Student Acceptance and Attitude Towards Using 3D Virtual Learning Spaces

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Abstract. The aim of this paper is to investigate the factors influencing student's acceptance and attitude towards using 3D virtual learning spaces for education. Extended Technology Acceptance Model has been utilized as its hypothetical premise by incorporating self-efficacy and perceived enjoyment as new external variables. The model is tested through a survey administered to 85 students who took an interest in using the 3D virtual learning spaces. We conducted a regression analysis to examine the potential influence of independent variables on the acceptance and attitude towards using 3D virtual learning spaces. Our result showed that attitude towards using was the significant influence on behavior intention to use. In addition, the reconciliation of self-efficacy and perceived enjoyment are also significant antecedents to perceived ease of use and perceived usefulness. This study confirms that self-efficacy, perceived enjoyment, perceived ease of use, and perceived usefulness are important variables of acceptance and attitude towards using 3D virtual learning spaces.

Keywords: 3D virtual learning spaces · Virtual worlds · Education · TAM · Self-efficacy · Enjoyment · Universiti Teknologi Brunei · Brunei Darussalam

1 Introduction

Learning spaces are places, physical or virtual, where learning happens. Information and Communication Technologies play an important role in provides education facilities creating and facilitating 21st century learning environments such as the digital world (i.e. digital learning objects, digital learning resources, digital game-based learning and etc.), virtual worlds (i.e. virtual world learning spaces, virtual world learning games, virtual world language learning and etc.), and the physical environment (campus, lecture room, library, computer lab and etc.) accommodate to support students and educators to achieve the 21st century knowledge and skills, to empower and enable students to be deep rooted learners and dynamic members in the public eye. A virtual learning environment is a powerful and purposeful tool for teaching and learning.

Three-dimensional (3D) virtual learning spaces, offer a stimulating and new environment to improve learning for students to generate interactive learning experience. 3D virtual worlds ordinarily give three fundamental components: the deception of

S. Phon-Amnuaisuk et al. (eds.), *Computational Intelligence in Information Systems*, Advances in Intelligent Systems and Computing 532, DOI 10.1007/978-3-319-48517-1_10

3D space; avatar that serves as the visual realistic of 3D representations of users; and intelligent 3D chat environment for users to interconnect with one another.

User acceptance in the proposed study refers to investigate the factors influencing student's acceptance and attitude towards using Universiti Teknologi Brunei (UTB) 3D Virtual Learning Spaces (3DVLSs) as learning tool which make use of an 3D immersive environment such as that presented by virtual worlds for learning, analyzing the facilitation of technology use, amongst others, factors affecting the Perceived Ease Of Use (PEOU), and Perceived Usefulness (PU). The conceptual framework guiding this study was the Technology Acceptance Model (TAM). UTB 3DVLSs combines aspects of game-based learning and simulations inside the virtual worlds of *OpenSim*, designed to resemble the Universiti Teknologi Brunei phase 3 building which typically include a lecture hall, meeting rooms, and different learning spaces for presentations, and group discussion as to develop the real world and flexible learning spaces.

The next section provides with a concise overview of the literature review on virtual worlds and virtual learning spaces, technology acceptance model, and technology acceptance model and virtual worlds. Section three presents the proposed research model and hypotheses, examines six variables. Section four discussed the research methodology outlines the data collection processes. Section five describes data analysis and results. The final section delivers a conclusion and discussion about student's acceptance and attitude towards using 3D virtual learning spaces for education.

2 Literature Review

2.1 Virtual Worlds and Virtual Learning Spaces

Virtual worlds have existed since the early 1980 s, there is no for the most part acknowledged meaning of the virtual world, however they do require that the world is constant; the world must keep on existing even after a user leaves the world, and user rolled out improvements to the world ought to protect [1, 2]. In a virtual world, the user makes an "avatar", a character that signifies a user in a recreated 3D space. Avatars can travel through the virtual world, and collaborate synchronously with other user and with objects in the world. Regularly, most depend upon text-based chat tools, despite the fact that a couple manage of audio chat, to communicate with another user. 3D virtual worlds are relatively new; however, preliminary research shows that they support various types of educational resourcefulness, such as studies examine whether 3D virtual world can be used for: learning science, used in the biology course and forensic science [3], teaching 3D virtual world in the chemistry virtual classroom [4], using 3D virtual classroom simulation for teachers' continuing professional development [5], and virtual classrooms for an online and a blended course [6].

Virtual learning spaces are designed for teaching, learning, communication, program delivery, knowledge development, and content access [7]. According to [8], the two case studies which prove that Virtual Space can be a new framework for learning are the framework of English as Second Language Academic class and 3D simulation of archeological excavation site, which demonstrate general advantages of 3D virtual environment technology which can be utilized as learning apparatus by giving a virtual

learning space that (i) assists activities that are not possible in physical locations; (ii) gives users access to facilities not accessible physically; (iii) allows people in different locations to interact, and (iv) offers a assortment of observation and measurement tools for execution assessment and improvement.

The Polytechnic University of Bucharest, [4] created a virtual learning space as a 3D virtual chemistry class using EON Creator software package which offers new opportunities for teaching in immersive and creative spaces. From the experiments of the chemical virtual environment, the students can travel through a 3D space and navigate through all the 3D objects, interaction in a virtual world increases student commitment in an online class and furthermore students' feeling of group with the class. They concluded that virtual world can be compelling and creative tool for a better and more advanced educational environment.

2.2 The Technology Acceptance Model (TAM)

The research studies focused of user acceptance of new innovation of utilizing virtual world as a learning domain by applied TAM. One of the outstanding models identified with technology acceptance and use is the TAM, initially presented by Davis [9]. TAM was observed to be much less difficult, simpler to utilize, and greater powerful mannequin of determinants of user acceptance of Information System and Technology, which were found to palatable foresee an individual's expectations. TAM is initially an extension of Theory of Reasoned Action (TRA). It is based on the TRA developed by Martin Fishbein and Icek Ajzen [10], a broadly concentrated on model from social psychological science which concerned with determinants of intentionally proposed individual's voluntary behaviors.

TAM sets that PEOU is liable to impact PU, where the increase of PEOU leads to improve the performance of an activity. Subsequently, PEOU impacts PU. Both PEOU and PU predict Attitude Towards Using (ATU), the evaluation of the user desirability of using the information system and technology. ATU alongside PU impacts individual user's Behavioral Intention to Use (BIU) of the information system and technology.

Past studies have suggested TAM is a useful framework for considerate user acceptance of new information system and technology. Since 2006, many attempts to adapt the TAM in various fields were found in literature such as: [11, 12] heavily applied TAM to understand user acceptance in e-learning. On the other side, the adaption of TAM to the m-learning is found to gain increasing importance lately, as can be found in published research of [13, 14]. Then again, TAM additionally utilized as a part of blended learning [15], virtual learning environment [16, 17], the virtual world [18–21].

2.3 The Technology Acceptance Model (TAM) and Virtual Worlds

A few studies have inspected TAM as a model how people accept, adopt and utilize the virtual world, specifically at the higher education level. [18] construct and moderating variables analyzed to evaluate user acceptance and adoption of virtual worlds using *Second Life (SL)* based on TAM. Results demonstrated that community factors for

instance communication, collaboration, and cooperation unequivocally impact the PU of Virtual Worlds and it demonstrates that probability to intermingle in a 3D environment in combination with Voice over IP plays a key theatrical role in user acceptance and technology adoption of Virtual Worlds.

TAM and Media Richness Theory have been utilized as a part of the study to looking at the media richness of *SL* and effect on the user acceptance which conducted by [19]. Found that the relationships among media richness and PEOU and PU lead to the actual usage and acceptance of the *SL*, validating that these three constructs are practical and useful in understanding the virtual experience in the context of use of education in virtual worlds. The beneficial effect of media richness on user acceptance of *SL* has all the earmarks of being a huge finding of the study.

In another study by [20] were surveys undergraduate business students' intention to accept and use the virtual world *SL* for education. This study is based on TAM and extended variables that add to the acceptance or abandonment of new Information Technology. The outcomes recommend that PEOU influences user's intention to adopt *SL* through PU and the "fun factor" is also specified which describes that the computer playfulness and computer self-efficacy is significantly related to acceptance and use of virtual worlds.

3 Research Model and Hypotheses

Base on TAM and extended TAM theories, the research model analyzes 6 variables: Self-Efficacy (SE), Perceived Enjoyment (PE), Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude towards Using (ATU), and Behavioral Intention to Use (BIU) to determine students' acceptance and attitude towards using 3DVLSs. The original TAM incorporated additional variables to produce extended TAM. SE and PE are the new or extended variables added to the TAM model to fit this study. Figure 1 portrays the research model utilized in this study.

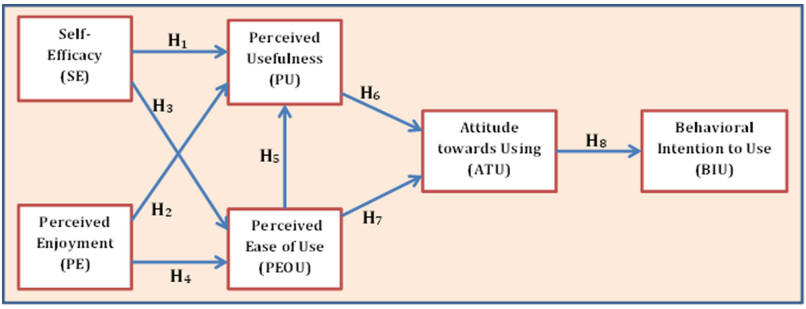

Fig. 1. The research model

There are eight hypotheses in this study. The hypotheses were formed according to the extended TAM that proposed as below:

Hypothesis 1: SE of 3DVLSs will have a significant influence on PU.

Hypothesis 3: SE of 3DVLSs will have a significant influence on PEOU.

SE refers to "the degree to which a person perceived his or her ability to perform a system specific computer related task" [22]. The four measurement items utilized and adjusted from [20, 23] are: I could complete the task using the 3DVLSs if there is no one around to tell me what to do as I go (SE1), I could complete the task using the 3DVLSs if I had never used a package like it before (SE2), I could complete the task using the 3DVLSs if I had only the software manuals for reference (SE3), I could complete the task using the 3DVLSs if I had seen someone else using it before trying it myself (SE4).

Hypothesis 2: PE of 3DVLSs will have a significant influence on PU.

Hypothesis 4: PE of 3DVLSs will have a significant influence on PEOU.

PE refers to "the degree to which performing an activity is perceived as providing pleasure or joy in its own right, aside from performance consequences" [23]. PE attempted to measure the degree to which users perceived their interaction with 3DVLSs to be enjoyable. Four measurement items used and revised from [17, 21, 23] are: Using the 3DVLSs makes learning more enjoyable (PE1), Using the 3DVLSs was pleasant (PE2), Using the 3DVLSs was an interesting experience (PE3), Overall, I found learning using the 3DVLSs is fun (PE4).

Hypothesis 5: PEOU of 3DVLSs will have a significant influence on PU.

Hypothesis 7: PEOU of 3DVLSs will have a significant influence on ATU.

PEOU refers to "the degree to which a person believes that using a particular system would be free of effort" [22]. Seven measurement items were applied and adapted from [9, 15, 16, 18–20, 23] are: Learning to operate 3D virtual learning spaces would be easy for me (PEOU1), I found it easy to get 3D virtual learning spaces to do what I want to do (PEOU2), My interaction with 3D virtual learning spaces was clear and understandable (PEOU3), 3D virtual learning spaces are flexible to interact with (PEOU4), It's easy for me to become skillful at using 3D virtual learning spaces (PEOU5), It's easy to play the role of the avatar (PEOU6), Overall, I believe 3D virtual learning spaces easy to use (PEOU7).

Hypothesis 6: PU of 3DVLSs will have a significant influence on ATU.

PU refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" [22]. Eight measurement items were applied and adapted from [9, 12, 15, 16, 18–20, 23] are: Using 3DVLSs enables me to accomplish my tasks in the coursework more quickly(PU1), Using 3DVLSs would improve my coursework performance (PU2), Using 3DVLSs would increase my productivity in my course work (PU3), Using 3DVLSs would enhance my effectiveness in learning (PU4), Using 3DVLSs improves my communication with my colleagues (PU5), Using 3DVLSs improves my collaboration with my colleagues (PU6),

Using 3DVLSs improves my cooperation with my colleagues (PU7), Overall, I found 3DVLSs useful in my course work (PU8).

Hypothesis 8: ATU of 3DVLSs will have a significant influence on BIU.

ATU refers to "the degree to which a person associated positive feelings with target system" [22]. Four measurement items were applied and adapted from [12, 18] are: 3DVLSs make learning more interesting (ATU1), 3DVLSs motivate learning (ATU2), I have a positive attitude toward using 3D virtual learning spaces (ATU3), Overall, I believe using 3DVLSs would be a good idea (ATU4).

BIU denotes "the degree to which a person has formulated conscious plans to perform or not to perform some specified future behaviors" [22]. Four measurement items were applied and adapted from [12, 15, 19, 20, 23] are: Assuming I had access to 3DVLSs, I intend to use it (BIU1), Given that I had access to 3DVLSs, I predict that I would use it (BIU2), I am going to positively utilize 3DVLSs (BIU3), I intent to use 3DVLSs frequently in future (BIU4).

4 Research Methodology

4.1 Data Collection and Procedure

Data were collected from a random sampling of around 85 students toward the end of the academic year (April and May 2016). The surveys were given to selected post-graduate and undergraduate students studying full time which enrolled in Computing, Business, and Engineering Courses.

The course conducted using UTB 3DVLSs platform to enhance technology use, acceptance, and experience. During the testing session the participating students are guided to explore the UTB 3DVLSs divided into four sessions; demonstration, hands-on, task-oriented, and questionnaires session. In the demonstration session (Fig. 2), all participants were briefly explained about the nature of the UTB 3DVLSs. Then, in brief hands-on they simply followed the instruction and played around with the UTB 3DVLSs. In task-oriented interaction session (Fig. 3), a list of tasks was given where the respondents were required to complete. After that, the respondents were asked to answer questionnaires that also included in the UTB 3DVLSs.

Fig. 2. Demonstration session

Fig. 3. Task-oriented interaction session

4.2 Instrumentation

The survey instrument was developed and designed in two parts. Part 1 contained personal information and part 2 captured the questionnaire, using a seven-point Likert-style scale ranging from "strongly disagree" (1) to "strongly agree" (7) which consists of 31 items for measuring the SE, PE, PEOU, PU, ATU and BIU. Questionnaire items were broadly utilized as a part of previous research identified with TAM; be that as it may, the questions were changed to fit the particular setting of the current research.

5 Results

5.1 Background Profile

The background data of participating students has been outlined in Table 1. Table 1 defines the characteristics of students. The majority are males within the age group of 21 to 30 years (78%).

The data was collected from the 85 students and analyzed through SPSS. At that point, the basic model was surveyed, giving results for hypothesis testing. The extended TAM hypotheses were affirmed by conducting the validity and reliability tests, presenting descriptive statistics of the research variables, then carry out the regression analyses and correlation analyses.

5.2 Validity and Reliability

In order to ensure the quality of the survey data, the validity and reliability tests were employed, two metrics are used: average variance extracted and composite reliability.

A Cronbach Alpha was conducted to determine the reliability for each construct variable. The overall Cronbach Alpha for all items is 0.96. It changes for corresponding construct variables somewhere around 0.77 and 0.90. [24] give the accompanying dependable guidelines: ">0 .9 – Excellent, >0.8 – Good, >0.7 – Acceptable, >0.6 – Questionable, >0.5 – Poor, and <0.5 – Unacceptable" (p. 231). As showed in Table 2, the estimation of all our variables exceed the minimum value of 0.70, propose that 0.5 to be a valid estimation of component, above 0.5 demonstrates a good convergent [25], which was significantly above the 0.70 level, indicating the reliability of the instrument.

Additionally, a validity test was performed using factor analysis. All constructs in the model satisfactorily pass the test; the variance is greater than 50%. Factor analysis shows the total no. of variance is greater than 50%, which is 73.5%. Thus, it was determined that this instrument had achieved acceptable levels of validity.

Construct validity of more than 0.50 and composite reliability of 0.70 or above are deemed acceptable. Therefore, its show that strong empirical support for the validity and reliability of the construct variables used in the research model. The study demonstrated that extended TAM is valid, reliable, and fit to assess the acceptance of the users of 3DVLSs processes. The accompanying Table 2 outlines the construct variables and number of basic measurement items, Cronbach Alpha and the Mean value and Variance.

Table 1. Profile of the respondents

Item	Variable	Description	Frequency	Percentage
1	Gender	Male	45	53%
		Female	40	47%
2	Age	20 or Under	4	5%
		21 to 30	66	78%
		31 or above	15	18%
3	Education level	Undergraduate (Degree)	71	84%
		Postgraduate (Masters)	14	16%
4	Faculty	Computing	48	56%
		Engineering	26	31%
		Business	11	13%
5	Internet experience	Less than 5 years	7	8%
		6 to 10 years	44	52%
		More than 11 years	34	40%
6	3D virtual experience	None	7	8%
		Less than 3 years	46	54%
		4 to 7 years	23	27%
		More than 8 years	9	11%
7	To what extent using 3D Virtual	Not at all	7	8%
		Very little	31	36%
		Average	29	34%
		More than average	5	6%
		Very much	13	15%
8	Speed of current internet	Very slow	6	7%
		Slow	28	33%
		Acceptable	33	39%
		Good	17	20%
		Excellent	1	1%

Table 2. Descriptive statistics of the constructs

Variable	No. of measurement items	Cronbach alpha	Mean	Variance
SE	4 items	0.77	5.08	0.80
PE	4 items	0.83	5.93	0.72
PEOU	7 items	0.84	5.26	0.68
PU	8 items	0.92	5.10	0.87
ATU	4 items	0.89	5.85	0.86
BIU	4 items	0.90	5.62	0.88
Overall	31 items	0.96		

5.3 Hypothesis Testing: Regression Analysis

To test the hypotheses, we conducted linear regression analysis in which the BIU was set as dependent variable. ATU explains 73% of the variance in BIU ($R^2 = 0.730$). PEOU and PU combined to explain 46% of the variance in ATU ($R^2 = 0.460$). SE and PE combined to explain 50% of the variance in PEOU ($R^2 = 0.504$). SE and PE combined to explain 47% of the variance in PU ($R^2 = 0.471$). The model (73%) has a strong prediction value and good parsimony as shown in Fig. 4 below.

All of the beta coefficients are significant at p<0.01 level. ATU is a strong antecedent to BIU with a beta coefficient of 0.88 supports H8. PEOU has a higher beta coefficient to ATU (0.54) than PU to ATU (0.32), supports H7 and H6. PEOU also has a high beta coefficient to PU (0.82), supports H5. PE has a high beta coefficient to PEOU (0.45) than SE to PEOU (0.20), supports H4 and H3. Additionally, SE has a higher beta coefficient

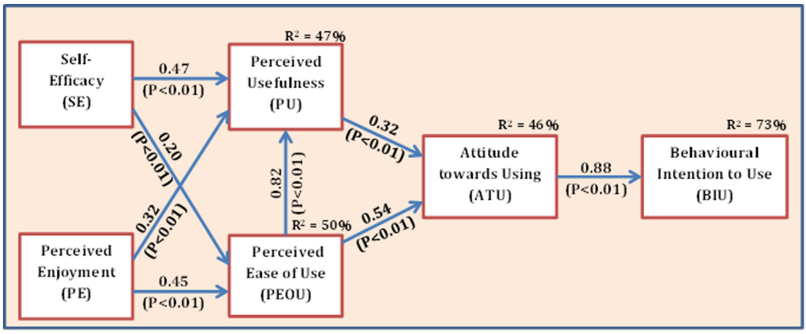

Fig. 4. The structural model results

Table 3. The summary of hypothesized results

H#	Path		R^2	Path coefficient	*t*-value	Results of hypotheses
	From	To				
H1	SE →	PU		0.471	4.385	Supported (P<0.01)
H2	PE →	PU		0.318	2.662	Supported (P<0.01)
H3	SE →	PEOU		0.202	3.925	Supported (P<0.01)
H4	PE →	PEOU		0.451	5.462	Supported (P<0.01)
H5	PEOU →	PU		0.823	7.672	Supported (P<0.01)
H6	PU →	ATU		0.320	3.042	Supported (P<0.01)
H7	PEOU →	ATU		0.538	3.999	Supported (P<0.01)
H8	ATU →	BIU		0.876	14.997	Supported (P<0.01)
	PU		47%			
	PEOU		50%			
	ATU		46%			
	BIU		73%			

to PU (0.47) than PE to PU (0.32) found that SE and PE have a significant positive influence on PU of 3D virtual learning spaces, supporting H1 and H2.

Correlation analyses showed that all the construct variable; SE, PE, PEOU, PU, and ATU had a high correlation among one another ($p<0.01$) as shown in Table 3. All eight hypotheses are supported. All the construct variables are statistically significant at 1% level of significance as the p value corresponding to all the construct variables are less than 0.01. Hence H1, H2, H3, H4, H5, H6, H7, and H8 are accepted.

6 Discussion and Conclusion

This study attempts to investigate the factors influencing student's acceptance and attitude towards using 3D virtual learning spaces for education. With survey data from 85 students, the research model with 6 variables were proposed and investigated. Overall the model clarified 73% of the variance in behavioral intention to use. The results supported the causal path from perceived ease of use to perceived usefulness, from perceived ease of use to attitude towards using, from perceived usefulness to attitude towards using, and from the attitude towards using to behavioral intention to use. Two significant antecedents to perceived ease of use and perceived usefulness were found: Self-Efficacy and Perceived Enjoyment.

The study revealed that Technology Acceptance Model construct: attitude towards using (ATU) was the most significant predictors of behavioral intention to use (BIU) with significant beta coefficient (0.88) demonstrating that students have a positive attitude towards using 3D virtual learning spaces, can influence their behavioral intention to use 3D virtual learning spaces as a learning tool. These findings are consistent with the literature [12–15].

Then again, perceived ease of use was influential in making its effect on perceived usefulness and attitude towards using, consistent with [12, 15]. The positive influence of perceived ease of use suggests that students discovered 3D virtual learning spaces simple to utilize, so they thought that it was more useful and they ought to have a positive attitude towards using the 3D virtual learning spaces. Perceived usefulness has reliably been significant antecedent in anticipating user's attitude towards using, were found similar to those of [12–15]. When students agreed that 3D virtual learning spaces represent useful environment for learning i.e. improve and increase productivity in coursework and enhance effectiveness in learning, this means that perceived usefulness has a positive influence on students attitude towards using of 3D virtual learning spaces.

The literature review led us to develop an extended Technology Acceptance Model incorporated two new constructs applicable to the understanding of student's acceptance and attitude towards using 3D virtual learning spaces for education: Self-Efficacy and Perceived Enjoyment. An appropriate consideration of these two constructs can increase student's perceived ease of use and perceived usefulness, thereby forming a more positive attitude and intention to use the 3D virtual learning spaces. The presence of self-efficacy and perceived enjoyment are as expected, play a significant role in determining student's behavior, by means increase student's ability and interactivity,

where students feel more confident and enjoyable of accepting and using towards the 3D virtual learning spaces.

Student's self-efficacy in virtual world learning can play a major role, ability to accomplish actions effect on usage and a high degree of effort effect easy to use, findings revealed that self-efficacy is a significant predictor for both perceived ease of use and perceived usefulness [11, 12]. Enjoyment also an important factor of virtual world's usage, considered that technology for fun denotes the extent to believe participating in 3D virtual learning spaces is enjoyable and high impact on how easy the student perceived the 3D virtual learning spaces can be used, findings revealed that perceived enjoyment is a significant predictor for both perceived ease of use and perceived usefulness [17, 21]. Our findings specify that "user's confidence" and the 'enjoyment factor" in technology use are significantly related to acceptance and attitude towards using the 3D virtual learning spaces for education.

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