Identifying Factors Affecting Acceptance of Virtual Reality in Classrooms Based on Technology Acceptance Model (TAM)

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ABSTRACT

Technology Acceptance Model (TAM) has received great recognition through the various research conducted on determining users' acceptance of relevant technology innovation. Past researches have focused on technology innovation in education such as e-learning, Learning Management Systems and online applications. The 21st century teaching and learning framework has identified the relevance of the Internet of Things (IoT) and online applications as part of the teaching and learning process. Besides e-learning, MOOCs, Virtual and Augmented Reality have also found their place in the emerging teaching and learning platforms. As Virtual Reality only became popularized in classrooms in the recent years, not much is known about users' acceptance of this technology innovation in the classroom. This paper, which is based on the TAM, attempted to identify the factors that could affect the respondents' acceptance of Virtual Reality (VR) in classrooms. Factors on the perceived ease of use (PEoU) and perceived usefulness (PU) affecting the respondents' attitude and intention to use VR in their classrooms were studied. Employing a quantitative research design, a set of questionnaire based on constructs adapted by Davis (1989) and adapted from past researches (Ngai et al, 2005; Weng et al, 2018, Muhamad Sufi, 2019) was distributed to a group of in-service teachers who were pursuing their postgraduate studies in one of the faculties in Universiti Teknologi MARA. The data was analyzed using SPSS in determining the relationships between the independent variables and the dependent variables. The analysis has further confirmed past research findings. However, in the context of VR, some suggestions to improve current practice are suggested. Policymakers and decision-makers could be enlightened by the present study's findings. Likewise, teachers may find VR a more convincing platform to be integrated in their classrooms.

INTRODUCTION

The 21st century has witnessed massive transformation in the delivery of education. Within this century alone, several generational concepts have played important roles in determining how education should be approached. From the Industrial Age and later to the Information Age, educators nowadays are faced with the challenges of the Experience Age. According to Wadhera (2016), one crucial aspect of the Experience Age is that 92% of the teenagers are online daily. As claimed by Hu-Au and Lee (2017, p. 216), teenagers spend most of their time online by "either playing games, live streaming their memorable experiences, sharing ephemeral moments on Snapchat, or posting pictures of exciting daily occurrences on Instagram".

Interestingly, living in the Experience Age, students nowadays are avid users of interconnected mobile devices as well as gaming and social networking software. The ubiquity of such devices and software has enabled them to experience and share new points of views (ibid.) by living in the virtual world. In catering to the present students' learning needs, educators are quick at finding alternatives in their teaching materials and activities. Knowledge transmission methods such as classroom lecture could lead to passive and disengaged learners (Capps and Crawford, 2013). On the other hand, attempting to include or integrate authentic, meaningful learning contexts may seem difficult due to logistics reasons (Hill and Smith, 2005). Hence, in addressing those issues, educators nowadays are given the opportunity to provide the best in their teaching delivery through Virtual Reality (VR) technology.

VR is defined as immersive, realistic, three-dimensional environments involving visual feedback from body movement (Aarseth, 2001). According to market researchers such as Boyle (2016), VR technology would become one of the most disruptive and influential industries by 2035. Currently, VR industry has already made its way in many sectors such as medical, astronomy and anthropology. Soon, VR technology would become a common platform for immersive, engaging experiences in other sectors such as shopping, entertainment, training and education (Hu-Au and Lee, 2017).

Anticipating a bright future for VR technology in the Malaysian education system, the present study was conducted to determine the acceptance of VR in the classrooms among in-service teachers who were pursuing their Education Master degree in one of the public universities in Malaysia. Technically, the in-service teachers had been exposed to what VR is and how VR could be integrated during lessons through some of the courses they took in their Master in Education programme. As VR has yet to become a common platform in Malaysian schools, the present study is seen as timely. This is especially so since the Minister of Education had recently launched the 21st century Teaching and Learning Framework which among others has put an emphasis on the 21st century education delivery using the IoT such as VR. The following are the research questions, which guided the data collection and analysis.

RQ1. How much variance of Perceived Usefulness (PU) of VR in the classroom can be explained by Perceived Ease of Use (PEoU) of VR in the classroom?

RQ2. How much variance of Attitude towards VR in the classroom (ATT) can be explained by Perceived Ease of Use (PEoU) and Perceived Usefulness (PU) of VR in the classroom?

RQ3. How much variance of Intention to use VR in the classroom (INT) can be explained by Perceived Usefulness (PU) of VR and Attitude (ATT) towards VR?

LITERATURE REVIEW

Virtual Reality (VR)

The advancement of technology and the Internet of Things (IoT) have seen rapid developments in education technology, one of which is Virtual Reality (VR). A simple definition of VR is as given by Kirner (2012) who claims that virtual reality is a computer interface that permits the user to interact in real time, in a tridimensional space generated by a computer, using their feelings, through special devices.

VR has become an attractive platform for various gaming, entertainment and medical industries. Unlike the technology before its time, VR offers a more realistic and meaningful experience through simulations. In simple terms, VR offers immersive and interactive experiences based on graphic images in 3D generated in real time by computer. According to Pinho (2004), VR can be categorized by three basic principles; a) immersion, in which users have real sensation of being inside the virtual world through devices such as digital helmet or digital cave; b) interaction, whereby users can manipulate virtual objects through devices such as digital gloves; and c) involvement, in which users are able to explore the virtual world by means of taking part in the virtual world, interfering directly in result of the application, and navigate the virtual environment either passively or actively.

The application of VR in education has begun to attract many researchers. For a start, VR is relevant with the students nowadays, who are millennials. Among the many traits of millennials is the fact that they spend most of their time online and some literally live in virtual world (Howe and Strauss, 2000; Wadhera, 2016; Boyle, 2016; Hu-Au and Lee, 2017). Clark (2006) for instance has confirmed that VR could benefit the teaching and learning process in many ways. According to Clark (2006), VR could make learning more interesting and fun, which could indirectly increase students' motivation and attention. Additionally, VR enables teachers to bring into the classroom contexts and environments, which are impossible to be explored or have in the real classroom.

21$_{st}$ century teaching and learning

Wadhera (2016) has stated the importance of educators to acknowledge the learning needs of the students nowadays who are living in the Experience Age. As the students spend most of their time online and are avid users of interconnected mobile devices, teachers need to consider having teaching materials and learning activities with similar attributes. Kong et al (2014) claim that 21$_{st}$ century teaching and learning will need to include out of the classroom context in maximizing students' potential in real meaningful learning. Experiencing real-world situations and environments is the way forward in the 21$_{st}$ century teaching and learning delivery. Scott (2015) has proposed specific pedagogies among which include the integrating of technology in lessons,

promoting learning without borders, employing appropriate learning tools and engaging and motivating the learners.

The P21 framework has illustrated specific skills, knowledge and expertise students need in surviving the 21st century industry demands. The three essential skills are life and career skills, learning and innovation skills, and information, media and technology skills. Thus, in meeting the needs of the 21st century learners' learning needs and in catering the 21st century framework, it is crucial educators are aware of the existing technology which could turn their classes into the 21st century classroom. Massive Open Online Courses (MOOCs), blended learning and e-learning are some examples of the 21st century education contexts. However, when dealing with the teaching and learning process, it is the class activities that mark a lesson as having the 21st century attributes. Integrating VR in a lesson is an example where 21st century teaching and learning activities could take place.

Technology Acceptance Model (TAM)
Technology Acceptance Model or TAM was developed based on Davis's et al (1989) constructs. It was specifically designed to explain and predict user acceptance of specific types of technology. According to Ngai et al (2005), TAM was built on collective findings suggesting that the desired technology was greatly dependent on user acceptance of technology. Additionally, TAM suggested that perceived usefulness and perceived ease of use were important factors in determining the use of information systems.

Since its development, TAM has received attention from various researchers (Ngai et al, 2005; Weng et al, 2018; Muhamad Amin, S.S, 2019). The various researches conducted have indicated that TAM has been widely used and verified. According to Davis (1989), there are two factors namely perceived ease of use (PEoU) and perceived usefulness (PU) that could influence users' attitude and later intention in using the technology innovation. The following are the definitions of the variables involved in TAM according to Davis (1989).

Davis defines perceived usefulness as the prospective user's subjective probability that using a specific application system will enhance his or her job or life performance. Perceive ease of use (EOU) on the other hand, is defined as the degree to which the prospective user expects the target system to be free of effort. In defining attitude, Davis states that is concerned with users' evaluation of the desirability of employing a particular information system application. Finally, intention is defined as the measure of the likelihood of a person employing the application. Figure 1 illustrates TAM as it is used in the present study.
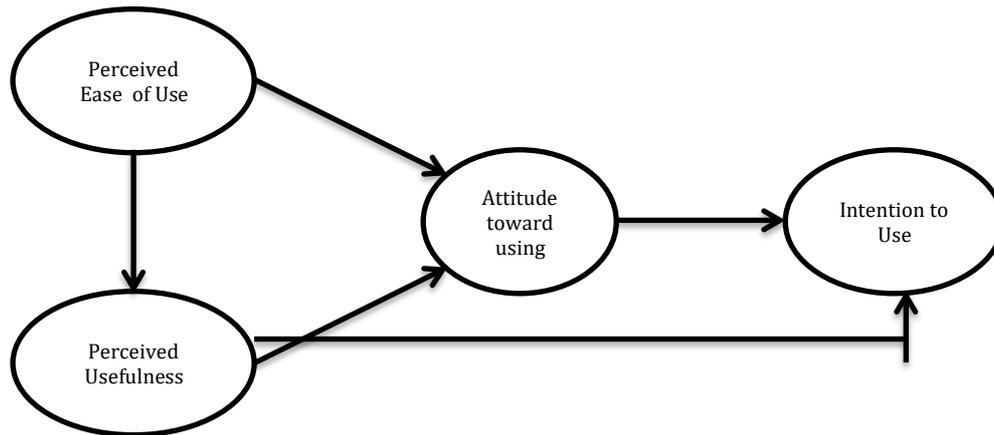
Figure 1 Technology Acceptance Model (TAM) for VR in the classroom

METHODOLOGY

The present study employed a quantitative research design. A set of questionnaire based on Davis's constructs (1989) and adapted from past researches such as Ngai et al (2005), Weng et al (2018) and Muhamad Sufi (2019) was distributed to a group of in-service teachers who were pursuing their Education Master's degree programme in one of the public universities in Malaysia. As the total student population was 202, a sample size comprising of 98 respondents (48.5%) was seen as acceptable.

The questionnaire consisted of two sections; Section A on demographic profile while Section B on the perceptions of the respondents on the Ease of Use (5 items), Usefulness (5 items), Attitude (5 items) and Intention (5 items). All the items were on a scale of 1 (Strongly disagree) to 5 (Strongly agree). Based on the theory of TAM, all variables affecting the acceptance of VR in classroom were investigated. Cronbach alpha was employed to determine the reliability. The following table summarizes the Cronbach alpha values for each construct. As the values are between 0.849 and 0.921, high reliability of each construct is indicated.

Table 1 Reliability analysis of each constructs

	Cronbach's Alpha	N of Items
Perceived usefulness	.864	5
Perceived ease of use	.887	5
Attitudes in using AR	.921	5
Behavioural intention	.849	5

Regression analysis was conducted to determine the relationship between the independent variables and dependent variables and explore the forms of those relationships. The findings based on the regression analysis were referred to in finding answers to the research questions.

RESULTS AND DISCUSSIONS

A total of 69 (70.4%) out of 98 respondents were female. In terms of their minimum teaching qualifications, 66.3% possess Bachelor's in Education, 5.1% has Diploma in Education, 4.1% has Teaching Certificate, while 24.5% of them has none. The respondents were teachers of various subjects such as English Language (42.9%), Math (30.6%) and Visual Art (26.5%). More than half of the respondents (63.3%) were teaching in public schools while 36.7% of them were teaching in private schools. Majority of the respondents (67.3%) had less than 5 years of teaching experience while the rest (32.7%) had between 5 and 10 years of teaching experience.

The following discussions are based on the research questions set as follows;

a) How much variance of Perceived Usefulness (PU) of VR in the classroom can be explained by Perceived Ease of Use (PEoU) of VR in the classroom?

The influence of PEoU on PU is as shown in the following table. In testing the goodness of fit, the PEoU would be able to elucidate the R^2 value of 0.391 of PU (i.e. capability of explanation of 39.1%). As the t value was positive, there is an indication that the PU was significantly and proportionally affected by the PEoU. The coefficient value is 0.625 suggesting that increasing PEoU by one unit, the PU will increase by 0.625 units. Table 2 below summarizes the statistical significance of the estimated parameters.

Table 2 Coefficients[a] of perceived ease of use

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.520	.220		11.434	.000
	PEoU	.467	.060	.625	7.845	.000

a. Dependent Variable: PU

b) How much variance of Attitude towards VR in the classroom (ATT) can be explained by Perceived Ease of Use (PEoU) and Perceived Usefulness (PU) of VR in the classroom?

Table 3 signifies the influence among PEoU, PU of VR on ATT towards VR in the classroom. In the testing of goodness of fit, both PEoU and PU would be able to elucidate the R^2 value of 0.572 (i.e. capability of explanation at 57.2%) of ATT. Likewise, as the t values are positive, it is safe to conclude that attitude towards VR in the classroom was significantly and proportionally affected by the independent variables. The standardized regression equation for attitude is 0.127 and 0.670 for PEoU and PU respectively. However, as the p-value (0.143) for PEoU is bigger than 0.05, it is deduced that while PU has a significant influence on ATT (0.670), there is no significant influence of PEoU (0.127) on ATT.

Table 3 Coefficients$_a$ of PEoU and PU

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.300	.278		4.681	.000
	PEoU	.092	.063	.127	1.476	.143
	PU	.652	.084	.670	7.790	.000

a. Dependent Variable: ATT

c) How much variance of Intention to use VR in the classroom (INT) can be explained by Perceived Usefulness (PU) of VR and Attitude (ATT) towards VR?

As could be derived from Table 4 below, in the testing of goodness of fit both PU and ATT would be able to elucidate the R_2 value of 0.469 of INT (i.e. capability of explanation of 46.9%). Similarly, as the t values are positive, there is a significant and proportionate affect by both PU and ATT on INT. The standardized regression equation is INT equals to 0.414 ATT and 0.317 PU. Both ATT and PU have significance influence on INT. Most importantly, ATT has stronger effects on INT (0.414) compared to PU (0.317). The statistical significance of the estimated parameters is summarized in Table 4.

Table 4 Coefficients$_a$ of PU and ATT

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.872	.369		2.362	.020
	PU	.332	.118	.317	2.807	.006
	ATT	.446	.122	.414	3.667	.000

a. Dependent Variable: INT

Figure 2 below summarizes the salient findings to all three research questions. The salient findings are as listed below. It is discovered that,

i. PEoU could affect PU (0.625).
ii. PEoU (0.127) has no significant influence on ATT (p-value > 0.05)
iii. PU (0.670) could affect ATT ($R_2 = 0.572$)
iv. Both PU and ATT could affect INT ($R_2 = 0.469$)
v. ATT (0.414) has stronger effects on INT than PU (0.391)

Perceived ease of use

.127

R2=.572

Attitude toward using

.414

R2=.469

.625

.670
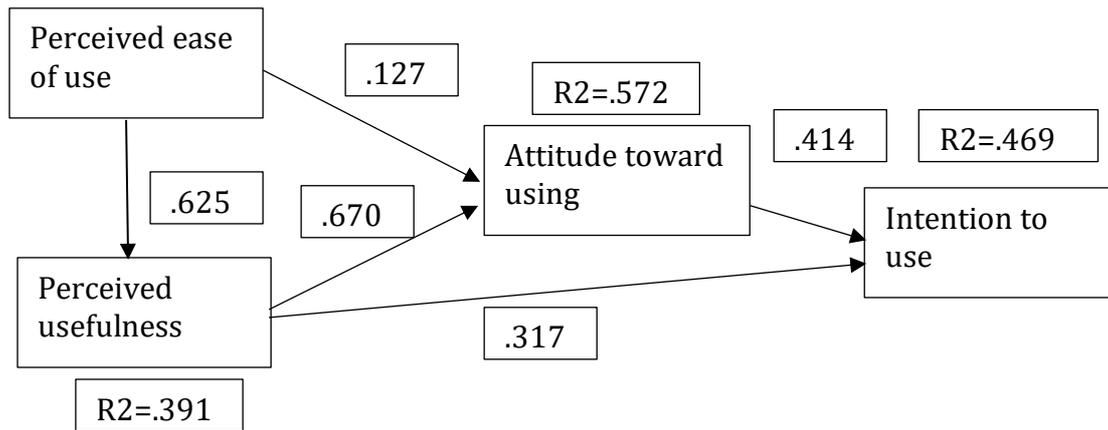
Intention to use

Perceived usefulness

.317

R2=.391

Figure 2 Summary of the coefficients[a]

CONCLUSION

At the onset of the present study, the acceptance towards VR in the classroom was the main purpose. Adopting TAM, a set of questionnaires adapted from past researches was distributed to a total of 98 respondents who were in-service teachers pursuing their Education Master's degree in one of the public universities in Malaysia. In addressing the need to embrace the 21st century Teaching and Learning Framework, which was launched recently by the Minister of Education, the present study was seen as timely. The analysis has yielded interesting findings. As the majority of the respondents were those with less than 5 years of teaching experience and possessed Bachelor of Education, it is safe to assume that they are the millennials. Being millennials, the internet and online technology are their norm. Hence, it is easy to accept why their perceived ease of use (PEoU) did not have significant influence on their attitude towards VR in the classroom. VR could be a familiar online platform to the respondents. However, it must be emphasized that their perceived usefulness (PU) of VR in the classroom has significant influence on their attitude (ATT) and intention (INT) to use VR in the classroom. Their attitude (ATT) has stronger influence on their intention (INT) to use VR in the classroom than their perceived usefulness (PU). Interestingly though, their perceived usefulness (PU) could influence their attitude (ATT).

To this end, it is concluded that in encouraging productive use of VR in the classroom, teachers need to have the relevant attitude towards VR. In order to have the relevant attitude, teachers need to have relevant perceptions of the VR usefulness in the classroom. Based on these conclusions, several implications could be derived. Firstly, the Ministry could expose teachers to the benefits of having VR in the classroom. This could be done through sharing sessions of VR best practices. Additionally, hands-on trainings on sample lessons on integrating VR in lesson developments could be conducted. Such exposure and hands-on trainings could encourage teachers' overall perceptions of the usefulness of VR in the classroom, which in turn could influence their attitude and intention of using VR in the classroom. On the part of the school administration, relevant technical support needs to be provided in assisting teachers' effort in using VR in the classroom. Certain investment on the equipment and

subscriptions to online VR materials could encourage active lessons integrated with VR.

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