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Sustainability Model for Predicting Smart Education Technology Adoption Based on Student Perspectives

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Abstract

Smart applications are perceived as an appropriate solution for promoting the sustainability of learning among students due to its useful and unique characteristics. Educational smart application is the use of smart applications for enhancing the learning process. Recently, this topic has been getting a lot of attention from many scholars. However, the amount of research undertaken on smart education is still limited. One of the main problems that hinder the success of smart education technology is sustainability. Designers might overlook some important factors that increase the sustainability of learning due to lack of models that covers all the essential factors to achieve this goal. Therefore, this study proposes a new model that aims to enhance the learning sustainability using smart education applications. This research provides empirical evidence and explains some important factors, such as enjoyment, perceived ease of use, perceived usefulness, behavioural intention to use, efficiency and effectiveness, to facilitate the effective utilization of smart education applications, and thus, will contribute in increasing the sustainability of learning effectively using smart education applications.

Keywords: *Smart Education Applications, Technology Adoption, sustainability, Enjoyment.*

1 Introduction

In the recent years, smart applications have been applied in higher education context [4]. Educational smart application like mobile devices and smart phones is the use of entertainment for conducting the learning process, which includes mobile games, simulations and gamification. Recently, educational smart applications have gained popularity in higher education context [1] and it is being benefited from its characteristics in the learning context [2], [3]. It is used to increase the learning motivation among students, enhance students' engagement and increase the sustainability of learning in an effectively way [4]. Educational smart applications can be defined in various ways. For example, Holden and Sykes [7] defined the educational smart applications as an entertainment activity in which students pursue educational goals in order to acquire knowledge and develop their skills in mobile learning environments. Huizenga et al. [8] defined the educational smart applications is one of the digital games designed for conducting the learning process in entertainment way. This definition comes close to the idea professed by Prensky [9], whose concept of digital learning is the marriage of learning and digital entertainment. In sum, these definitions indicate the role of digital learning games (computer and mobile) as acting as an entertainment platform designed for the learning process of its students.

However, there are several ways for implementing educational smart applications in order to promote student's engagement. But, it is not always guaranteed that the implementation of educational smart applications in a successful way due to lack some important factors and techniques. Thereby, in order to success these applications, it is very important to complement educational smart applications with these factors and techniques. For example, many studies showed that including some crucial factors like enjoyment, easefulness and ease of use to educational smart applications can further enhance student’s engagement [5]. In fact, the more educational smart applications application is simple, more easy to use and more entertainment, longer students will interact with these applications, they will become an expert with it, and thus, increasing the sustainability of learning through using educational smart applications.

Although there are several factors that promote the sustainability of learning including enjoyment, easefulness, ease of use, efficiency and effectiveness. However, applying these factors into educational smart applications has not been adequately addressed in the literature. Moreover, it is necessary to understand their effects on educational smart applications usage among students. For example, enjoyment is one of the key factors for motivating students to use educational smart applications since this factor helps in increasing students' engagement in learning process. However, designers might overlook some important factors that increase the sustainability of learning due to lack of models that covers all the essential factors to achieve this goal.

Therefore, this study proposes a new model that may increase the sustainability of learning among students by exploring the essential factors that influencing the enhancement usage of educational smart applications. The proposed model includes the following factors: enjoyment, ease of use, usefulness, behavioural intention to use, efficiency, effectiveness and utilization in the adoption of educational smart applications. The proposed model will help researchers to guide future research in the field of educational smart applications adoption in higher education. Therefore, this study aims to achieve the following objective:

- To identify the essential factors that influencing the enhancement usage of educational smart applications in higher education of Saudi Arabia.

The remainder of the research paper is organized as follows: Section 2 presents the theoretical background and the research model of this study. In the section 3, we explain the research method. Section 4 includes the research findings. Finally, sections 5 and 6 concludes with the discussions and conclusions.

2 Theoretical Background

Recently, an educational smart application is one a useful digital tool for learning process using mobile games. This kind of games based learning now is one of the most important topics in modern education and is rapidly growing research trend [6], around the adoption of mobile games in the learning process and their impact on students' learning effectiveness. A review of educational smart applications literature by Koutromanos and Avraamidou [10], who commented on the need for further studies into how students use and accept educational smart applications in effectively way in higher education in order to enhance the sustainability of learning. Rashid, Salleh, and Noor [11] identified that the main challenge for the successful integration of educational smart applications into learning activities is relevant significantly to students' acceptance.

In order to solve this issue, several researchers have started to clarify the factors that affect students' usage and acceptance of educational smart applications. For example, Dele-Ajayi et al. [21] used TAM to identify the factors that influence intention to continuously use digital educational games. Their results showed that the users' acceptance of digital games was positively influenced by perceived ease of use, perceived and self-efficacy. They also revealed that TAM model is a useful instrument for exploring the attitude of learners to accepting digital games for learning. Chen and Lin [22] also employed the TAM, aiming to examine Chinese students' acceptance of mobile games in the classroom. Their results suggested that the students' preference for using mobile games was most significantly affected by their perception of usefulness and ease of use. In another study, Wang

and Sun [23] also applied TAM to examine students' acceptance of an educational computer game. Their findings showed that perceived ease of use and perceived usefulness significantly influenced students' acceptance of the proposed game. However, these studies not only signified the extensive use of TAM in examining students' acceptance of digital games, but also indicated the lack of scholarly attention to the critical role of some other important factors such as enjoyment, efficiency and effectiveness behind students' utilization of educational smart applications.

In fact, one of the main concerns in the literature of educational smart applications adoption is assuring students utilization and of the mobile games [12]. Several studies have investigated the following question: what are the main factors affecting students' utilization of educational smart applications. Most of these works have focused on the TAM constructs to investigate the students' utilization of educational mobile games. After the introduction of TAM, educational mobile games studies have merely focused on use-based view of users acceptance [13]. In other word, researchers have used the main constructs of TAM such as ease of use and usefulness actual use and intention to use to study the utilization of educational smart applications.

3 Technology Acceptance Model (TAM)

According to previous studies, constructs of TAM model like perceived ease of use, perceived usefulness and behavioural intention to use have been widely used to evaluate users' utilization of several types of educational technologies [14],[15],[16]. Perceived usefulness means that "the degree to which a person believes that using a particular system would enhance his or her job performance", and perceived ease of use signifies "the degree to which a person believes that using a particular system would be free from effort", and behavioural intention to use defined as the degree to which a user is willing to use a particular technology [20]. Moreover, investigating these constructs behind users' utilization of technologies have been proven helpful in providing users with more acceptable educational technologies, and therefore have been widely regarded as vital factors for studying users' utilization of mobile technologies [17], [18],[19]. For example, Dele-Ajayi et al. [21] used TAM to identify the factors that influence intention to use digital educational games. Their results showed that the users' acceptance of digital games was positively influenced by perceived ease of use, perceived and self- efficacy. They also revealed that TAM model is a useful instrument for exploring the attitude of learners to accepting digital games for learning. Chen and

Lin [22] also employed the TAM, aiming to examine Chinese students' acceptance of mobile games in the classroom. Their results suggested that the students' preference for using mobile games was most significantly affected by their perception of usefulness and ease of use. In another study, Wang and Sun [23] also applied TAM to examine students' acceptance of an educational computer game. Their findings showed that perceived ease of use and perceived usefulness significantly influenced students' acceptance of the proposed smart application.

3 Research Model and Hypotheses

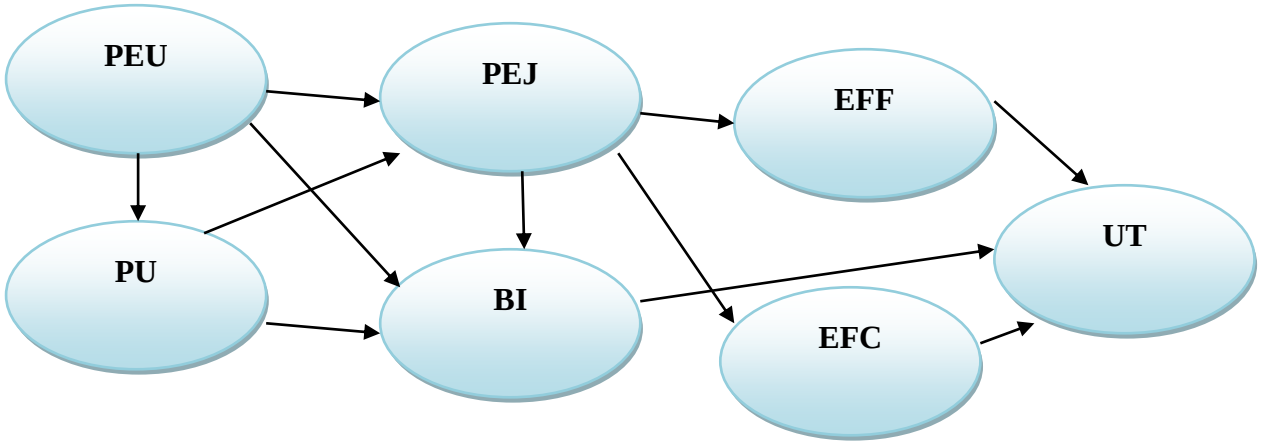

Figure 1. Research Model

Based on above discussions, this study proposes the following hypotheses as shown in the research model in Figure 1:

H1: Perceived ease of use has a significant relationship with users' intention to use of educational smart applications.

H2: Perceived usefulness has a significant relationship with users' intention to use of educational smart applications.

H3: Perceived ease of use has a significant relationship with perceived usefulness of educational smart applications.

H7: Behavioural intention to use has a significant relationship with users' utilization of educational smart applications.

Furthermore, current studies have indicated that perceived enjoyment is one of the crucial factors motivating students to use digital game applications [24],[25]. For example, a study conducted by Baek [24], who investigated the factors that influence individuals' acceptance of mobile learning games. They found that perceived enjoyment is the key factor that determines individuals' utilization of mobile learning game applications. Gökalp [25], also found that perceived enjoyment had a significant influence on students' behavioural intentions to use mobile games applications among students. Overall, these studies not signified the extensive use of perceived enjoyment in examining students' utilization of educational mobile games, also there is lack of scholarly attention to investigate the influence of perceived ease of use and perceived usefulness on perceived enjoyment in order to encourage students' utilization of mobile games applications. Based on that this research seeks to fill this research gap by investigating the following hypotheses:

H4: Perceived ease of use has a significant relationship with perceived enjoyment of educational smart applications.

H5: Perceived usefulness has a significant relationship with perceived enjoyment of educational smart applications.

H6: Perceived enjoyment has a significant relationship with users' intention to use of educational smart applications.

According to efficiency and effectiveness factors, some studies have found that both factors have significant and positive influence on users' utilization of technologies [26]. However, no one of current studies have examined the effect of efficiency and effectiveness on students' utilization of educational mobile game applications. Thereby, in the research model of this study, utilization of mobile educational smart applications is measured by two main constructs are effectiveness and efficiency, as shown in Figure 1. Therefore, this study proposes the following:

H8: Perceived enjoyment has a significant relationship with effectiveness of educational smart applications.

H9: Perceived enjoyment has a significant relationship with efficiency of educational smart applications.

H10: Effectiveness has a significant relationship with users' utilization of educational smart applications.

H11: Efficiency has a significant relationship with users' utilization of educational smart applications.

4 Research Methodology

4.1 Data Collection

In this research, an online questionnaire survey was employed for data collection due to the Covid-19 pandemic lockdown situation. The researchers of this study had distributed the online questionnaire via email and Google sheet for students at five universities in Saudi Arabia. These universities have already developed e-learning system and mobile learning system in their settings. Using online survey questionnaire, students were invited to participate in this study through online classes, during the summer semester 2020. The participants in this study were from different colleges.

Due to Covid-19 and its prevention face to face data collection was not possible. The questionnaire in the form of Google Sheet has been sent to the students through university lecturers. They were asked to fill the form and submit their responses if they were willing to participate in the research. The participants had not forced to participate in this research and it was clearly mentioned that if they didn't like to continue then they were not forced to submit the form. In total, 417 online questionnaires were distributed, with 399 questionnaires being returned, indicating an 95.68% response rate. Using guidelines by Sekaran [29], the target minimum sample size for the study was 384 participants. Therefore, the sample size in this research is acceptable. Most of responses had incomplete or invalid answers and therefore were excluded. Hence, 397 responses were considered valid for further analysis. Among 399 valid responses, 52.7% of respondents were female, while 47.3% were male. Moreover, 52.6% of respondents who responded were undergraduate; 47.4% were postgraduate students.

4.2 Instrument Items

The items and scales for measuring the hypotheses in the proposed research model were derived from existing prior studies. The online questionnaire included two main parts, the first part included demographic information such as gender, age and others. The second part included the variables in the research model, including enjoyment, perceived ease of use, perceived usefulness, behavioural intention to use, efficiency, effectiveness and utilization. As presented in Table 1, the items for measuring enjoyment construct was adopted from a study of mobile learning games conducted by Baek and Touati [27]. The scales of perceived ease of use, perceived usefulness and behaviouralintention to use were taken from technology acceptance model study by Davis [20]. The measurement items for efficiency, effectiveness and utilization constructs were developed from Ghapanch and Talaei-Khoei [26]. In our research, we used a 5 point scale similar to Likert scale for measuring all items, ranging from "strongly disagree = 1" to "strongly agree = 5". We requested from seven experts in the field of digital games development, each of them holding Associate Professors and Professors rank and

they have more ten years experience for testing the appropriateness and clarify of the questionnaire items before conducting the study. After that, we conducted a pilot study with 37 students from King Faisal University for testing the reliability and validity of the questionnaire items. The results indicated that questions and items were completely understood.

Table 1. Instrument items and their resources

Factors	Number of items	Sources
Perceived Enjoyment (PEJ)	4	Baek and Touati [27]
Perceived Ease of Use (PEU)	3	Davis [20]
Perceived Usefulness (PU)	3	Davis [20]
Behavioral Intention to Use (BI)	3	Davis [20]
Effectiveness (EFF)	3	Ghapanch and Talaei [26]
Efficiency (EFC)	3	Ghapanch and Talaei [26]
Utilization (UT)	3	Ghapanch and Talaei [26]

4.3 Data Analysis Method

In our research, we have employed two methods to analyze the data and evaluate the proposed hypotheses in the research model. The first method is the confirmatory factor analysis (CFA) in order to evaluate the measurement model in terms of reliability, convergent validity, and discriminant validity. In the second technique, a structural equation modelling (SEM) method was applied to test the proposed relationships value of this coefficient ranged between 0.796 and 0.917, exceeding the critical value of 0.7 as suggested by Kannan in the research model.

5 Results, Analysis and Findings

5.1 Reliability Analysis

The Cronbach's alpha analysis was employed to evaluate the reliability of items for each construct in the proposed research model. As the results summarized in Table 2 indicating satisfactory reliability for all variables in the proposed research model.

Table 2. Reliability Analysis Findings

Factors	Cronbach's alpha	Variance Extracted (AVE>0.5)
Perceived Enjoyment (PEJ)	0.887	0.796
Perceived Ease of Use (PEU)	0.865	0.801
Perceived Usefulness (PU)	0.917	0.862
Behavioral Intention to Use (BI)	0.902	0.847
Effectiveness (EFF)	0.853	0.826
Efficiency (EFC)	0.796	0.752
Utilization (UT)	0.887	0.840

5.2 Convergent and Discriminante Analysis Findings

In this study, all variables in the proposed model were evaluated using two types of validity analysis: convergent and discriminant validity. For convergent validity analysis, Table 2 shows that the average variance extracted (AVE) was above (0.5). According to Hair et al. [31], specify that a variance greater than 0.5 is acceptable. Therefore, the convergent validity values for the research constructs are acceptable. Concerning the discriminant validity analysis, the square root of AVE was obtained to correlate the latent constructs. Table 3 highlights that the square root of the AVE for each construct is greater than the pairwise correlations. This result means that the psychometric characteristics of the instrument are also deemed acceptable in terms of their discriminant validity [32].

Table 3. Findings of Discriminant Validity Analysis

	PEJ	PEU	PU	BI	EFF	EFC	UT
PEJ	**0.907**						
PEU	0.797	**0.941**					
PU	0.630	0.758	**0.953**				
BI	0.646	0.684	0.545	**0.959**			
EFF	0.759	0.769	0.563	0.689	**0.944**		
EFC	0.769	0.792	0.643	0.707	0.790	**0.982**	
UT	0.530	0.623	0.506	0.643	0.527	0.614	**0.985**

5.3 Structural Model Analysis Findings

The results of the structural model analysis indicated that 11 hypotheses were supported, as presented in Table 4. The findings indicated that that perceived ease of use have a significant and positive influence on perceived enjoyment (β-value = 0.362, p < 0.001), perceived usefulness (β -value = 0.475, p < 0.001) and behavioural intention to use (β -value = 0.325, p < 0.001), these results supporting hypotheses H1, H3 and H4. The findings also found that perceived usefulness have a significant and positive influence on students' perceived enjoyment (β -value = 0.417, p < 0.001) and their behavioural intention to use (β -value = 0.392, p < 0.001).

Table 4. Findings of SME AnalysisThus, the hypotheses H2 and H5 were supported. In addition, the results supported H6 (β -value = 0,542, p < 0.001), which indicated that perceived enjoyment have a significant and positive influence on students' behavioural intentions to use. Furthermore, the findings revealed that perceived enjoyment have a significant influence on perceived effectiveness (β - value = 0,496, p < 0.001) and perceived efficiency (β -value = 0,479, p < 0.001), this means that hypotheses H8 and H9 were supported. Finally, the findings confirmed that utilization influenced significantly and positively by behavioural intention to use (β -value = 0.527, p < 0.001), perceived effectiveness (β-value = 0,317, p < 0.001) and perceived efficiency (β -value= 0,242, p < 0.001), thus, H7, H10 and H11 were supported.

Table 4. SEM Analysis Findings

Hypotheses	(β) value	T-value	Results
H1	**0.325****	**2.994**	**Supported**
H2	**0.392****	**3.837**	**Supported**
H3	**0.475*****	**9.015**	**Supported**
H4	**0.362****	**4.023**	**Supported**
H5	**0.417*****	**5.017**	**Supported**
H6	**0.542*****	**6.042**	**Supported**
H7	**0.527*****	**5.098**	**Supported**
H8	**0.496*****	**5.357**	**Supported**
H9	**0.479*****	**5.045**	**Supported**
H10	**0.317****	**2.785**	**Supported**
H11	**0.242****	**2.435**	**Supported**

6 Discussion

According to the literature, understanding the effective factors that could enhance students' utilization of educational smart applications has considered as a crucial

step to success these applications. However, investigating these factors has received little scholarly attention. Therefore, in order to fill this gap, this study developed a conceptual model to understand the effective factors for enhancing students' utilization of educational mobile games. To attain the research objective, an empirical design with a research model was developed to investigate the role of six important factors, perceived enjoyment, perceived ease of use, perceived usefulness, behavioural intention to use, efficiency and effectiveness on students' utilization of educational mobile games. The research results indicated that the introduction of these important factors in the development process of mobile game applications had a significant and positive effect on enhancing utilization of educational smart applications among students, and thus, will increase the sustainability of learning effectively using educational smart applications.

Table 4 presents the empirical analysis results of the hypothesized relationships between the constructs in the proposed research model in Figure 1. The findings indicated that perceived ease of use had a direct significant and positive influence on perceived enjoyment, perceived usefulness and behavioural intention to use. This implies that the perceived ease of use have a significant and positive effect on students' utilization of educational mobile games significantly. The logical explanation of these results because when the educational smart applications more easier to play, use and learn and thereby exerts a positive effect on students' perceived usefulness of the game, enjoyment in playing the game, and thus enhancing their behavioural intention to use the educational smart applications. In contrast, when students face difficult games due to the lack of ease of use, this will make them to give up playing the game to learn. Moreover, ease of use factor plays an a key role in increasing the students enjoyment through helping them to tackle the challenges in the stages mobile games more easily through using some facilitations such as tips and guidelines to accomplish the mission, this will promote students' motivation to learn by educational smart applications, and thus, will increase the sustainability of learning.

The findings of this study also showed that perceived usefulness had a significant and positive influence on students' perceived enjoyment and their behavioural intention to use. This means that the perceived usefulness have a significant and positive effect on students' utilization of educational smart applications significantly. These results can be explained through that when students feel that educational smart applications will helps them to easily understand the learning materials content in a fun way, this will enhance their learning effectiveness and performance, and thus, will increase students' motivation to play it. These results are inconsistent with Huang [27] who found that students' perceived usefulness had no significant and positive influence on their behavioural intention, which might be explained that students perceive that the learning by mobile game applications more useful and fun than computer games due to unique characteristics of Smartphones. Also, it might be explained by their lack of

interest in learning by computer games that led to their ignorance of the usefulness of the games.

The results revealed that perceived enjoyment had a significant and positive influence on students' behavioural intentions to use educational smart applications. The results showed that perceived enjoyment was the most important factor in enhancing students' utilizations of educational smart applications. The main explanation for this result is that students preferred the use of educational smart applications in their learning because these applications were as entertainment tool that brought them fun and pleasure; and thus, served as the key factor that influenced their intention to use the educational smart applications. This result is agreement with a study findings of Baek and Touati [28], they found that perceived enjoyment is the key factor that determines individuals' utilization of educational smart applications.

In terms of the relationship between perceived enjoyment with perceived effectiveness and perceived efficiency, the findings revealed that perceived enjoyment had significant influence on perceived effectiveness and perceived efficiency of mobile game applications. This explains that students in this study were interested in the entertainment as an helping tool for learning, and thus perceived enjoyment is a significant factor behind enhancing students' learning effectiveness and efficiency. In addition, this factor played a significant role in their utilization of the mobile game applications. In other words, students prefer the mobile game applications as entertainment tool for enhancing their learning effectiveness and efficiency and they perceive that the usefulness of the mobile game applications for their learning process could be achieved through providing enjoyment for them through playing. This result inconsistent with a study conducted by Huang [27], who found that perceived enjoyment is not a significant factor behind enhancing students' learning effectiveness and efficiency. It might be explained this result that students did not care about the usefulness of the educational smart applications as a tool for enhancing their learning effectiveness and efficiency; they preferred the educational smart applications as entertainment tool.

Furthermore, the results revealed that effectiveness and efficiency had a significant and positive influence on students' utilization of Educational smart applications. This implies that effectiveness and efficiency have a significant and positive effect on students' utilization of Educational smart applications significantly. The logical explanation of these results because the unique features of mobile devices and applications increased students' interest for learning through the educational smart applications more than as an entertainment tool. This finding is consistent Hwang et al. [29], who mentioned that the introduction of learning strategies in educational computer games might not only improve students' learning effectiveness but also reinforce their learning efficiency. Finally, the findings indicated that the developed model in this research is able to explain 67.7% of the variance in students' utilization of Educational smart

applications. The results of this research present several recommendations to help developers and designers of Educational smart applications to promote students' utilization of Educational smart applications.

6 Conclusion

This research aimed to investigate the sustainability of educational smart applications by proposing a conceptual model to explore the essential factors that influence on students' utilization of Educational smart applications. The findings of this study present an valuable theoretical and practical recommendations for researchers, practitioners and developers about the critical factors for enhancing the utilization of Educational smart applications, which can be summarized as following: first, perceived ease of use had a direct significant and positive influence on perceived enjoyment, perceived usefulness and behavioural intention to use. This implies that the perceived ease of use have a significant and positive effect on students' utilization of Educational smart applications significantly. Second, perceived usefulness had a significant and positive influence on students' perceived enjoyment and their behavioural intention to use. This means that the perceived usefulness have a significant and positive effect on students' utilization of Educational smart applications significantly. Third, perceived enjoyment had a significant and positive influence on students' behavioural intentions to use Educational smart applications. The results showed that perceived enjoyment was the most important factor in enhancing students' utilizations of Educational smart applications. Fourth, perceived enjoyment had significant influence on perceived effectiveness and perceived efficiency of Educational smart applications. This explains that students in this study were interested in the entertainment as an helping tool for learning, and thus perceived enjoyment is a significant factor behind enhancing students' learning effectiveness and efficiency. Finally, effectiveness and efficiency had a significant and positive influence on students' utilization of Educational smart applications. The results of this research present several recommendations to help developers and designers of Educational smart applications to promote students' utilization of Educational smart applications, and thus, enhancing the sustainability of learning using Educational smart applications.

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