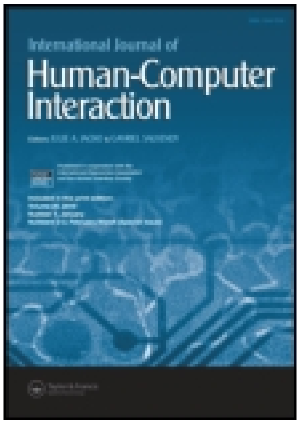

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Understanding the Intention to Use Technology by Preservice Teachers: An Empirical Test of Competing Theoretical Models

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The proliferation of technology has provided educational institutions with opportunities to integrate technology into their curriculum. Technology acceptance refers to a user's willingness to employ information technology for the tasks it is designed to support. This study compared the four models (TRA, TPB, TAM, and integrated) to examine which model best helps to predict preservice teachers' intentions to use technology. Data were gathered from 429 preservice teachers from a teacher training institute in Singapore, and structural equation modeling was used to compare the four models in terms of overall model fit, explanatory power, and path significance. The results demonstrate that the models did not differ in explanatory power. Attitude as an independent variable was found to have the greatest impact on the intention to use technology.

1. INTRODUCTION

For some time, developers and procurers of technology could rely on organizational authority to ensure that technology was used, as is the case in many industrial/organizational contexts. However, the present working practices in many places have enabled greater discretion among users, thus increasing the need for the relevant agencies to determine the dynamic nature of user-acceptance. User-acceptance is referred to as the demonstrated behavior or intention by a user to employ information technology for the tasks it is designed to support. Consequently, intention to use or adopt technology, also referred to as user-acceptance, has become one of the most researched areas in the information science literature (Smarkola, 2007). Whereas there has been much research on user-acceptance in commercial/industrial settings since the 1980s, interests in user-acceptance in education contexts have increased in recent years (e.g., Hu, Clark, & Ma, 2003; Teo, 2010). A major portion of these studies were conducted to examine the factors affecting the intention to use technology among teachers and preservice teachers (e.g., Ma, Andersson, & Streith, 2005; Teo, 2009).

Research to determine the factors that acted as facilitators and barriers to teachers' intention to use in teaching and learning are numerous and diverse, as shown by studies conducted in different parts of the world (Baek, Jung, & Kim, 2008; Robertson, 2007). Many of these studies drew on the models and theories from psychology and information sciences to explore the determinants that affect users' intention to use technology. Research on the intention to use technology is anchored on the premise is that an individual is conscious about his or her decision to accept or adopt a technology and, as such, user-acceptance can be explained by his or her underlying intention (Davis, 1989). In this vein, the challenge for researchers is to identify the important forces or drivers that shape or influence behavioral intention. Previous research suggests that an individual's intention to use technology is likely to be affected by his or her attitudinal, cognitive, and normative assessments of factors relevant to the technology; the social system; the target task; and the implementation context (Hu et al., 2003).

These factors were documented in a review of ICT adoption/acceptance research by Jeyeraj, Rottman, and Lacity (2006). The factors were used to identify variables in various theories and models such as the innovation diffusion theory (Rogers, 2003), social cognitive theory (Bandura, 1986), technology acceptance model (TAM; Davis, 1989), theory of reasoned action (TRA; Fishbein & Ajzen, 1975), theory of planned behavior (TPB; Ajzen, 1991), and the unified theory of acceptance and use of technology (Venkatesh, Morris, Davis, & Davis, 2003). From a total of 99 empirical studies (both quantitative and qualitative), Jeyeraj et al. listed 135 independent variables and eight dependent variables (e.g., actual use, intention to use). The independent variables were grouped into four categories: innovation characteristics (e.g., perceived ease of use, perceived usefulness), individual characteristics (e.g., computer experience, gender, and age), organizational characteristics (e.g., management support, facilitating conditions, and

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subjective norms), and environmental characteristics (e.g., government policy, competition). From these, the authors coded 505 relationships involving the eight dependent variables and, based on established meta-analytic procedures, proposed the best predictors for technology use at the individual and organizational levels. The following section describes the three theories that are commonly being found in the technology acceptance literature: theory of reasoned action, theory of planned behavior, and TAM.

2. LITERATURE REVIEW

2.1. TRA

The TRA was proposed by Fishbein and Ajzen in 1975. Over the years, it has been used as one of the intention-behavior models for studying human behaviors related to information technology. A major assumption of TRA is that most human social behavior is under volitional control and can be predicted from people's intentions (Ajzen, 2002). In TRA, Fishbein and Ajzen (1975) postulated that an individual's intention to perform an action is driven by two antecedents: attitude toward the behavior and subjective norms. Attitude toward the behavior represents an evaluation of an object or event that is captured in various attribute dimensions such as good–bad, harmful–beneficial, or pleasant–unpleasant. For example, attitude toward an intended behavior such as using technology is defined as the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question.

Subjective norms toward behavior are defined as the perceived social pressure to perform or not perform the behavior in question. Such pressures may be exerted by peers or persons whom an individual perceives to be significant. From the literature, attitudes and subjective norms have been shown to be significant in predicting intentions (Ajzen, 2001; Fishbein & Ajzen, 1975; Teo, 2009). Figure 1 shows the TRA.

2.2. TPB

Despite being useful in predicting social behaviors, the TRA is limited when accounting for behaviors that are not under an individual's volitional control (e.g., a user does not have a choice whether to use technology). To address this limitation, Ajzen (1991) proposed the TPB to improve the

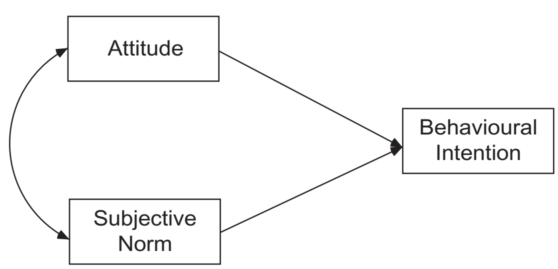

FIG. 1. Theory of reasoned action (adapted from Fishbein & Ajzen, 1975).

explanatory power of TRA by adding the construct of perceived behavioral control (PBC). Over the years, support for TPB as a model of general social behavior came from many studies. Several meta-analyses have found that the three constructs in TPB—attitude toward the behavior, subjective norm, and PBC—together account for between 39% and 50% of the variance in behavioral intention (e.g., Armitage & Conner, 2001).

In TPB, PBC refers to the perceived ease or difficulty of performing a particular behavior and the amount of control one has over the attainment of the goals from the said behavior. Actual and perceived personal inadequacies and external obstacles can interfere with the ability to perform a given behavior, and consequently with the perception of control that one has over the action and outcomes of the behavior. TPB was introduced to be applied in situations where people may lack volitional control over the behavior in question (Ajzen, 1991). In the context of technology-based behaviors, PBC has been found to correlate well with perceived ease of use or difficulty related to a particular technology, the latter of which has been found to be a major factor in predicting intention to use that technology (Compeau & Higgins, 1995; Davis, Bagozzi, & Warshaw, 1989; Teo, 2009).

In recent years, Ajzen (2002) decomposed the PBC construct into two components: controllability and self-efficacy. He noted that this term (PBC) has been taken to refer to the belief that performance of a behavior allows control over the attainment of an outcome. In TPB, Ajzen had meant PBC to denote the subjective degree of control over performance of the behavior itself. This is similar to the difference between efficacy expectation (i.e., the perceived ability to perform a behavior) and outcome expectation (i.e., the perceived likelihood that performing the behavior will produce a given outcome). To avoid misunderstanding, Ajzen clarified the conceptual and methodological ambiguities surrounding the concept of perceived behavioral control by redefining PBC as two separate components: self-efficacy and controllability. Controllability is defined as the individual's assessment about the availability of resources and opportunities to perform the behavior (e.g., facilitating conditions; Ajzen, 2002) whereas self-efficacy refers to people's judgment of their abilities to execute courses of action required to attain designated types of performance (Bandura, 1986). It is primarily concerned with what one believes one can do under a variety of circumstances rather than the number of skills one possesses. Bandura noted that the stronger an individual's perceived self-efficacy with regard to meeting his or her standard (goal), the more the individual will pursue his or her effort. The TPB is shown in Figure 2.

2.3. TAM

Like TPB, the TAM follows the common thread of belief–intention–behavior and has been applied extensively to examining user-acceptance of a wide array of information technologies.

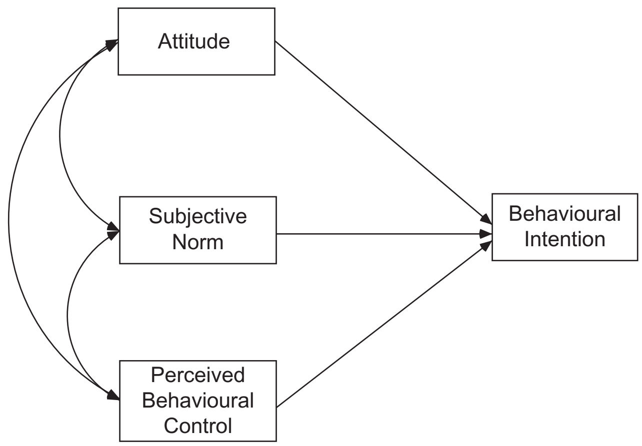

FIG. 2. Theory of planned behavior (adapted from Ajzen, 1991).

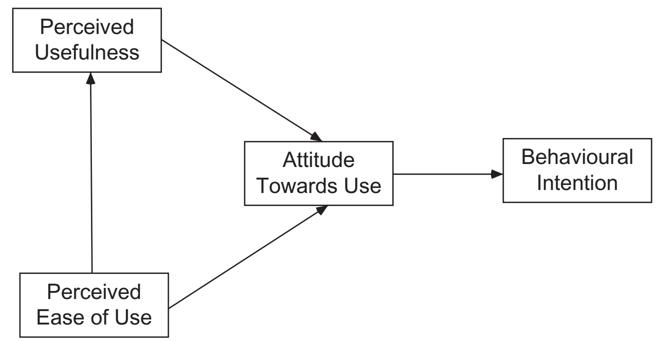

FIG. 3. Technology acceptance model (adapted from Davis, 1989).

Developed by Davis (1989), TAM describes how people's beliefs and attitudes are related to their intention to perform a behavior. In TAM, two beliefs—perceived usefulness and perceived ease of use—form the primary predictors of users' attitude or overall affect toward technology usage. Perceived usefulness is the extent to which a person believes that using a system will enhance her performance, and perceived ease of use is the extent to which a person believes that using the system will be relatively free of effort. Attitude toward use is posited to influence intention to use, which in turn influences actual usage behavior. Davis (1989) also hypothesized perceived usefulness to have a direct effect on intention, in addition to its indirect effect via attitude, to account for circumstances where utilitarian considerations may dominate users' decision to use information technology. In addition, Davis et al. (1989) also found perceived ease of use to be an antecedent of perceived usefulness. This is because, regardless of how useful a technology is, it will not be used if users perceive that a lot of effort will be required in order to use the technology.

Several studies have provided empirical support for the use of TAM (Hong, Thong, Wong, & Tam, 2002; Shin, 2009; Tan & Chou, 2008; Teo, 2009). In recent years, researchers have used TAM to examine the acceptance of various technology applications in educational contexts, such as an online learning portal (Drennan, Kennedy & Pisarski, 2005), word processing software (Shapka & Ferrari, 2003), an Internet-enhanced course (Pan, Sivo, & Brophy, 2003), the Internet (Riemenschneider, Harrison, & Mykytyn, 2003), and a course management system (Sivo, Pan, & Hahs-Vaughn, 2007). Although it was originally conceived as a model to explain technology acceptance in business and commercial environments, the results of research suggest that TAM is a stable and parsimonious model for applications in educational contexts (see, e.g., Drennan, Kennedy & Pisarski, 2005; Hasan & Ahmed, 2007). Figure 3 shows the TAM.

2.4. Integrated Model

Although the aforementioned models have been employed in several studies to examine the intention to use technology, few have compared these models to assess the level of contribution by each variable in explaining the intention to use technology. Within the models, various constructs are found in more than one model (e.g., attitude toward the behavior and intention are present in TRA, TPB, and TAM). Given their complementary nature, a model that integrates all the constructs from TRA, TPB, and TAM was proposed in this study to allow for a closer examination on whether this integrated model would explain more variance in the intention to use technology than any of the model alone. Figure 4 shows the integrated model.

2.5. Intention to Use

In this study, intention to use is used as the dependent variable because of its close link to actual behavior (e.g., Hu et al., 2003; Ma et al., 2005; Mathieson, 1991). It is reasonable to expect a person to do only what she or he intends to do. The close relationship between intention and behavior was supported by a meta-analysis of 87 studies employing TPB as the research framework showing that an average correlation of .53 between intention and actual behavior (Sheppard, Hartwick, & Warshaw, 1988).

2.6. Aim of the Study

The aim of this study is twofold. First, four models (TRA, TPB, TAM, and integrated model) are compared against each other to decide on the most parsimonious model. Second, the effects of these variables on the dependent variable are assessed.

3. METHOD

3.1. Participants and Procedure

Participants in this study were 429 full-time preservice teachers who were enrolled at a teacher training institute in Singapore. Preservice teachers were selected for this study because they (a) were regular users of technology, (b) exercised volition for their technology use (i.e., make decisions on

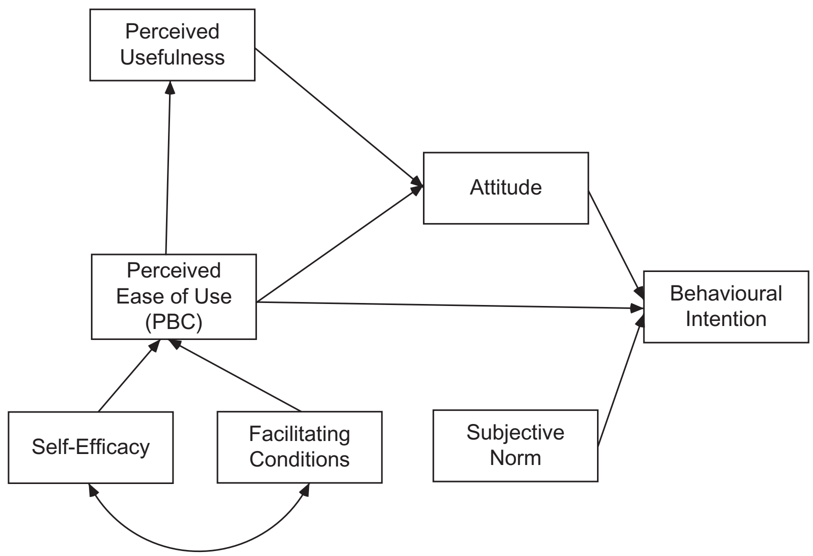

FIG. 4. Integrated model.

when to use technology, what technology to use, and how technology is used), and (c) were trained to be agents of change in technology use at their future workplaces (i.e., schools). In essence, preservice teachers used technology as a student and as a teacher-in-training. As students, they used technology for note taking, completing assignments, social networking, and conducting research. As teachers-in-training, the participants learned how to teach with technology, employ technology for assessment, design different strategies to engage learners, and deal with other issues in the use of technology in teaching and learning. Hence, it is reasonable to assume that experiences of the participants in this study to be representative of educational users of technology.

The 429 participants were enrolled in the 1-year Postgraduate Diploma in Education ($N = 216$) and the 4-year Bachelor degree in Arts/Science with Education ($N = 213$) programs. Both programs were taught in English. The mean age of all participants was 23.69 ($SD = 5.06$). They represent about 50% of the population in each program. Participants responded to an invitation issued by the author, and those who agreed to take part in this study were given a website address to access the online survey questionnaire in English. All participants had received a minimum of 16 years of schooling in English. They were briefed on the purpose of this study and told of their rights to withhold their participation during or after they had completed the questionnaire. No course credit or reward was given to the participants, who, on average, took about 10 min to complete the questionnaire.

3.2. Measures

A survey questionnaire was developed using items that were validated from previous studies and used with users in educational settings (e.g., Ma et al., 2005; Teo, 2009). In this questionnaire, participants provided their demographic information and responded to 28 items on the seven constructs in this study. These are Perceived Usefulness (PU; four items), Perceived Ease of Use/ Perceived Behavioural Control (PEU/PBC; six items), Attitude (ATT; three items), Subjective Norm (SN; three items), Self-Efficacy (SE; four items), Facilitating Conditions (FC; five items), and Intention to Use (ITU; three items). Each items was measured on a 7-point Likert scale with 1 (*strongly disagree*) to 7 (*strongly agree*). These items and the sources from which the items were adapted are listed in the appendix.

Based on a recent discussion of PBC (Azjen, 2002), PEU and PBC were combined into one construct in this study. An initial exploratory factor analysis of the measure demonstrated that items that were originally formulated for PEU and PBC loaded onto one factor and this result provided support for the decision to treat them as one construct in this study.

3.3. Statistical Analyses

In this study, a two-stage approach to data analysis was employed (Anderson & Gerbing, 1988). In the first step, the measurement model, which specifies the relationships between the latent constructs and the observed measures, is analyzed. The second step analyzes the structural model, which specifies the relationships among the latent constructs. The models were analyzed using Amos 7.0 and used a variance-covariance matrix as input and maximum likelihood as the method for estimation.

4. RESULTS

The statistical analyses in this section proceeded by examining the descriptive statistics of the 28 items and assessing for univariate normality. This was followed by establishing the reliability and construct validity of the measures used in this study. Next, the measurement model was assessed using confirmatory factor analysis. The structures of TRA, TPB, TAM, and the integrated model were then tested and compared. Finally, the effects of the independent variable on the dependent variables (intention to use) were assessed.

4.1. Descriptive Statistics

The descriptive statistics of the constructs are shown in Table 1. All means were above the midpoint of 4.00, ranging from 4.70 to 5.87. The standard deviations ranged from .93 to 1.20, and this was indicative of a narrow spread around the mean. The skew and kurtosis indices ranged from –.77 to –.07 and –.28 to .68, respectively. Following the guidelines presented by Kline (2005), the results for skew and kurtosis in this study suggested the presence of univariate normality. Because the reliability of results obtained by structural equation modeling was influenced by multivariate normality, it was necessary to assess the data for multivariate normality before proceeding with other analyses. Mardia's coefficient was used measure of multivariate normality, and its value obtained in this study was 360.374. This figure was less than the recommended value ((p (p+2), where p = total number of observed indicators) by Raykov and Marcoulides (2008); hence, the requirement of multivariate normality was satisfied. On this basis, the data for this study were considered adequate for structural equation modeling.

4.2. Test of the Measurement Model

The quality of the measurement model was tested via confirmatory factor analysis. Convergent validity was established by examining the significance, via t values, of individual item loadings. Hair, Black, Babin, Anderson, and Tatham (2006) suggested using fit indices from various categories. Absolute fit indices that measure how well the proposed model reproduces the observed data, parsimony indices are similar to absolute fit indices except that they take into account the model's complexity, and incremental fit indices assess how well a specified model fit relative to an alternative baseline model. In this study, the chi-square statistic, standardized root mean residual (SRMR), root mean square error of approximation (RMSEA), comparative fit index (CFI), and Tucker-Lewis index (TLI) were used. In addition, for a model to be assessed as a good fit, the chi-square normalized by degrees of freedom (χ^2/df) should not exceed 3.00 (Carmines & McIver, 1981) and the TLI and CFI should both exceed 0.90. The RMSEA and SRMR should both not exceed 0.08 to be considered adequate (Hair, et al., 2006).

TABLE 1
Descriptive Statistics of the Study Constructs

Construct	Items	*M*	*SD*	Skewness	Kurtosis
PU	4	5.68	.98	–.89	1.30
PEU/ PBC	6	4.82	1.13	–.42	–.08
ATT	3	5.12	1.08	–.47	.18
SN	3	4.70	1.13	–.07	–.28
SE	4	4.83	1.21	–.34	–.18
FC	5	4.47	1.13	–.14	–.26
ITU	3	5.87	.93	–.68	.22

Note. PU = Perceived Usefulness; PEU/PBC = Perceived Ease of Use/Perceived Behavioral Control; ATT = Attitude; SN = Subjective Norm; SE = Self-Efficacy; FC = Facilitating Conditions; ITU = Intention to Use.

Table 2 shows the factor loadings of each item on the constructs in the measurement model. All parameter estimates were significant at the $p < .05$ level, as indicated by the critical ratio (CR) or t value (greater than 1.96). In addition, we want to know the proportion of variance accounted for in the endogenous variables, and this was reflected in the R^2 values, all of which were above .50. The alpha values for each construct, which ranged from .86 to .95, were high (Nunnally & Bernstein, 1994), indicating that the items were internally consistent. Finally, there was adequate model fit for the measurement model, $\chi^2(317) = 846.31$, $\chi^2/df = 2.67$, TLI = .954, CFI = .961, RMSEA = .062, SRMR = .062. The adequacy of the measurement model indicated that the items were reliable indicators of the hypothesized constructs, thus allowing tests of the structural relationships in the various models to proceed.

4.3. Convergent and Discriminant Validity

Convergent validity, which examines whether individual indicators are indeed measuring the constructs they are purported to measure, was assessed using standardized indicator factor loadings, and they should be significant and exceed 0.7, and average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct (i.e., AVE should exceed 0.50). Table 3 indicates that, except for SN3, all item factor loadings of the seven constructs exceeded the minimum of 0.70. SN3 was not excluded from further analysis because it was statistically significant. The AVE values ranged between .71 for subjective norm to .85 for perceived usefulness, and these are well above the threshold value of 0.50. Hence, convergent validity was established for all of the measurement items in this study.

Discriminant validity, which assesses whether individual indicators can adequately distinguish between different constructs, is ensured if the square root of AVE for each construct is greater than the correlation between that and all other constructs in the model. The correlation matrix in Table 3 indicates that the square root of AVE (shown in parentheses along the diagonal) of each construct was higher (.84 to .92) than corresponding correlation values for that variable in all cases, thereby assuring discriminant validity.

TABLE 2
Measures of Convergent and Discriminant Validities, and the Measurement Model

Item	UFL	SFL	SE[a]	CR[b]	R^2	AVE[c]	α
Perceived Usefulness						.85	.95
PU1	.885	.87	.033	27.053	.76		
PU2	.978	.94	.029	34.319	.88		
PU3	1.000	.95	—	—	.89		
PU4	.950	.93	.030	31.667	.86		
Perceived Ease of Use/Perceived Behavioral Control						.73	.95
PEU/PBC1	.992	.92	.037	27.044	.85		.
PEU/PBC2	.996	.88	.025	39.207	.78		
PEU/PBC3	1.000	.90	—	—	.81		
PEU/PBC4	.949	.89	.026	36.452	.80		
PEU/PBC5	.729	.76	.037	19.517	.57		
PEU/PBC6	.790	.77	.038	20.755	.60		
Attitude						.82	.93
ATT1	1.045	.88	.038	27.402	.78		
ATT2	1.070	.94	.034	31.803	.89		
ATT3	1.000	.90	—	—	.81		
Subjective Norm						.71	.86
SN1	1.793	.92	.120	14.957	.84		
SN2	1.000	.94	—	—	.89		
SN3	.543	.63	.036	25.268	.40		
Self-Efficacy						.82	.95
SE1	.758	.80	.031	24.651	.65		
SE2	1.006	.94	.026	39.021	.88		
SE3	1.000	.95	—	—	.89		
SE4	.966	.93	.026	36.937	.86		
Facilitating Conditions						.71	.93
FC1	.743	.72	.040	18.368	.53		
FC2	.817	.78	.040	20.316	.60		
FC3	1.000	.89	—	—	.79		
FC4	1.009	.90	.037	27.196	.81		
FC5	1.016	.91	.036	27.909	.82		
Intention to Use						.81	.95
ITU1	1.134	1.00	.031	36.630	1.00		
ITU2	.793	.77	.033	23.952	.59		
TU3	1.000	.92	—	—	.84		

Note. Parameter fixed at 1.0 in the original solution. UFL = unstandardized factor loading; SFL = standardized factor loading; CR = critical ratio; AVE = average variance extracted.

[a]Estimate of the standard error of the covariance. [b]Critical ratio obtained by dividing the estimate of the covariance by its standard error. [c]Average variance extracted = $(\sum\lambda 2)\ /\ n$.

4.4. Test of Structural Models

Table 4 shows the structural coefficients of each path in the four models and the total variance (R^2) of each dependent variable explained by its determinants in the models.

TRA. As noted in Table 4, attitude and subjective norm were significantly related to intention to use, but attitude had a stronger relationship to intention to use. The predictive power of TRA was greater than 50% (R^2 = .547%) and was comparable to that of the other models.

TPB. From Table 4, attitude and subjective norm were significant influences on intention to use, but PBC was not. The predictive power (R^2 = 0.542) of TPB model was closer to that of TRA, compared to the rest, and this is expected because TPB was an extension of TRA. However, the variance of PBC accounted for by self-efficacy and facilitating conditions

TABLE 3
Results for the Test of Discriminant Validity

	PU	PEU/ PBC	ATT	SN	SE	FC	ITU
PU	(.92)						
PEU/PBC	.53	(.85)					
ATT	.63	.65	(.91)				
SN	.38	.35	.37	(.84)			
SE	.48	.85	.60	.29	(.91)		
FC	.32	.52	.36	.34	.43	(.84)	
ITU	.57	.51	.69	.37	.45	.31	(.90)

Note. All correlation coefficients significant at $p < .01$. Diagonal in parentheses: square root of average variance extracted from observed variables (items). Off-diagonal values: Pearson's correlation between constructs. PU = Perceived Usefulness; PEU/PBC = Perceived Ease of Use/Perceived Behavioral Control; ATT = Attitude; SN = Subjective Norm; SE = Self-Efficacy; FC = Facilitating Conditions; ITU = Intention to Use.

was high ($R^2 = 0.79$). As in TRA, attitude had the strongest relationship with intention to use in TPB.

TAM. From Table 4, all paths in TAM were statistically significant. In terms of predictive power, TAM accounted for 55.1% of the variance in intention to use, 58.7% of the variance in attitude, and 29.4% of the variance in perceived usefulness. Consistent with the results for TRA and TPB, attitude had the strongest relationship with intention to use.

Integrated model. From Table 4, all paths except PBC → ITU were significant. Attitude had the greatest direct influence on intention to use. As in the TPB model, self-efficacy had a stronger influence on PBC than facilitating conditions. Although self-efficacy and facilitating conditions were significant influences on PBC, PBC was not a significant influence on intention to use. In terms of predictive power, the integrated model accounted for 54.9% of the variance in intention to use, 58.7% of the variance in attitude, 29.8% in perceived usefulness, and 78.4% of the variance in perceived behavioral control.

4.5. Model Comparison

This study compares four models: TRA, TPB, TAM, and the integrated model. Given the minuscule differences (less than 1%) in variance explained in the final outcome (behavioral intention), it seems that a comparison in terms of estimates of parameter and fit, and statistical inference of difference would not be helpful. More useful is the assessment of effect size of each variable. However, in terms of TLI and CF all four models were satisfactory with values exceeding .90 (see Table 5).

4.6. Assessment of Effect Size of Each Variable

Table 6 shows the standardized direct, indirect, and total effects on intention to use. A coefficient linking one factor to another in the path model represents the direct effect of a determinant on an endogenous variable. An indirect effect reflects the impact a determinant has on a target variable through its effect on one or more other intervening variables in the model. A total effect on a given factor is the sum of the respective direct and indirect effects. Interpretation of the effect sizes was based on the recommendations by Cohen (1988), with values up to 0.2 considered small. Values from 0.5 and above are medium, and those with 0.8 or more considered large. Analysis of the effects of one factor on another provides

TABLE 4
Structural Coefficients for the Various Models

Relationship	TRA	TPB	TAM	Integrated
ATT → ITU	.699***	.675***	.742***	.705***
SN → ITU	.106***	.105***		.105***
PBC → ITU		.034		.013
PU → ATT			.416***	.408***
PEU → ATT			.457***	463***
PEU → PU			.542***	.546***
SE → PBC		.807***		.801***
FC → PBC		.161***		.165***
Explanatory power (R^2)				
Intention to Use	.547	.542	.551	.549
Attitude			.587	.587
Perceived Usefulness			.294	.298
Perceived Behavioral Control		.790		.784

Note. Although treated as one construct, PEU and PBC are differentiated in this table to reflect their role in the respective models. TRA = theory of reasoned action; TPB = theory of planned behavior; TAM = technology acceptance model; ATT = Attitude; ITU = Intention to Use; SN = Subjective Norm; PBC = Perceived Behavioral Control; PU = Perceived Usefulness; PEU = Perceived Ease of Use; SE = Self-Efficacy; FC = Facilitating Conditions.

$^{***}p < .001$.

TABLE 5
Fit Indices of the Various Models

Model	χ^2	*df*	TLI	CFI	RMSEA	SRMR
1. TRA	163.961	24	.944	.962	.117	.088
2. TPB	1181.414	241	.905	.917	.095	.074
3. TAM	475.891	100	.944	.953	.094	.054
4. Integrated	1405.916	339	.912	.921	.086	.081

Note. TLI = Tucker-Lewis index; CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean residual; TRA = theory of reasoned action; TPB = theory of planned behavior; TAM = technology acceptance model.

information on the strength of the relationship between factors or variables under study.

Across the models, the most dominant direct effect on intention to use was attitude, with a total effect ranging from of 0.68 (TPB) to 0.74 (TAM). These values are close to being regarded as large effects (Cohen, 1988). Subjective norms had a small effect (0.11) on intention to use, followed by perceived ease of use/perceived behavioral control. However, the latter had medium indirect effects (0.51 for TAM and 0.48 for the integrated model) on intention to use. Facilitating conditions and self-efficacy had small indirect effects on intention to use, although the effect size of the latter was close to medium (0.40) for the integrated model.

5. DISCUSSION

The first aim of this study was to compare four models (TRA, TPB, TAM, integrated) to determine the most parsimonious model and assess the effect of each variable in these models on the dependent variable (intention to use). However, little differences were found between the integrated model and the other models. The second aim of this study was to examine the effect of each independent variable on the dependent variable. Attitude appeared to be the most important determinant of the intention to use technology. The path coefficients from attitude to intention were consistently the highest in all the models examined. This highlights the critical role of attitude in technology acceptance decision making by users and therefore singles out the importance of attitude development and cultivation to successful technology implementation.

Perceived ease of use did not have a large effect on intention to use technology. However, it exerts an indirect effect through perceived usefulness and attitude. This is consistent with the results of some prior studies that examined the relationship between perceived ease of use and intention to use (e.g., Hong et al., 2002). As teachers-in-training, the participants in this study have to engage technology in many aspects of their studies, from taking lectures notes to using presentation tools for assessment purposes. Under such circumstances, it was possible that the preservice teachers in this study were more influenced by their perceived usefulness of technology than their perception on how easy it was to use technology.

TABLE 6
Direct, Indirect, and Total Effects on Intention to Use in Research Models

Effect on Intention to Use	TRA	TPB	TAM	Integrated
Direct effect				
Attitude	.70	.68	.74	.71
Perceived Ease of Use/ Perceived Behavioral Control		.03		.02
Subjective Norm	.11	.11		.11
Indirect effect				
Perceived Usefulness			.31	.29
Perceived Ease of Use/ Perceived Behavioral Control			.51	.48
Facilitating Conditions		.01		.08
Self-Efficacy		.03		.40
Total effect				
Attitude	.70	.68	.74	.71
Perceived Usefulness			.31	.29
Perceived Ease of Use/ Perceived Behavioral Control		.03	.51	.50
Subjective Norm	.11	.11		.11
Facilitating Conditions		.01		.08
Self-Efficacy		.03		.40

Note. TRA = theory of reasoned action; TPB = theory of planned behavior; TAM = technology acceptance model.

Next, perceived usefulness had a small effect on users' intention to use technology. This finding has several implications. First, users in education tended to be pragmatic in their technology acceptance decisions, appearing to focus on the usefulness in technology. For example, the preservice teachers in this study may use (or accept) a technology if it is considered to be useful to their studies. Second, perceived usefulness was a significant determinant of attitude, demonstrating its ability to influence the attitude formation process. This finding is consistent with the results from many prior studies that examined the effect of perceived usefulness on attitude (e.g., Teo, 2009). The observed limited effect of perceived usefulness in this study might have been partially explained by the preservice teachers' lack of familiarity with specialized technologies for use in education, hence the focus on utility or usefulness.

Although self-efficacy had a medium indirect effect on intention to use, it was a significant predictor of perceived ease of use. It is possible that the preservice teachers in this study already possessed a certain level of computer skills and knowledge before their enrollment in teacher training, thus allowing self-efficacy to influence perceived ease of use in a way that indirectly affected their intention to use technology.

In the integrated model, subjective norm and facilitating conditions had very small effects on intention to use. It is possible that the preservice teachers' perceptions on the use of technology in education had been influenced by their past experiences and interactions with technology to an extent that they had place less weight on others' opinions (subjective norms). In addition, they also did not give much weight to the support that they received during their training (facilitating conditions) because they may have possessed sufficient skills and knowledge to use technology effectively without much assistance. In addition, the results demonstrate that the preservice teachers' perceptions of support did not influence perceived ease of use to the degree than self-efficacy did in this study.

There are several limitations to this study. This study used self-reports as the tool for data collection. Although the affordances of self-reports are widely recognized as valuable in the social sciences, they are vulnerable to a number of biases. A specific professional group—preservice teachers—was used as participants in this study. Despite the rationale for using such a sample in this study being given (see section 3.1), caution needs to be taken when generalizing the results to other population groups (e.g., students and commercial technology users). Finally, because this sample was collected in Singapore, there are limitations in generalizing the results to other countries due to cultural differences in technology usage. Hence, the four competing models should be further tested by using samples from other national cultures in order to obtain a more comprehensive understanding of and further insights into these models and their interactions.

6. CONCLUSION

This study contributes to the literature by generating empirical evidence that highlighted plausible differences among TRA, TPB, TAM, and an integrated model in explaining or predicting the intention to use technology among preservice teachers. These four models were able to account for more than half the portion of observed variance on intention to use, although an increase in the number of variables did not improve their explanatory utility for intention to use. This finding signaled a need for a broader exploration of factors beyond TRA, TPB, and TAM. From the theory-testing perspective, this study represented an initial effort to validate or extend the research results from existing studies to empirically investigate the intention to use to use technology among preservice teachers.

Future research may include a search for additional or mediating factors that impact on the intention to use technology in educational contexts. These may include factors such as user-participation and involvement, previous usage and experience, interaction experience (van Schaik & Ling, 2005), and other user-characteristics. Although these may provide additional insights into intention to use, there is no guarantee that the explanatory or predictive power of any model would be improved. Further theory expansion through model integration may be performed to provide an avenue for identifying additional or mediating factors or developing theoretical frameworks with potential to advance our understanding of technology acceptance in education.

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APPENDIX: List of constructs and their items

Construct	Item	
Perceived Usefulness (adapted from Davis, 1989)	PU1	Using technology enables me to accomplish tasks more quickly.
	PU2	Using technology improves my performance.
	PU3	Using computers will increase my productivity.
	PU4	Using technology enhances my effectiveness.
Perceived Ease of Use/ Perceived Behavioural Control (adapted from Davis, 1989; Thompson et al., 1991)	PEU/PBC1	I find it easy to use technology to do what I want to do.
	PEU/PBC2	My interaction with technology does not require much effort.
	PEU/PBC3	It is easy for me to become skilful at using technology.
	PEU/PBC4	I find computers easy to use.
	PEU/PBC5	I have control over technology
	PEU/PBC6	I have the knowledge necessary to use technology.
Attitudes (adapted from Compeau & Higgins, 1995; Thompson et al., 1991)	ATT1	I look forward to those aspects of my job that require me to use technology
	ATT2	I like working with technology
	ATT3	I have positive feelings towards the use of technology.
Subjective Norm (adapted from Taylor & Todd, 1995)	SN1	People who influence my behaviour think that I should use technology.
	SN2	People who are important to me will support me to use technology.
	SN3	People whose views I respect support the use of technology.
Self-Efficacy (Compeau & Higgins, 1995)	SE1	I can learn to use new technology easily.
	SE2	I can use technology even if there is no one to teach me.
	SE3	I can use technology with minimal help.
	SE4	I can figure out how to use technology on my own.
Facilitating Conditions (Thompson et al., 1991)	FC1	Guidance is available to me in selecting the technology to use.
	FC2	Specialized instruction concerning technology is available to me.
	FC3	When I encounter difficulties in using technology, a specific person is available to provide assistance.
	FC4	When I encounter difficulties in using technology, I know where to seek assistance.
	FC5	When I encounter difficulties in using technology, I am given timely assistance.
Behavioral Intention (adapted from Davis, 1989)	BI1	I intend to continue to use technology in the future.
	BI2	I expect that I would use technology in the future.
	BI3	I plan to use technology in the future.