STUDENT ACCEPTANCE IN AUGMENTED REALITY COMPUTER HARDWARE LEARNING MEDIA

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Abstract: Augmented Reality (AR) application has been widely used for educational purposes. This study introduced AR in computer hardware (ARCH) learning media. ARCH is an application prototype which helps student identify computer hardware devices. It was important to measure student acceptance to evaluate attitude toward using and intention to use the application. Student acceptance would be measured using Technology Acceptance Model (TAM) approach. The constructs involved were perceived usefulness, perceived ease of use, perceived enjoyment, attitude toward using and intention to use. The purpose of this study was to investigate the most significant factors that affect attitude toward using and intention to use ARCH system. The methods consisted of collecting data in the questionnaire form, converted the data result into 5-point range Likert scale, reliability, and correlation test and delivered regression analysis test. The results showed that perceived ease of use was the most significant factor in regards to attitude toward using, and perceived enjoyment was the most affecting factor in regards to intention to use the ARCH system.

Keywords: *Augmented Reality, Computer Hardware, Acceptance Model, Attitude Toward Using, Intention To Use*

1. INTRODUCTION

Augmented Reality (AR) is a technology when virtual objects added in reality world. It allows users to interact with virtual objects, generally in 3d form, in real time (Sumadio and Rambli, 2010). Azuma (1997, cited in Santos, et al., 2014) explained AR to be when there is an integration of 3d virtual objects into the 3d real environment and it happens in real time. There are many fields that could use the advantages of using AR, such as advertising, entertainment, maintenance and repair, medical application, etc (Carmigniani, et al., 2011). Van Krevelen and Poelman (2010) stated that the first system of AR is indeed focused on industrial, military and medical applications purposes, but shortly thereafter was also used for entertainment and commercial, including in education.

Education is one among many fields that have benefited from the use of AR system. Sumadio and Rambli (2010) stated that there was a high possibility that traditional learning methods could be improved when AR used in education. With virtual and augmented reality, researchers have suggested that learners can increase their motivation to learn and improve their realism-based education practices (Chang, Morreale and Medicherla, 2010). AR has been applied to learning biology, chemistry, mathematics, physics and other subjects in the classroom. AR also used for both higher education such as colleges and universities because of its efficiency (Lee, 2012).

One of many studies of implementing AR as a learning media in higher education was conducted by Mustika, et al. (2015). The research produced a prototype of AR in computer hardware (ARCH) as an interactive learning media. The ARCH would be used as a tool to help students learn about computer hardware. The objective of this study was to measure acceptance of the student when learning using ARCH system. The study would investigate the factors which affected the attitude toward using and intention to use on ARCH system using Technology Acceptance Model (TAM).

TAM was proposed by Davis in 1996 (cited in Chang, et al., 2011) and it used to explain how the user's response in accepting new technologies (Yusoff, et al., 2011). It is important to understand users' acceptance because it determines the success or failure of a system (Goldiez and Livingston, 2004 cited in Yusoff, et al., 2011). Thus, it is important to measure the acceptance of the student when learning computer hardware using ARCH before it used as a learning media in the classroom.

2. THEORETICAL BACKGROUND

2.1 Augmented Reality (AR) Technology

AR is a technology which combining real and virtual objects in the real environment and real time, aligning them with each other and running them in three-dimensional interactively. (Azuma, 1997 cited in Van Krevelen and Poelman, 2010). AR is not limited to specific technologies such as the use of head-mounted display nor to the sense of sight, because it could potentially be applicable to all the senses, including smell, hearing, and touch (Van Krevelen and Poelman, 2010). Supported by the rapid development of technology, the concept of AR could be expanded so that more devices can be used to create an augmented reality application, such as mobile AR and GPS-based AR (Wu, et al., 2013).

There are more fields that can benefit by utilizing the AR technology, including in education field. There were many researchers suggested that AR technology can be used for education purposes because of its features and affordances. According to Wu, et al. (2013), AR could bring learning content in three dimensions, allow interactive and collaborative learning anywhere, stimulate the senses of learners, visualize invisible objects, and as a bridge technology between formal and informal learning. El Sayed, Zayed and Sharawy (2010) suggested, utilizing the AR technology as a medium of teaching in schools could improve visualization capabilities for students, and also would lower the cost of education. AR could enhance the interest of students to take part in the learning, creates chances that encourage a deeper understanding, and makes it possible to become a student-centered learning (Antonioli, Blake and Sparks, 2014).

2.2 Technology Acceptance Model (TAM)

TAM is generally used to explain how a company and individual responses and adapts to a new technology (Chen, Q., Chen, H.M., and Kazman, R., cited in Huang and Liao, 2014). TAM theory is based on Theory of Reasoned Action adopted from Fishbein and Ajzen (1975, cited in Dalbouh, 2013) relating to a person's behavior or habits. The TAM suggested that willingness to accept and adopt new technologies is determined directly by the attitude, usability and ease of use. According to TAM, a person's intention to use technology determines application usage and attitudes toward technology affect such intention (Venkatesh et al., 2012).

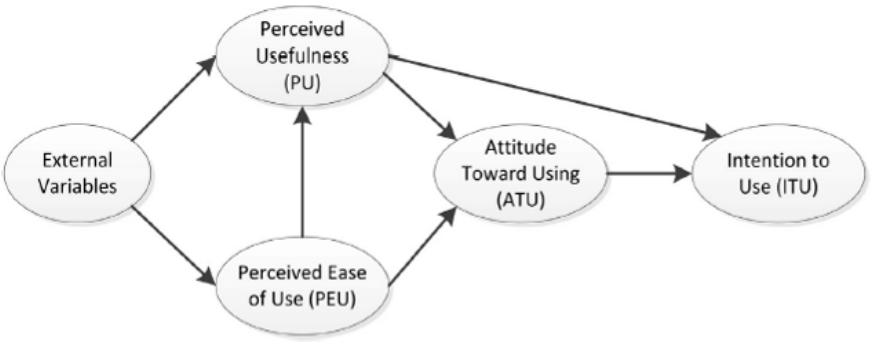

Figure 1 original Technology Acceptance Model (TAM)
Source: Wojciechowski and Cellary, 2013

Davis (1989, p.320, cited in Wojciechowski and Cellary, 2013) defines perceived usefulness as the extent to which a person believes that his job performance would enhance using a particular system. He also defines perceived ease of use as the extent to which a person does not experience difficulties when using a particular system. More recently, previous research proves that perceived enjoyment has a positive influence both on attitude toward using (Teo & Noyes, 2011) and intention to use (Balog and Pribeanu, 2010), so it needs to be taken into account in the TAM. Perceived enjoyment is defined as the extent to which one takes pleasure when using a particular system, regardless of the consequences of its performance (Davis et al., 1992, p.1113, cited in Wojciechowski and Cellary, 2013).

3. RESEARCH METHOD

3.1 Research Model

The constructs in this study consisted of Perceived Usefulness (PU), Perceived Easy of Use (PEU), Perceived Enjoyment (PE), Attitude toward Using (ATU) and Intention to Use (ITU). The research model developed originally from TAM model, with perceived enjoyment added but minus external variables. External variables not included because the ARCH was still in a prototype form and had not been ready to use yet. A research model for this study shown in Figure 2.

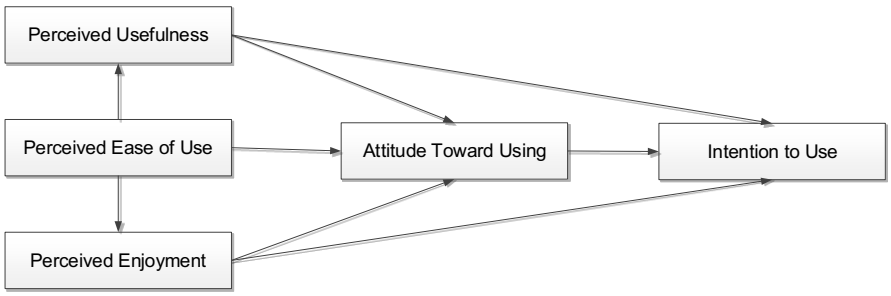

Figure 2 research model
Source: Personal Documentation

The proposed research hypotheses were as follow:
H1. Perceived Easy of Use (PEU), Perceived Easy of Use (PEU) and Perceived Enjoyment (PE) would positively affect Attitude Toward Using (ATU).
H2. Perceived Usefulness (PU), Perceived Enjoyment (PE) and Attitude Toward Using (ATU) would positively affect Intention To Use (ITU).

3.2 Methodology

This study started from distributed and collected questionnaire on students after using ARCH prototype. The questionnaire elicited information about respondent profiles and the statement related about PU, PEU, PE, ATU, and ITU. The interface of ARCH prototype is shown in Figure 3 to Figure 6. The respondents consisted of 132 PalComTech's students, which divided to 82 students from Informatics Engineering, 30 students from Information System and 20 students from Informatics Management. The questionnaire using 5-point Likert scale. The point was given as 1: strongly disagree, 2: disagree, 3: abstain, 4: agree and 5:strongly agree. Reliability test then conducted to validate items in the questionnaire and validity test to obtain a correlation between constructs. The reliability test using Cronbach alpha value while validation test using bivariate Pearson correlation. The final step was regression analysis test. Stages of the study illustrated in Figure 7.

Figure 3 ARCH prototype interface

Figure 4 3D model of processor

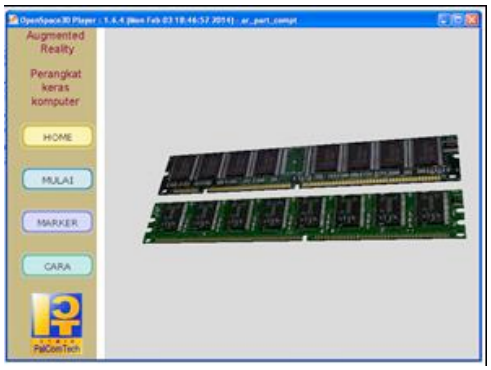

Figure 5 3D model of RAM

Figure 6 3D model of hard drive
Source: Mustika, et al., 2015

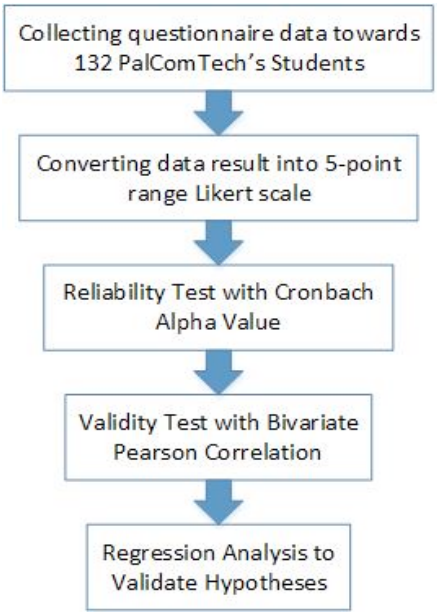

Figure 7 stages of the study
Source: Personal Documentation

4. RESULT AND DISCUSSION

Table 1 Questionnaire statement, Mean (M) and Standard Deviation (SD)

Contruct	Items	M	SD
Perceived Usefulness	This ARCH is helpful in learning in classroom	4.20	0.585
	I believe using this ARCH improves my understanding	4.50	0.502
	Using this ARCH is useful in learning independently (outside classroom)	4.13	0.336
Perceived Easy of Use	This ARCH is easy to use	4.55	0.499
	Using this ARCH does not require a lot of effort	4.24	0.594
	Learning to operate this ARCH is clear and understandable	4.39	0.489
Perceived Enjoyment	Using this ARCH in fun	4.48	0.501
	I feel enjoy when using this ARCH	4.49	0.502
	I feel entertained using this ARCH when learning	4.19	0.393
Attitude Toward Using	I would like this ARCH used in classroom	4.37	0.485
	I feel that using this ARCH is quite boring	3.90	0.346
	I find that learning with this ARCH is interesting	4.11	0.433
Intention To Use	I'd like to use this ARCH independently (outside classroom)	4.36	0.481
	I'd like to use this kind of system for other course subjects	4.37	0.485
	I'd like to use this ARCH application in the future	4.36	0.496

Source: Personal Documentation

The questionnaire statement, mean and standard deviation values were presented in Table 1. Mean values varied between 3.90 and 4.55 while standard deviation values varied from 0.336 to 0.594. The smallest mean value occur in the "I feel that using this ARCH is a quite boring" statement, while the highest mean value can be found in "The ARCH is easy to use" statement. The lack of mean values could be the effect of negative statement used in that item.

Cronbach alpha value was presented in Table 2. Cronbach alpha was calculated to measure the internal consistency among statements. The statements considered reliable if the Cronbach alpha value was greater than 0.6 (Santos, 1999, cited in Salman, M., Abdullah, F. and Saleem, A., 2016). Cronbach alpha had values which varied from 0.612 to 0.875. PE had the smallest value (0.612) while ITU had the biggest one (0.875). Based on the result which greater than 0.6, all statements considered reliable and could be used in the questionnaire.

Table 2 Reliability test

Construct	**Cronbach alpha**
Perceived Usefulness	0.614
Perceived Easy of Use	0.638
Perceived Enjoyment	0.612
Attitude toward Using	0.752
Intention to Use	0.875

Source: Personal Documentation

Table 3 Regression analysis result

Dependent variables	**Independent variables**	***R²***	***p***
Perceived Usefulness	Perceived Easy of Use	0.626	<0.001
Perceived Enjoyment	Perceived Easy of Use	0.616	<0.001
Attitude toward Using	Perceived Usefulness	0.543	<0.001
	Perceived Easy of Use	0.626	<0.001
	Perceived Enjoyment	0.571	<0.001
Intention to Use	Perceived Usefulness	0.525	<0.001
	Attitude toward Using	0.621	<0.001
	Perceived Enjoyment	0.638	<0.001

Source: Personal Documentation

Regression analysis result is presented in Table 3. PEU affects PU (R^2 = 0.626) and PE (R^2 = 0.616). ATU was affected by PU (R^2 = 0.543), PEU (R^2 = 0.626) and PE (R^2 = 0.571). ITU was affected by PU (R^2 = 0.525), ATU (R^2 = 0.621) and PE (R^2 = 0.638). All calculated regression values had coefficient *p* less than 0.05, which the tolerable significance level, so all the hypotheses proposed were accepted.

Final objective of the study was to investigate factors that affect ATU and ITU simultaneously, thus, multiple regression analysis was carried out. The result presented in Table 4. Based on the result, PU, PEU, and PE simultaneously affect ATU with R^2 = 0.697, with PEU as the largest value (β = 0.343). This meant that PEU was the strongest impact factor of ATU. PU, ATU, and PE simultaneously affect ITU with R^2 = 0.736, with PE as the largest value (β = 0.417). This meant that PE was the strongest impact factor of ITU. It might as well explained that the large number for PE was the effect of the novelty of ARCH system. Students more interested to the ARCH because

they never used it before. These effects usually diminished over time when students accustomed with the technology.

Table 4 multiple regression analysis results

Dependent variables	**Predictors**	**Standardized coefficients β**	R^2	*p*
Attitude toward Using	Perceived Usefulness	0.252	0.697	<0.001
	Perceived Easy of Use	0.343		<0.001
	Perceived Enjoyment	0.317		<0.001
Intention to Use	Perceived Usefulness	0.210	0.736	<0.001
	Attitude toward Using	0.318		<0.001
	Perceived Enjoyment	0.417		<0.001

Source: Personal Documentation

5. CONCLUSION

Based on the result, all hypotheses proposed in this study were accepted. Perceived Usefulness (PU), Perceived Easy of Use (PEU), and Perceived Enjoyment (PE) were proven to be the factors that affected Attitude Toward Using (ATU) on ARCH system. The strongest factor that affects ATU was PEU, rather than PU and PE. PU, ATU, and PE were proven to be the factors that affected Intention To Use (ITU) on ARCH system, with PE as the strongest impact factor. It might as well concluded that PE was the essential factor that influences the willingness of students to use the ARCH system in the learning process.

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