only include (i) 'active' first-year students, referring to the students who completed more than 50% of the total published quizzes, and (ii) calculated at a 95% confidence level as proposed by Cochran (1977) formula (Bartlett et al., 2001), which makes the minimum sample size as 180. On the other hand, according to Salkind (2018), 40% to 50% of the sample is recommended to be added to the sample size to ensure the utilisation of sufficient respondents, minimise the associated errors and aid the problem of non-returned questionnaires or incomplete responses. Therefore, this study applied Salkind (2018) recommendation involving the addition of 50% of the total respondents, which is equal to additional 90 respondents. This means that the maximum sample size calculated for this study was 270, resulted from 180 being added with 90.

For the sampling technique, this research applied the proportionate stratified random sampling technique due to having three different diploma programmes involved (i.e., Civil = 116, Information Technology = 106 and Animation = 48). The participation of all these Diploma programmes' students was based on the educators' willingness and decision, to use the gamified m-learning application for their academic sessions involving formative assessment. The usage of Kingdom Quizzes lasted eight weeks throughout the semester, and the total number of examinations published for each course is at least three sets. A total of 317 questionnaires were collected during the survey session. Subsequently, 48 responses were excluded due to extreme cases identified by Mahalanobis's multivariate outlier test (Leys et al., 2018). As a result, 269 valid responses were retained and acted as the final sample for further analysis, which is not more than the maximum sample size (270). Overall, the responses comprised of 140 (52%) male and 129 (48%) female respondents. In comparison, the portion or distribution of programmes is acceptable with 122 out of 220 IT students (45.3%), 103 out of 240 civil engineering students (38.3%) and 44 out of 100 animation students (16.4%).

Fig. 3 - Gamified formative assessment mobile application (Kingdom Quizzes)

2.2 Measures

The instrument used in this research is based on relevant existing instruments that were adapted and modified to fit the aim and context of this study. A pre-test was carried out beforehand, in which the survey items were evaluated by five experts in the field of educational technology. Subsequently, a pilot test consisted of 60 first-year students from the previous cohort to ascertain the reliability of items at the preliminary level. Table 1 illustrates the final items with the source of the instrument. All items were measured with the Likert scale of 5 – points ranging from strongly disagreed (1), disagreed (2), somewhat agreed (3), agreed (4), to strongly agreed (5).

The Cronbach's Alpha (α) values of each construct based on the pilot study result are displayed as .70 and above (refer to Table 1). Based on Hair et al. (2018), a reliability score that is higher than .69 is the ideal threshold for obtaining the suitable reliability of an instrument. Additionally, the average value of α for the whole instrument is .797, which shows that the research instrument is acceptable and reliable.

Table 1 - The pilot study instruments' items, source, and Cronbach's Alpha values

Construct	Num. of Items	Source	Cronbach's Alpha (α)
Perceived Usefulness (PU)	5	Bhattacherjee (2001); Venkatesh et al. (2012)	.818
Perceived Enjoyment (PENJ)	4	Venkatesh et al. (2012), Thong et al. (2006)	.707
Satisfaction (S)	6	Bhattacherjee (2001), Roca et al. (2006)	.831
Confirmation (C)	6	Bhattacherjee (2001), Hsu et al. (2013)	.855
Continuance Use Intention (CI)	5	Bhattacherjee (2001),	.776
Total	26	Average (α)	.797

2.3 Data Analysis

A preliminary analysis was conducted where the 269 final data were inspected for multivariate normality using multivariate coefficients demonstrated in Mardia (1970). The Mardia's coefficient procedure is being implemented with the reference of threshold score of 20 (Byrne, 2013; Kline, 2015). The kurtosis coefficient (β = 45.44) resulted as being above the threshold score, indicating data being non-normally distributed. Based on this result, the partial least square-structural equation modeling (PLS-SEM) is selected to be applied (Sarstedt et al., 2017). As the minimum sample size that is proposed in the PLS-SEM is more than 160, based on Kock and Hadaya, (2018), the final data of 269 is acceptable for further analysis.

Firstly, the Common Method Bias (CMB) has to be verified by performing two types of approaches which are the Harman's Single Factor (HSF) (Podsakoff et al., 2003) and the full collinearity assessment (Kock & Lynn, 2012). The HSF results displayed that the largest variance explained by an individual factor was 30.43% which complied to the recommendation (< 50%) by Podsakoff et al. (2003). Furthermore, the full collinearity assessment illustrated in Table 2, produced a variance inflation factor (VIF) that is below 3.30 as recommended by Kock and Lynn (2012). This concludes that this study has no issue related to CMB.

The first assessment will be done towards the reflective measurement model, which involves (i) an internal reliability test, (ii) a convergent validity test, and (iii) a discriminant validity test (Hair et al., 2018). The internal reliability is acceptable when the composite reliability value is .70 or higher (Bagozzi & Yi, 1988). Meanwhile, the average variance extracted (AVE) threshold for convergent validity is above .50 (Nunnally & Bernstein, 1994). Lastly, discriminant validity will be assessed with the Heterotrait-Monotrait ratio of correlations (HTMT) due to its superior performance, according to Ghasemy et al. (2020). Therefore, the threshold value below .90 (Gold et al., 2001) is applied in this study.

The subsequent analysis will validate the structural model (i.e., the inner model in PLS or reflective model), which was conducted to find the relationship between the variables. The five steps evaluation was performed; (i) the lateral collinearity (VIF) (Becker et al., 2015), (ii) the path coefficients, (iii) the coefficient of determination (R^2) (Hair et al., 2018), (iv) the effect size (f^2) (Cohen, 1988), and (v) the predictive accuracy (Q^2) (Geisser, 1975; Stone, 1974).

3. Results

3.1 Verification of the Reflective Measurement Model

The convergent validity can be assessed based on outer loading and average variance extracted (AVE). A high outer loading value reflects that the indicators belong to the particular construct. According to Hair et al. (2017), the outer loading value that should be achieved is .708 and above, indicating that the construct can explain at least 50% of the indicators' variance. On the contrary, the outer loadings with a value less than .40 should be dismissed (Hair et al., 2017), meanwhile the items with outer loadings greater than .40 can be accepted if the construct has a value of .50 and above for the AVE score (Ramayah et al., 2016).

In addition, two items (i.e., CU1R= .264; SS1R= .561) were removed due to low loading, which is less than .708 (Hair et al., 2019). However, one of the satisfactions' items (SD1R= .522) and two of the continuance use intentions' items (i.e., CIU4R= .519, CIR2= .694) were retained as the AVE of each construct is already greater than .50. The values of AVE ranged from .554 to .647. Therefore, the composite reliabilities were greater than .70, proving sufficient internal reliability and convergent validity. The internal and convergent validity results are displayed in Table 2.

Table 2 - The pilot study instruments' items, source, and Cronbach's Alpha values

Latent Variable	Item	Loading	Random Dummy Variable (*VIF*)	Cronbach's Alpha (α)	Composite Reliability (> .7)	*AVE* (> .5)
Perceived Usefulness (PU)	PUP1	0.801	1.170	.854	.895	.630
	PUT2	0.740				
	PUT3	0.808				
	PUU2	0.794				
	PUU3	0.824				
Perceived Enjoyment (PENJ)	PENJE1R	0.729	1.474	.750	.832	.554
	PENJE2R	0.729				
	PENJF1R	0.816				
	PENJI1	0.697				
Satisfaction (S)	SD1R	0.522	1.060	.795	.859	.554
	SD2	0.752				
	SI1	0.828				
	SS2	0.783				
	SS3	0.797				
Confirmation (C)	CP1	0.836	2.731	.863	.901	.647
	CP3	0.808				
	CS1	0.776				
	CS1a	0.791				
	CS2	0.808				
Continuance Use Intention (CI)	CIR1	0.860	2.632	.809	.871	.582
	CIR1a	0.860				
	CIR2	0.694				
	CIU1	0.826				
	CIU4R	0.519				

Note: VIF Variance Inflation Factor, AVE Average Variance Extracted

The following assessment is the discriminant validity using the Heterotrait-Monotrait ratio of correlations (HTMT) listed in Table 3. The HTMT values were below Gold et al. (2001) threshold limit of .90, thereby establishing discriminant validity.

Table 3 - HTMT results for discriminant validity assessment

	1	2	3	4	5
1. Confirmation (C)					
2. Continuance Use Intention (CI)	0.896				
3. Perceived Enjoyment (PENJ)	0.529	0.716			
4. Perceived Usefulness (PU)	0.898	0.856	0.538		
5. Satisfaction (S)	0.863	0.889	0.751	0.797	

Note: HTMT value < 0.90

3.2 Verification of the Structural Model

In assessing the structural model, lateral collinearity (VIF) was examined between the latent variables. Table 4 illustrates that the VIF values were below the cut-off score of 3 (Becker et al., 2015), that is, between 1 and 2.523. The results indicate that the problem of multicollinearity does not exist. Next, the hypotheses in the structural model were tested by implementing the bootstrap re-sample technique with an iteration of 5000 sub-sample. DiCiccio and Efron (1996) recommended that at least 2000 replications should be applied when conducting bootstrap resampling; however, 5000 replications were chosen for this study. This is because, more bootstrapped samples applied will improve estimation and the 5000 sub-samples managed to operate at an optimum processing time using the operating machine (i.e., personal computer or notebook). Table 4 listed the results supported by the illustration of path coefficients (*t*-statistics and R^2) in Figure 6.

Table 4 - Hypotheses testing and structural model results

	β	**Confidence Interval**	***t*-value**	***p*-value**	**Inner *VIF***	R^2	f^2	Q^2	**Result**
H1a: C -> S	.524	(.427, .634)	8.375**	.000	2.523	.574	.257	.305	S
H1b: C -> PU	.777	(.735, .823)	29.492**	.000	1.000	.602	1.523	.368	S
H2a: PU -> S	.277	(.161, .387)	4.026**	.000	2.523		.072		S
H2b: PU -> CI	.385	(.288, .468)	7.008**	.000	1.943	.646	.218	.368	S
H3: PENJ -> CI	.211	(.118, .305)	3.707**	.000	1.535		.083		S
H4: S -> CI	.340	(.233, .460)	4.894**	.000	2.171		.152		S

Note: **p ≤ .001, S (Supported hypothesis), PU (Perceived Usefulness), PENJ (Perceived Enjoyment); C (Confirmation), S (Satisfaction), CI (Continuance Use Intention), VIF (Variance Inflation Factor)

Based on Table 4, all the relationships showed significance (p ≤ .001), resulting in an accepted or supported the hypothesis. In conclusion, confirmation and perceived usefulness have a direct positive effect on satisfaction with (H1a: β = .524, t = 8.375, p = .000) and (H2a: β = .277, t = 4.026, p = .000), respectively. In another case, confirmation also positively influenced perceived usefulness (H1b: β = .777, t = 29.492, p = .000). Meanwhile for the relationships associated with continuance use intention, all the variables involved proved significant influence; perceived usefulness (H2b: β = .385, t = 7.008, p = .000), perceived enjoyment (H3: β = .211, t = 3.707, p = .000) and satisfaction (H4: β = .340, t = 4.894, p = .000).

The following assessment is the coefficient of determination (R^2) representing the in-sample predictive power. Based on Hair et al. (2017), the strength of R^2 values sufficiently categorised as greater than .25, .50, and .75, which equals weak, moderate, and substantial, respectively. Meanwhile, the results revealed that 64.6% of the variance in continuance use intention is explained by satisfaction, perceived usefulness, and perceived enjoyment; 60.2% of the variance in perceived usefulness is explained by confirmation, while 57.4% of the variance in satisfaction is explained by perceived use and confirmation (refer Table 4 and Fig. 4).

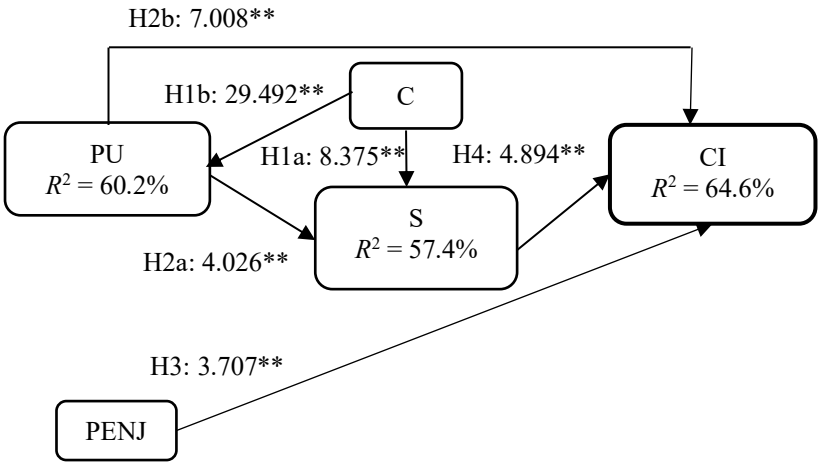

Fig. 4 - Research structural model

Note: **p ≤ .001, PU (Perceived Usefulness), PENJ (Perceived Enjoyment), C (Confirmation), S (Satisfaction), CI (Continuance Use Intention)

To summarise, the in-sample predictive power (R^2) of this model has considered moderate as all of the endogenous variables showed that R^2 values were greater than .50. Additionally, 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= .619) as displayed in Figure 5, the results proved that the proposed research model shows an increment of 2.7% (R^2= .646). On the other hand, the other two endogenous variables (i.e., satisfaction and perceived usefulness) remain at the same values. This proved that more value is added to the original model (i.e., ECM) when extended. This means that the proposed model with the extension of perceived enjoyment (PENJ) managed to serve more explanatory power on the outcome variable (i.e., continuance use intention).

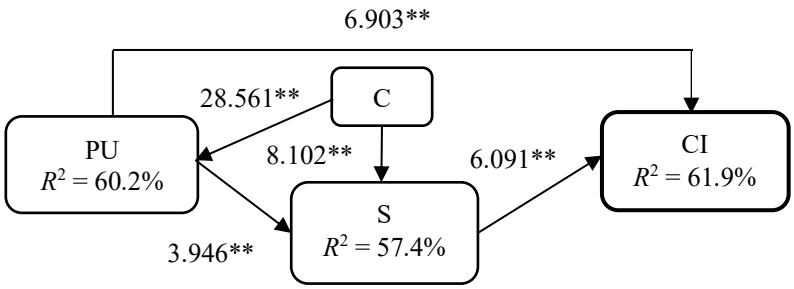

Fig.5 - Structural model of the original ECM

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

Subsequently, based on Cohen's f^2 (Cohen, 1988), the effect size (f^2) was measured based on values above .02, .15, and .35 representing small, medium, and large effects, respectively. By observing the f^2 values in Table 4, it can be concluded that confirmation (f^2 = .257) and perceived usefulness (f^2 = .072) demonstrated medium and small effect size in generating R^2 for satisfaction, respectively, whereas confirmation (f^2 = 1.523) portrayed a large effect size in developing R^2 for perceived usefulness. On the other hand, the perceived usefulness and satisfaction reflect a medium effect size towards R^2 of continuance use intention with (f^2 = .218) and (f^2 = .152), respectively. Lastly, the perceived enjoyment exerts a small effect size (f^2 = .083) in generating R^2 for the continuance use intention.

Next, this study identified the predictive accuracy of the structural model based on the Geisser Stone–Geisser test criterion (Q^2), where the blindfolding method was involved. The predictive relevance of the model is supported when the Q^2 value exceeds the threshold of 0 for all the endogenous variables (Stone, 1974). To enrich the explanation of Q^2, this study determined its effect using Cohen (1988)'s rule of thumb. When the Q^2 value is greater than .02, .15, or .35, it signifies small or low, medium or moderate, and large or strong predictive power, respectively (Suhan et al., 2018). As illustrated in Table 4, two endogenous variables (i.e., perceived usefulness, continuance use intention) exhibited strong predictive accuracy with .368 (Q^2 value > .35), while one endogenous variable (i.e., satisfaction = .305) exhibited

moderate predictive accuracy. Overall, the model represents a robust predictive model for investigating the continuance use intention factors for a gamification-based m-learning application.

4. Discussion

In sum, all the hypotheses were supported, proving that students' initial expectations regarding the benefits, pleasure, and achieving satisfaction in confirming all the gamified m-learning application benefits are essential to secure continuance usage from them. Hypothesis H1a result revealed that the students' satisfaction is strongly affected by confirmation of the features and functions of the product. In accordance with Poromatikul et al. (2019) study, as the students discover that their expectations of the product are being met, their level of satisfaction increases. Furthermore, another confirmation of expectation hypothesis (i.e., H1b) showed that the student's level of product confirmation, is positively associated with their perceived usefulness, similar to Ouyang et al. (2017) finding. When certain benefits of the gamified m-learning application are fulfilled, it increases the students' perception of product usefulness. Following that, the perceived usefulness of the product also positively affected the student's satisfaction with the product's usage, which corresponds to hypothesis H2a.

Moreover, it was discovered that the antecedents of continuance use intention among students on a gamified m-learning application were perceived usefulness, enjoyment, and satisfaction, which corresponded to hypotheses H2b, H3, and H4, respectively. All variables from the ECM resulted as expected (positive influences). Meanwhile, the extended variable (i.e., perceived enjoyment) performed similarly to Tam et al. (2020) study, which verifies that it is one of the critical determinants of behavioural intention, especially for an m-learning product equipped with gamification items or even a progressive game. Most importantly, the proposed model showed moderate in-sample predictive power, having perceived usefulness and satisfaction reflecting a medium effect size. Meanwhile, perceived enjoyment exerts a negligible effect on the continuance use intention. Lastly, the model proposed in this study holds predictive relevance based on the Geisser Stone–Geisser test criterion (Q^2) and, overall, exhibited substantial accuracy.

5. Conclusions

As ECM is a widely applied post-adoption model used to determine the users' future intention towards technology, it is also valid to be applied to a gamification-based mobile application (Abdullahi et al., 2021, Daneji et al., 2019). Along with the perceived enjoyment factor, it is also proven that the users expect the m-learning application to provide pleasure. With the implementation of the perceived enjoyment variable in an ECM model, the students will be able to express their thoughts on the fun aspect and gamification items embedded in it. Furthermore, the instrument and model offered by this research can act as references when collecting gamified m-learning applications' post-usage information to design suitable future interventions. Additionally, the HEIs' m-learning designers and developers can focus on the significant influencing factors and gamification items related to usefulness and enjoyment when upgrading gamified m-learning resources. Lastly, the outcome of this research revealed that constructing enjoyable and engaging content in an m-learning application helps connect educators with technical and vocational education students, leading to a promising continuance usage of the particular tool. Hence, the HEIs' management should take this seriously as it also shaped the future direction of the 'in-house' developed m-learning application, with the purpose of populating their institutions' digital learning resources.

6. Suggestions for Future Research

Further study is needed that considers larger populations from several programs and universities to enhance the generalizability of this research's results. It is also recommended to perform the longitudinal type of research, which enables researchers to comprehend the dynamics of the constructs over time. Additionally, other variables outside the scope of this study may also be included to improve the explanations of gamified m-learning application continuance use intention, directly or as mediating sources, for example, perceived ease of use, subjective norm, or task-technology-fit. Finally, researchers must consider the relevance of any future added variables according to the type of technological product used in the study and the users involved.

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Appendix A: Survey Instrument

Construct	Code	Item	Source
Perceived Usefulness (PU)	PUP1	The Kingdom Quizzes application increases my academic productivity.	Bhattacherjee (2001)
	PUT2	The use of Kingdom Quizzes application enables me to solve academic assessment (i.e., quiz) faster.	Venkatesh et al. (2012)
	PUT3	The Kingdom Quizzes application assists me to study efficiently.	Bhattacherjee (2001)
	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.	Bhattacherjee (2001)
	PUU3	Overall, the Kingdom Quizzes application is advantageous for my learning due to the mobility concept in executing quizzes.	Bhattacherjee (2001)
Perceived Enjoyment (PENJ)	PENJE1R	I do not enjoy the quiz module in the Kingdom Quizzes application.	Venkatesh et al. (2012)
	PENJE2R	I do not enjoy the game module (i.e., tower defense game) in the Kingdom Quizzes application.	Venkatesh et al. (2012)
	PENJF1R	It is not enjoyable to use the Kingdom Quizzes application.	Venkatesh et al. (2012)
	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.	Thong et al. (2006)
Satisfaction (S)	SD1R	I am not satisfied with the limited game level on the tower defense game in the Kingdom Quizzes application.	Bhattacherjee (2001)
	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.	Roca et al. (2006)
	SI1	I feel pleased towards the use of the Kingdom Quizzes application.	Roca et al. (2006)
	SS2	I am satisfied with the output (e.g., completed quiz, revision session, mark and ranking of the students' progress, game session) achieved when using the Kingdom Quizzes application.	Bhattacherjee (2001)
	SS3	My lecturer/educator had made the right decision choosing the Kingdom Quizzes application as a tool for students to perform quick formative assessment.	Roca et al. (2006)
	SS1R	I am unsatisfied with the overall experience of using the Kingdom Quizzes application. B	Bhattacherjee (2001)
Confirmation (C)	CP1	The benefits delivered by the Kingdom Quizzes application are better than I expected.	Hsu et al. (2013)
	CP3	Overall, my expectations throughout using the Kingdom Quizzes application are fulfilled.	Bhattacherjee (2001)
	CS1	The quiz module in the Kingdom Quizzes application is better than expected.	Bhattacherjee (2001)
	CS1a	The game module in the Kingdom Quizzes application is better than expected.	Bhattacherjee (2001)
	CS2	The services provided in the Kingdom Quizzes application were carefully thought by the product developer as expected.	Hsu et al. (2013)
	CU1R	The experience while using the Kingdom Quizzes application is worse than expected.	Bhattacherjee (2001)

Continuance Use Intention (CI)	CIR1	I recommend others to use the quiz module in the Kingdom Quizzes application for peer assessment throughout their learning.	Bhattacherjee (2001)
	CIR1a	I recommend others to use the quiz module in the Kingdom Quizzes application for self-assessment throughout their learning.	Bhattacherjee (2001)
	CIR2	I recommend others to also play the game module in the Kingdom Quizzes application for fun.	Bhattacherjee (2001)
	CIU1	I intend to proceed with using the Kingdom Quizzes application for future quizzes or on other subjects.	Bhattacherjee (2001)
	CIU4R	I do not intend to frequently use the Kingdom Quizzes application in the future.	Bhattacherjee (2001)

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