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An assessment of the influence of perceived enjoyment and attitude on the intention to use technology among pre-service teachers: A structural equation modeling approach

Timothy Teo [a,*], Jan Noyes [b]

[a] Learning Sciences & Technologies Academic Group, National Institute of Education, Nanyang Technological University, 1 Nanyang Walk, Singapore 637616
[b] School of Experimental Psychology, University of Bristol, UK

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ABSTRACT

This study examined the influence of perceived enjoyment on pre-service teachers' intention to use technology, in addition to re-appraising the role of attitude toward use in the Technology Acceptance Model (TAM; Davis, Bagozzi, & Warshaw, 1989). One hundred and fifty-three participants in Singapore completed a survey questionnaire measuring their responses to five constructs from a research model that was developed specifically for the study. Structural Equation Modeling (SEM) showed that perceived enjoyment was a significant predictor of perceived usefulness, perceived ease of use, and intention to use technology. The findings of this study support the view of Davis et al. (1989) from over 30 years ago that attitude toward use contributes only modestly to the TAM.

1. Introduction

The use of technology by teachers and pre-service teachers has been extensively researched. For example, Albion (2001) found that self-efficacy was the key to explaining teachers' use of technology for teaching in the classroom. Associated with self-efficacy is the amount of time spent in using computers, together with access to computers and computer training. From another perspective, Anderson and Maninger (2007) postulated that pre-service teachers' intention to use technology was influenced by intrinsic and extrinsic factors. Intrinsic factors include personal beliefs and intentions with regard to the integration of technology into the curriculum. Extrinsic factors include access to computers, time, training, and technical support. Since teachers are crucial to the success of using technology in the educational system, the factors that drive their intention to use technology have interested researchers for some time.

Motivated by this need, studies have been conducted with models which were developed to explain technology acceptance. Originating from the information science disciplines, the Technology Acceptance Model (TAM; Davis, Bagozzi, & Warshaw, 1989) is among the most widely-used and tested model in technology acceptance studies (see Teo, 2009; Teo, Lee, & Chai, 2008; Teo, Lee, Chai, & Wong, 2009).

1.1. The technology acceptance model

Among the first models to include psychological factors that affect technology acceptance, the TAM addresses the issue of how users accept and use a technology. See Fig. 1. In the model, two variables, perceived usefulness and perceived ease of use, are hypothesized to be the fundamental determinants of user acceptance. Together, perceived usefulness and perceived ease of use act as antecedents in attitude toward computer use. However, the TAM has been found to be parsimonious in explaining user behavior across a broad range of end-user computing technologies and user populations; for example, different usage conditions (e.g. Venkatesh, 2000), across genders (e.g. Venkatesh & Morris, 2000), and across cultures (e.g. Teo, Wong, & Chai, 2008).

In the TAM, intention to use is influenced by attitude toward use, as well as the direct and indirect effects of perceived usefulness and perceived ease of use. Perceived usefulness and perceived ease of use jointly affect attitude toward usage, with perceived ease of use having

* Corresponding author. Tel.: +65 6790 3275; fax: +65 6896 8038.
E-mail address: timothy.teo@nie.edu.sg (T. Teo).

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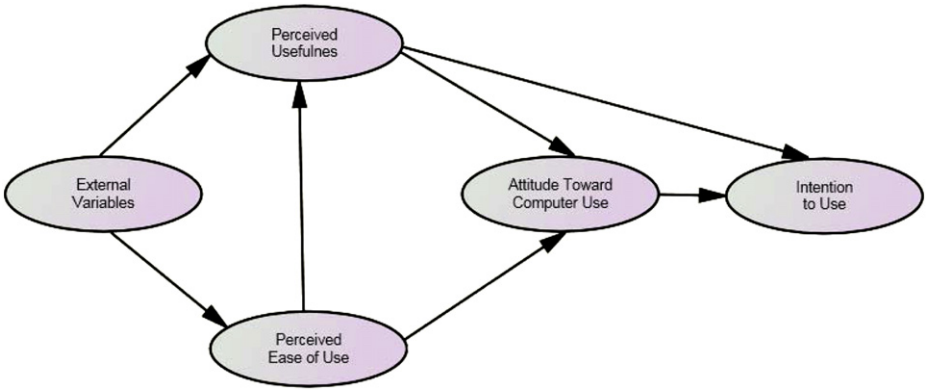

Fig. 1. Technology acceptance model (TAM; Davis et al., 1989).

a direct impact on perceived usefulness. Perceived usefulness refers to the extent to which a person believes that using technology will enhance his/her productivity (Davis et al., 1989). On the other hand, perceived ease of use has to do with the extent to which a person thinks that using technology will be relatively free of effort. Davis et al. hypothesized that perceived ease of use will have an effect on perceived usefulness but only in this direction and not on the other way around. This is because perceived usefulness concerns the overall impact of technology use on job performance (process and outcome) whereas perceived ease of use pertains to the process of using the technology *per se*.

Despite the accolades given to the TAM for its predictive ability of behavioral intention to use technology (Yuen & Ma, 2002) there are two primary limitations. First, Dishaw and Strong (1999) pointed out that it is necessary to investigate further the nature and specific influences of technological and usage-context factors that may alter the user's acceptance in order to increase the external validity of the TAM. This was corroborated by a more recent, meta-analysis of the TAM literature which identified a shortcoming of TAM to be the non-inclusion of external variables (Legris, Ingham, & Collerette, 2003). One objective in studying external variables is to determine the chain of influence from these variables to the behavioral intention to use technology. Over the years, external variables such as subjective norm, facilitating conditions, self-efficacy, and technological complexity have been found to be significant influences of pre-service teachers' attitudes and intention to use technology (e.g. Teo, 2009, 2010). In addition to these factors, some studies have found perceived enjoyment to be a robust construct that is associated with the core constructs of the TAM (namely, perceived usefulness and perceived ease of use) in explaining the intention to use technology (e.g. Chesney, 2006; Van der Heijden, 2004; Wu, Chen, & Lin, 2007).

Perceived enjoyment (PEN) is defined as the degree to which the activity of using technology is perceived to be enjoyable in its own right apart from any performance consequences that may be anticipated (Davis, Bagozzi, & Warshaw, 1992). Research has found that PEN plays an important role in user technology acceptance and that the correlation between perceived enjoyment and perceived ease of use is supported by research findings (see Venkatesh, Speier, & Morris, 2002; Yi & Hwang, 2003). Previous research has found PEN to be significant in explaining behavioral intention to use hedonic systems (Van der Heijden, 2003) and blogs (Hsu & Lin, 2008). In another study, Liao, Tsou, and Shu (2008) examined the role of PEN in determining the acceptance of a multimedia on demand (MOD) service among subscribers of a telecom service using an extended TAM as a research framework. However, the use of perceived enjoyment as an external variable in the TAM is not commonly found in studies relating to technology acceptance in educational contexts.

Second, opinions on the role of attitude in the TAM remained divided. Attitude is often defined as an individual's positive or negative feelings about performing the target behavior (e.g., using technology) or object (e.g., technology) within the TAM framework. Davis et al. (1989) proposed that attitude was only modest in predicting technology acceptance and that individuals may use a technology even if they did not have a positive attitude toward technology *per se*, as long as it is perceived to be useful and/or easy to use in ways that enhance their productivity. With reference to this, Mathieson (1991) suggested that eliminating attitude would not significantly lower the predictive capability of the TAM. However, more recent studies have found attitude toward use to be a significant predictor of the intention to use technology, especially in settings where the use of technology is voluntary (see, Athiyaman, 2002). It is possible that the role of attitude in the TAM may not be as simple as previous research has suggested, and that further work is needed to achieve greater clarity on this issue (Yang & Yoo, 2004). Despite the state of uncertainty, no studies have been located which perform model comparisons to establish the significance of the attitude toward use construct in the TAM. This paper attempts to address this issue.

1.2. Aim of this study

The aim of the study reported here is to assess the contribution of perceived enjoyment to the TAM in explaining pre-service teachers' intention to use technology by empirically testing the parsimony of the TAM with a focus on the role of attitude toward computer use. The following research questions guide the present research:

1. To what extent does perceived enjoyment contribute to the TAM in explaining pre-service teachers' intention to use technology?
2. Does attitude toward computer use make the TAM more parsimonious in explaining pre-service teachers' intention to use technology?

2. Research hypotheses and model

The TAM has been widely accepted as a robust and efficient model to be used across gender, settings, and times (see, Cheung & Huang, 2005; Drennan, Kennedy, & Pisarksi, 2005; Groves & Zemel, 2000; Liaw & Huang, 2003; Pan, Sivo, & Brophy, 2003). Thus, there is much support to justify the hypotheses relating to these constructs in this study. Further, the choice of the TAM was based on its ability to

explain pre-service teachers' intention to use technology (e.g. Kiraz & Ozdemir, 2006; Ma, Andersson, & Streith, 2005; Teo, 2009). Here, perceived usefulness (PU) is defined as the degree to which a person believes that using a particular technology will enhance his or her job performance. Perceived ease of use (PEU) refers to the degree to which a person believes that using a particular technology will be free of effort. Together, perceived usefulness and perceived ease of use constitute a significant influence on attitude toward usage (ATU), which in turn affects the intention to use (ITU) technology.

H_1 Attitude Toward Use (ATU) will have a significant influence on Intention To Use (ITU)
H_2 Perceived Usefulness (PU) will have a significant influence on Attitude Toward Use (ATU)
H_3 Perceived Ease of Use (PEU) will have a significant influence on Attitude Toward Use (ATU)

2.1. Perceived enjoyment (PEN)

Within the framework of the TAM, Davis et al. (1992) suggested that perceived enjoyment is similar to intrinsic motivation which drives the performance of an activity that is not linked for any reason other than the process of performing the activity *per se*. As an example, when comparing two training methods (traditional training vs. game-based training) Venkatesh and Speier (2000) found that the game-based training method aimed at enhancing intrinsic motivation resulted in higher enjoyment and higher perceived ease of use results than the traditional training method. In addition, Venkatesh (2000) found that the effect of enjoyment on perceived ease of use became stronger as users gained more direct experience with the system over time. These findings suggest that perceived ease of use is influenced by the extent to which users perceive using the system to be enjoyable.

Davis et al. (1992) found that usefulness and enjoyment were significant determinants of behavioral intention and Venkatesh (2000) showed that enjoyment influenced perceived usefulness via ease of use. Perceived usefulness measures how people believe their productivity and effectiveness can be improved as a result of using technology. Perceived enjoyment has also been found to be significantly related to the intention to use computers (Igbaria, Guimaraes, & Davis 1995). Teo, Lim, and Lai (1999) investigated the impact of PU, PEU, and PEN on Internet use and found that respondents' enjoyment of the Internet was influenced by perceived usefulness and perceived enjoyment. They also found that PEN had a significant effect on frequency of use. Further, Moon and Kim (2001) used a sample of 152 Korean graduate students to test the influence of perceived usefulness and perceived enjoyment (defined as perceived playfulness in their study) on Internet use and they had similarly found support for the mediation of PEN on intention. Thus, it can be seen that perceived enjoyment may act to exert a significant influence on a user's intention to use, perceived usefulness, and perceived ease of use of technology. The following three hypotheses were generated.

H_4 Perceived Enjoyment (PEN) will have a significant influence on Intention To Use (ITU)
H_5 Perceived Enjoyment (PEN) will have a significant influence on Perceived Usefulness (PU)
H_6 Perceived Enjoyment (PEN) will have a significant influence on Perceived Ease of Use (PEU)

In summary, the six hypotheses and the research model are represented in Fig. 2.

3. Methodology

3.1. Research design

This study employs a structural equation modeling (SEM) approach to develop a model that represents the relationships among the five variables in this study: intention to use (ITU), attitudes toward use (ATU), perceived usefulness (PU), perceived ease of use (PEU), and perceived enjoyment (PEN). Data was collected via an online survey questionnaire on with demographic questions and multiple items for each of the five variables in the study. Analyses were conducted using AMOS 7.0 (Arbuckle, 2006) and the usual steps for doing SEM were followed. Data was screened for missing values and outliers, and the convergent and discriminant validities were established. To obtain reliable results in SEM, Kline (2005) recommended a sample size of 100–150 cases. An examination of the Hoelter's (1983) critical N, which shows the minimum sample size required for a valid model at the $p < 0.05$ level, reveals a figure of 111. The sample size of this study is 153 and thus, meets recommended guidelines.

3.2. Participants and data collection

Participation in this study was voluntary and 153 pre-service teachers who were enrolled at the National Institute of Education (NIE) in Singapore agreed to take part in this study. An invitation to participate in this study was made to students enrolled in the 4-year Bachelor of Arts (with Education) and one-year Postgraduate Diploma in Education programmes. A total of 77 and 76 students responded from each programme respectively. Among them, 56.9% ($n = 87$) were female. The mean age of all participants was 26.2 years (SD = 5.58). Ethical procedures were followed: participants were briefed on the study and informed of their rights of participation. When completing the questionnaire, participants were directed to frame the items in the context of their technology use during teacher training.

3.3. Measures

A survey questionnaire comprising items that were adapted from scales that have been validated in previous studies was devised (Teo, 2009; Yi & Hwang, 2003). Participants were asked to provide demographic information and respond to 14 statements on the five constructs in this study. These are: perceived usefulness (PU) (three items), perceived ease of use (PEU) (three items), perceived enjoyment (PEN)

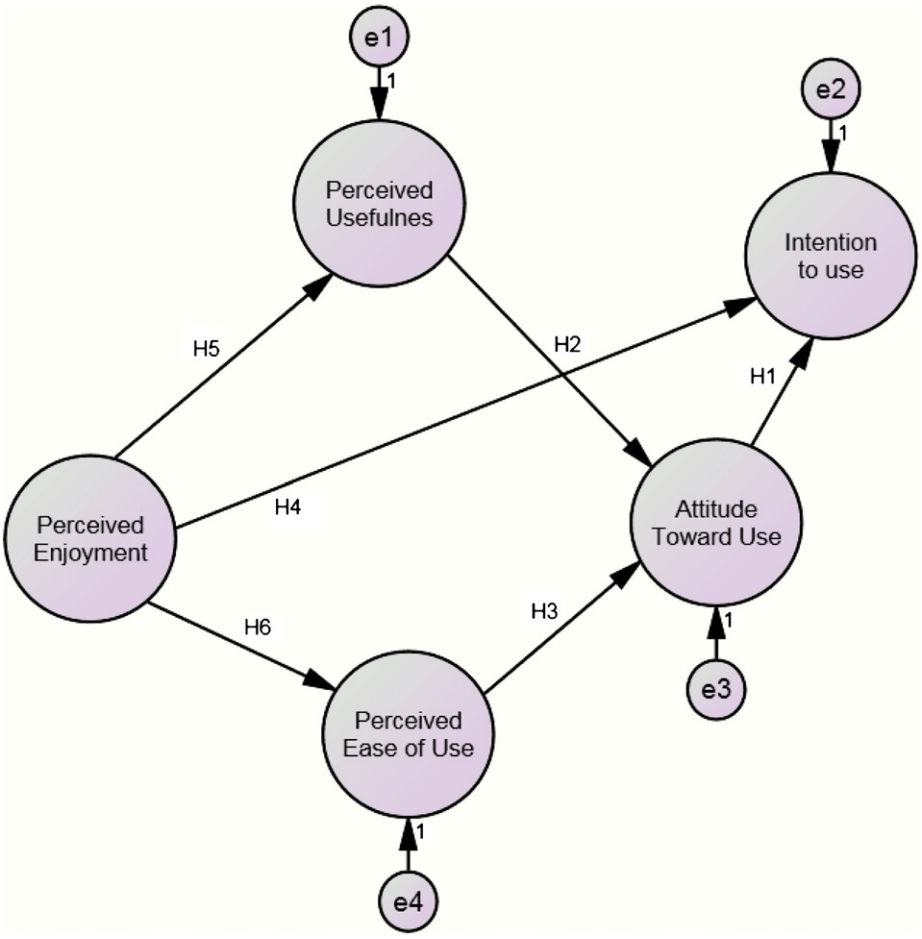

Fig. 2. Research model.

(four items), attitudes toward usage (ATU) (two items), and intention to use (ITU) (two items). Each statement was measured on a five-point Likert-type scale from '1 = strongly disagree' to '5 = strongly agree' (as shown in the Appendix).

4. Results

4.1. Descriptive statistics

The descriptive statistics for each item are shown in Table 1. All mean scores are above the midpoint of 3.00, with a range of 3.31–4.04. The standard deviations range from 0.70 to 1.10. The skewness index and kurtosis index show acceptable ranges and following Kline's (2005) recommendations that the skew and kurtosis indices should not exceed |3| and |10| to ensure normality of the data, the data in this study is regarded as normal for the purposes of SEM.

Table 1
Descriptive statistics of the items in the measure.

Construct	Item	Mean	Standard deviation	Skewness	Kurtosis
Perceived usefulness	PU1	3.80	0.87	−0.68	0.52
	PU2	3.87	0.82	−0.78	1.19
	PU3	3.80	0.85	−0.56	0.49
Perceived ease of use	PEU1	3.84	0.88	−0.92	1.17
	PEU2	3.31	1.10	−0.28	−0.86
	PEU3	3.92	0.83	−0.62	0.44
Perceived enjoyment	PEN1	3.92	0.81	−0.59	0.88
	PEN2	3.80	0.84	−0.48	0.44
	PEN3	3.92	0.78	−0.45	0.38
	PEN4	3.54	0.90	−0.11	−0.21
Attitude toward use	ATU1	3.75	0.90	−0.46	−0.21
	ATU2	3.62	0.92	−0.39	−0.22
Intention to use	ITU1	4.04	0.70	−0.53	0.59
	ITU2	3.96	0.75	−0.50	0.21

Table 2
Results for the measurement model.

Latent variable	Item	Factor loading (>0.70)*	SRW	*t*-Value[a]	R^2	AVE[b] (>0.50)*	Coefficient *H*[c]
Perceived usefulness						0.67	0.93
	PU1	0.778	0.860	15.869**	0.740		
	PU2	0.848	0.930	–	0.866		
	PU3	0.829	0.881	16.762**	0.777		
Perceived ease of use						0.64	0.91
	PEU1	0.740	0.874	14.300**	0.763		
	PEU2	0.871	0.664	9.427**	0.441		
	PEU3	0.775	0.920	–	0.846		
Perceived enjoyment						0.59	0.80
	PEN1	0.762	0.895	16.722**	0.801		
	PEN2	0.797	0.909	–	0.826		
	PEN3	0.723	0.846	14.862**	0.717		
	PEN4	0.793	0.758	12.015**	0.574		
Attitude toward use						0.70	0.90
	ATU1	0.781	0.942	6.510**	0.887		
	ATU2	0.886	0.665	–	0.442		
Intention to use						0.88	0.92
	ITU1	0.935	0.929	–	0.862		
	ITU2	0.939	0.924	8.560**	0.854		

* Indicates an acceptable level of reliability or validity; $^{**}p < 0.001$.
SRW: standardised regression weight.
[a] *t*-Value (critical ratio) shows whether the parameter is significant at the 0.05 level.
[b] AVE: average variance extracted. $(\sum\lambda^2)/n$.
[c] CR: composite reliability $= (\sum\lambda)^2/(\sum\lambda)^2 + (\sum\delta)$.

4.2. Test of the measurement model

A confirmatory factor analysis was conducted to assess the reliability and validity of the measures. Table 2 shows the results of the measurement model. All factor loadings are above 0.70 and range from 0.740 to 0.939. Together, the principal component analysis showed that these five factors in the proposed model explained 84.09% of the total variance. All standardised regression weights are above 0.70, except for PEU2 and ATU2. However, these two items were above 0.65 and their *t* values were significant at the 0.001 level. The multiple square correlations (R^2) of all items ranged from 0.441 to 0.886, indicating that these items were explained by their predictors at a range from 44.1% to 88.6%.

Tests of convergent validity were conducted using average variance extracted and composite reliability measures. The average variance extracted (AVE) measures the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error (Fornell & Larcker, 1981). Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50. In this study, coefficient *H* (Hancock & Mueller, 2001) was used as a measure of composite reliability. For composite reliability to be adequate, a value of 0.70 and higher was recommended (Nunnally & Bernstein, 1994). Table 2 shows the values of the AVE and coefficient *H* to be adequate representation of convergent validity.

Discriminant validity is assessed to be adequate when the variance shared between a construct and any other construct in the model is less than the variance that the construct shares with its indicators (Fornell, Tellis, & Zinkhan, 1982). In this study, discriminant validity was assessed by comparing the square root of the AVE for a given construct with the correlations between that construct and all other constructs. If the square roots of the AVEs are greater than the off-diagonal elements in the corresponding rows and columns and exceed the correlations between a given construct and others in the model, discriminant validity is achieved. Table 3 shows the diagonal elements in the correlation matrix to be greater than the off-diagonal elements, indicating that discriminant validity to be satisfactory at the construct level in this study.

A variety of indices was used in this study as suggested by Hair, Black, Babin, Anderson, and Tatham (2006) in order to obtain a comprehensive model fit. These include: the χ^2 statistic, ratio of χ^2 to its degree of freedom be computed (χ^2/df), Tucker-Lewis index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and the standardised root mean residual (SRMR). These fit indices are typically used to represent the three categories of model fit indices: absolute, parsimonious, and incremental fit indices. However, since the χ^2 has been found to be too sensitive to large sample sizes and a high number of observed variables (Hair et al., 2006), the ratio of χ^2 to its degree of freedom was computed (χ^2/df), with a value of not more than 3 being indicative of an acceptable fit between the hypothetical model and the sample data (Carmines & McIver, 1981). Table 4 shows the level of acceptable fit and the fit indices for the proposed research model in this study. From the table, there is evidence to suggest that the measurement has a good fit.

Table 3
Discriminant validity for the measurement model.

Construct	PU	PEU	PEN	ATU	ITU
PU	(0.82)				
PEU	0.54	(0.80)			
PEN	0.71	0.60	(0.77)		
ATU	0.46	0.44	0.52	(0.84)	
ITU	0.35	0.22	0.35	0.21	(0.94)

Notes: (1) $^*p < 0.01$. (2) Diagonal in parentheses: square root of average variance extracted from observed variables (items); off-diagonal: correlations between constructs.

Table 4
Fit indices for the measurement model.

Model fit indices	Values	Recommended guidelines	References
χ^2	106.469$P < 0.001$	Non-significant	Klem (2000), Kline (2005), McDonald and Ho (2002)
χ^2/df (deg. of freedom)	1.613	<3	Kline (2005)
TLI	0.965	≥0.90	Klem (2000), McDonald and Ho (2002)
CFI	0.975	≥0.90	Klem (2000), McDonald and Ho (2002)
RMSEA	0.064 (0.040, 0.085)	<0.08	McDonald and Ho (2002)
SRMR	0.040	<0.05	Klem (2000), McDonald and Ho (2002)

4.3. Test of the structural model

A test of the structural model showed a good model fit ($\chi^2 = 125.699$, $p < 0.001$; χ^2/df = 1.796; TL1 = 0.955; CFI = 0.965; RMSEA = 0.072 (0.052, 0.092); SRMR = 0.050). Fig. 3 gives the results of the hypothesis test and path coefficients of the proposed research model. The result showed that six out of seven hypotheses were supported by the data. Except for H_1, all the hypotheses relating to the core TAM variables (H_2–H_3) were significant. The remaining three hypotheses (H_4, H_5, and H_6) relating to perceived enjoyment were supported, demonstrating the significant relationship between PEN and PU, and PEU, and ITU. Four endogenous variables were tested in the research model. Intention to use was predicted by ATU and PEN, resulting in an R^2 of 0.158. This means that ATU and PEN explained 15.8% of the variance in ITU. The variances of the other three endogenous variables, ATU, PU, and PEU, were explained by their antecedents in amounts of 38.3%, 63.0%, and 46.8%, respectively (Table 5).

4.4. Assessment of total, direct, and indirect effects

In assessing the extent to which each exogenous variable has an impact on the endogenous variables, the standardised total effects, and the direct and indirect effects associated with each of the five variables were examined. A coefficient linking one construct to another in the model represents the direct effect of a determinant on an endogenous variable. An indirect effect indicates the impact which a determinant has on a target variable through its effect on other intervening variables in the model. A total effect on a given variable is the sum of the respective direct and indirect effects. According to Cohen (1988), effect sizes of 0.2 are considered small, those with 0.5 are medium, and values with 0.8 and above are considered large. These effects are summarized in Table 6.

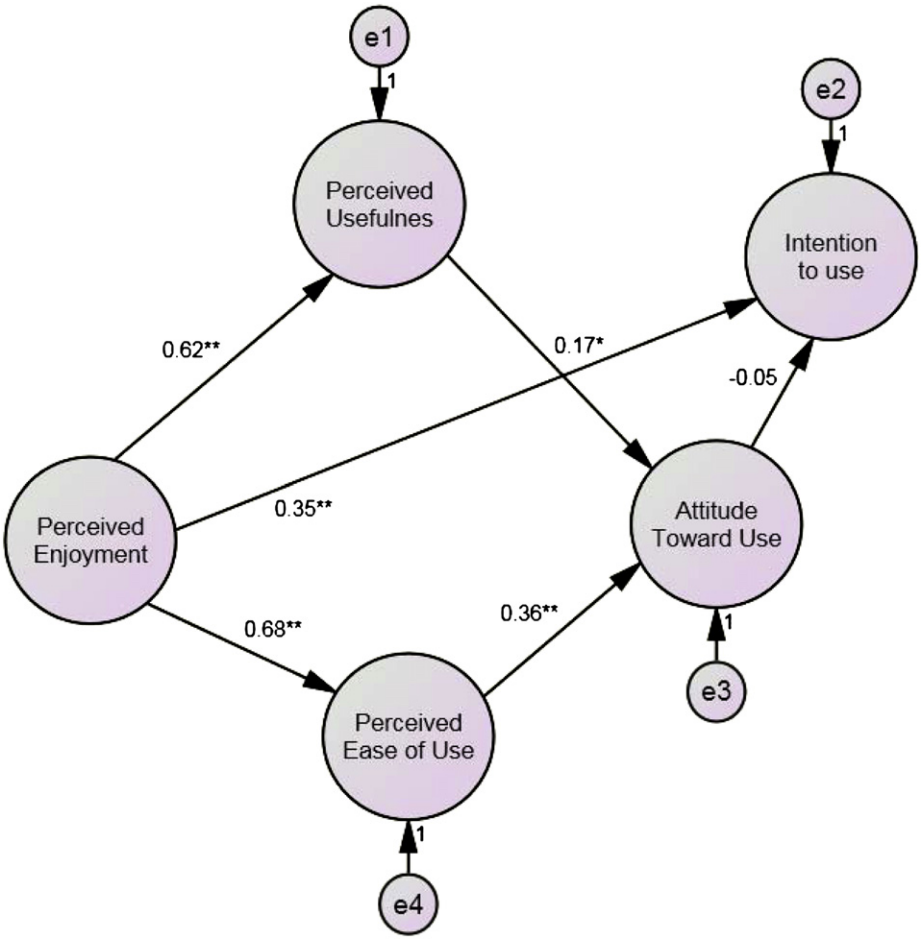

Fig. 3. Results of the test of structural model. *$p < 0.05$; **$p < 0.01$.

Table 5
Hypothesis testing results.

Hypotheses	Path	Path coefficient	t-value	Result
H_1	ATU → ITU	−0.054	−0.539	Not supported
H_2	PU → ATU	0.168	2.021*	Supported
H_3	PEU → ATU	0.364	3.700**	Supported
H_4	PEN → ITU	0.350	4.188**	Supported
H_5	PEN → PU	0.624	6.957**	Supported
H_6	PEN → PEU	0.678	9.079**	Supported

*$p < 0.05$; **$p < 0.01$.

The result show perceived enjoyment (PEN) is the most dominant determinant of all endogenous variables in the model. The PEN has a small medium effect on ITU ($d = 0.395$) and ATU ($d = 0.479$), a medium effect on PEU ($d = 0.684$), and a large effect on PU ($d = 0.778$). This is followed by PEU with medium effect on ATU ($d = 0.506$) and a small effect on PU ($d = 0.217$). The findings also support current research that suggests the strong relationship among PU, PEU and ATU (e.g. Teo, Lee, et al., 2008; Teo, Wong, et al., 2008). However, the strong link between PU and PEU in this study appears to be over shadowed by PEN which acts a strong determinant of PU, followed by PEU, ATU, and ITU.

4.5. Model comparison

To test for the role of attitude toward use in the TAM, the research model was tested with and without attitude as a construct in the model. Traditionally, the $\Delta\chi^2$ (chi-square change) has been used as the index of difference in fit. However, the use of $\Delta\chi^2$ has been criticized because of its sensitivity to sample size. Recently, Cheung and Rensvold (2002) recommended that ΔCFI could be used as supplementary evidence and suggested that a ΔCFI value higher than 0.01 to be indicative of a significant drop in fit. Table 7 shows the results of the model comparison. The $\Delta\chi^2$ and ΔCFI between Model 1 and Model 2 was significant at $p < 0.001$, suggesting that Model 2 has a better fit than Model 1. An examination of the CFI and RMSEA indices supported model 2 as a better fitting model. In conclusion, when attitude toward use was removed from the research model, the resultant model had a significantly better fit than before.

5. Discussion

This study aims to assess the impact of perceived enjoyment as an external variable to the TAM and appraise the role of attitude toward use in the TAM. All hypotheses, except one, were supported. This study showed that attitude toward use was not a significant predictor of intention to use technology and this is consistent with previous research suggesting that attitude toward use was a significant predictor of intention to use technology mainly under mandatory conditions of technology use (see, Venkatesh, Morris, Davis, & Davis, 2003).

It was possible that the participants in this study had not perceived their use of technology to be mandatory because of their student status and they were not yet subject to the demands that practicing teachers faced with respect to technology integration in schools. Although the participants were required to complete courses in various aspects of technology use and encouraged to use technology for their learning and assignments, their engagements with technology as pre-service teachers differs from those of practicing teachers in three ways. First, pre-service teachers use technology mainly for self-development and to prepare for their impending career as a teacher. Second, pre-service teachers have more time to experiment with technology under training conditions. This also implies that mistakes could be made without having to face consequences in terms of creating misconceptions among school students or receiving an adverse performance report. Third, pre-service teachers have access to more support to use technology as part of their training. It is possible that these three factors created a perception among pre-service teachers that the use of technology was not mandatory at the point when the data of this study was collected, thus explaining the lack of a significant relationship between attitude toward use and intention to use.

The findings of this study indicate that perceived enjoyment had a significant influence on the core constructs of the TAM: perceived usefulness, perceived ease of use, and intention to use technology. From the effect sizes, perceived enjoyment had the largest effect on perceived usefulness, followed by perceived ease of use, attitude toward use, and intention to use. This finding is contrary to existing work which found perceived enjoyment to affect perceived usefulness indirectly via perceived ease of use (Venkatesh, 2000) or as a sub-scale in a multidimensional variable named cognitive absorption (Agarwal & Karahanna, 2000). Consistent with the literature, this study found a significant relationship between perceived enjoyment and perceived ease of use ($\beta = 0.678$, $p < 0.001$). Among the four endogenous variables in the research model, perceived enjoyment explained 46.8% of the variance in perceived ease of use, more than the variance in

Table 6
Direct, indirect, and total effects of the research model.

Outcome	Determinant	Standardised estimates		
		Direct	Indirect	Total
Intention to use ($R^2 = 0.158$)	ATU	−0.051	–	−0.051
	PU	–	−0.011	−0.011
	PEU	–	−0.026	−0.026
	PEN	0.420	−0.024	0.395
Attitude toward use ($R^2 = 0.383$)	PU	0.212	–	0.212
	PEU	0.460	0.046	0.506
	PEN	–	0.479	0.479
Perceived usefulness ($R^2 = 0.630$)	PEU	0.217	–	0.217
	PEN	0.630	0.148	0.778
Perceived ease of use ($R^2 = 0.468$)	PEN	0.684	–	0.684

Table 7
Results of model comparisons.

Model	χ^2	df	CFI	RMSEA	$\Delta\chi^2$	Δdf	ΔCFI
1. Research model	125.699	70	0.965	0.072	–	–	–
2. Research model with ATU removed	83.247	48	0.976	0.070	42.452	22	0.011

which the former had explained in the other endogenous variables (perceived usefulness, attitude toward use, and intention to use). Practically, this suggests that pre-service teachers perceive technology to be easy to use (i.e. relatively free of effort) when they enjoy using technology.

In terms of study limitations, these include the use of self-reports and a single method of data collection. These practices have been shown to have the potential to lead to the common method variance, where the associations between variables become inflated. Second, the total variance accounting for the dependent variable, intention to use, was only 15.8%, leaving 84.2% unexplained. It is possible that other predictor variables have been excluded from this study. The need to consider other intervening variables is necessitated by the constantly changing environments under which pre-service teachers use technology. These changes are the results of technological advancements and changes in the demands of the teaching profession in Singapore.

6. Implications for teacher training

Following the significant influences that perceived enjoyment has on perceived ease of use, teacher educators could focus on aspects of their curriculum in ways that promote enjoyment for the pre-service teachers. A balance between activities that are utilitarian and those perceived to be hedonic should be made in order for pre-service teachers to acquire relevant skills for their future jobs as teachers and at the same time, experience pleasure and enjoyment from these activities. Although it is important to ensure that pre-service teachers acquire the necessary technical skills to perform their role as a teacher, it is important for teacher educators to focus on developing positive perceptions of usefulness and the extent to which technology is easy to use, both of which are significantly affected by perceived enjoyment.

7. Conclusions

This study compared models with and without the 'attitude toward use' construct and found that the models without attitude toward use had a significantly better model fit. Although this finding supports the view of Davis et al. (1989) that attitude toward use contributes only modestly to the TAM, two issues were not considered. First, the existing TAM literature contains studies that either tested their research model with or without attitude toward use on the evidence from past research. Second, the structure of attitude has been recently re-defined. Yang and Yoo (2004) proposed that the attitude in the TAM should be perceived as two separate constructs: cognitive attitude and affective attitude.

Thus, future research could test the validity of this proposition, preferably with various user types and conditions of technology use. Multigroup analyses could be used as a technique to test for the invariance of the validity of perceived enjoyment as an external variable in the TAM and to assess further the role of attitude toward use by different samples, technology type, gender, and culture. In addition, given that perceived enjoyment is a significant variable concerning perceived usefulness, perceived ease of use, and intention to use technology, studies could be conducted to establish the dimensionality of perceived enjoyment. Current research has treated perceived enjoyment as both a unidimensional (e.g. Yi & Hwang, 2003) and multidimensional construct (e.g. Agarwal & Karahanna, 2000). Further research into the dimensionality of perceived enjoyment should reveal insights pertaining to pre-service teachers' intention to use technology.

Appendix. List of constructs and corresponding items

Construct	Item	
Perceived usefulness*	PU1	Using computers will improve my work.
	PU2	Using computers will enhance my effectiveness.
	PU3	Using computers will increase my productivity.
Perceived ease of use*	PEU1	My interaction with computers is clear and understandable.
	PEU2	I find it easy to get computers to do what I want it to do.
	PEU3	I find computers easy to use.
Perceived enjoyment (adapted from Yi & Hwang, 2003)	PEN1	Work is more interesting with computers.
	PEN2	Using computers is fun.
	PEN3	I like using the computer.
	PEN4	I enjoy those aspects of my job that require me to use computers.
Attitude toward use*	ATU1	Using the computer is frustrating for me. (R)
	ATU2	I get bored quickly when I use the computer (R).
Intention to use*	ITU1	I will use computers in the future.
	ITU2	I plan to use the computer often.

*Adapted from Davis et al. 1989.
(R) This item has been reversed-scored.

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