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Evaluating the Intention to Use Technology among Student Teachers: A Structural Equation Modeling Approach

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This study examined student teachers' self-reported intentions to use technology. One hundred and fifty-nine participants completed a survey questionnaire measuring their responses to four constructs derived from the Technology Acceptance Model (TAM). Using Structural Equation Modeling (SEM), a path analysis was conducted to analyze the data. The results of this study showed that the TAM is a valid model in explaining student teachers' intention to use technology. Overall, this study indicated that attitude towards computer use had the largest effect on the intention to use technology, followed by perceived usefulness and perceived ease of use.

Keywords: technology acceptance model, intention, structural equation modeling

Teachers, like employees in the businesses, are faced with situations where they need to use sophisticated tools to fulfill their job requirements. In many educational systems, technology has been recognized as one of the key drivers for the improvement of teaching and learning. Faced with governmental initiatives and considerable capital investments to build and maintain support info-communications technology (ICT) infrastructures in the schools, teachers experience the pressures to navigate between pedagogy and technology usage seamlessly (Pelgrum, 2001). Attendant to this is a necessity to examine teachers' willingness to employ technology in teaching and learning. The importance of this issue is exemplified by the numerous studies that have been conducted to examine the factors that influence users' acceptance of technology. A topic that has occupied researchers for the last two decades, researchers were interested in identifying the conditions or factors that influence technology acceptance and usage (Legris, Ingham, & Collerette, 2003). Arising from this interest, models were developed to help in predicting and explaining technology acceptance. Among these, the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) has received widespread attention and usage. Over the years, the TAM has been widely accepted as a robust and parsimonious model to be used across gender, settings, and times (e.g. Cheung & Huang, 2005; Drennan, et al., 2005; Groves & Zemel, 2000; Liaw & Huang, 2003; Pan, Sivo, & Brophy, 2003). For example, Teo, Lee, and Chai (2008) found that the attitude construct in the TAM could account for 42% of the variance explained by

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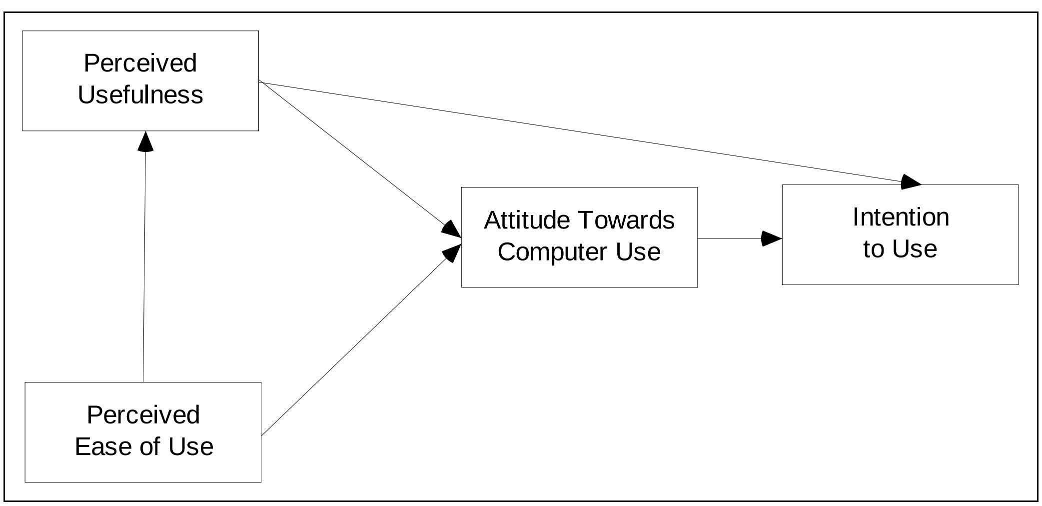
perceived usefulness, perceived ease of use, subjective norm, and facilitating conditions. In another study with attitude as the dependent variable in the TAM framework, Teo and Van Schiak (2009) found that the same exogenous variables explained 61% of the variance in attitude. For its predictive ability in studies involving student teachers (e.g. Kiraz & Ozdemir, 2006; Ma, Anderson, & Streith, 2005; Teo, 2009), the TAM was chosen as the framework in this study. Given that student teachers are future teachers, it is important to understand their reactions towards technology, in particular, the drivers of student teachers' intention to use technology.

The purpose of this study is to examine student teachers' intention to use technology within context of the TAM as a research framework.

TECHNOLOGY ACCEPTANCE MODEL (TAM)

The TAM was proposed by Davis et al. (1989) to explain IT users' intention and behavior regarding IT usage. Two salient beliefs were identified in the TAM, perceived usefulness and ease of use, as the primary predictors of user's attitude or overall affect toward IT usage (Figure 1). 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. User attitude is posited to influence behavioral intention to use technology, which in turn, influences actual usage behavior. Davis et al. 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 technology over and above any negative attitude toward such usage. In addition, a positive association between perceived usefulness and ease of use was also hypothesized in the TAM.

Figure 1. Technology Acceptance Model. Adopted from Davis, Bagozzi & Warshaw (1989).



The TAM is among the first models to include psychological factors that affect technology acceptance. It has shown to be capable of explaining user behavior across a broad range of end-user computing technologies and user populations (Legris, Ingham, & Collerette, 2003, Teo, 2008; Teo, 2009). In the TAM, behavioral intention to use a particular technology is an important factor that determines whether users will actually utilize technology or not. Over the years, research has provided evidence for the close relationship between behavioral Intention and actual usage. For example, Yi and Hwang (2003) found a direct and significant influence ($\beta = 0.19$; $p < .001$) between behavioral intention and actual usage of the web-based environment in their study.

From Figure 1, intention to use is directly influenced by attitude towards computer use, as well as the direct and indirect effects of perceived usefulness and perceived ease of use. Both perceived usefulness and perceived ease of use jointly affect attitude towards usage, whilst perceived ease of use has a direct impact on perceived usefulness.

PERCEIVED USEFULNESS (PU)

In the TAM, perceived usefulness (PU) refers to the degree to which a person believes that using technology will enhance his or her job performance (Davis et al., 1989). It was posited that a person's tendency to use or not to use technology is influenced by his/her belief on the extent to which using technology would enhance job performance (Davis et al.). This includes decreasing the time for doing the job, and achieving more efficiency and accuracy. From another perspective, Phillips, Calantone, and Lee (1994) regarded perceived usefulness to be indicative of the prospective users' subjective probability that using technology will be beneficial to his/her personal and/or the adopting organization's well-being. Teo, Lee, and Chai (2008) found that perceived usefulness is also an antecedent of attitude and that perceived usefulness to be a significant influence on attitude towards computer use (β= .46). PU is believed to exert direct influences on intention to use and attitude towards computer use.

PERVEIVED EASE OF USE (PEU)

Perceived ease of use (PEU) refers to the degree to which a person believes that using a particular technology will be free of effort (Davis et al., 1989). While users may believe that technology is useful, they may be, at the same time, perceive it to be too difficult to use and that the benefits of usage do not justify the amount of effort needed to use the technology (Davis, 1989). As such, it is possible that technology with a high level of perceived usefulness is more likely to induce positive attitudes. Furthermore, the relation between PU and PEU is that PU mediates the effect of PEU on attitude (Teo, Lee, & Chai, 2008). In other words, while PU has direct impacts on attitude, PEU influences attitude indirectly through PU.

ATTITUDE TOWARDS COMPUTER USE (ATCU)

Attitude guides behavior and refers to the way an individual respond to and is disposed towards an object (Ajzen & Fishbein, 2005). This response or disposition may be negative or positive. In the educational milieu, any initiatives to implement technology in an educational program depend strongly on the support and attitudes of teachers involved. For example, if teachers believed or perceived computers not to be fulfilling their own or their students' needs, they are likely to resist any attempts to use computers in the teaching and learning process (Yildrim, 2000). In other words, attitudes, whether positive or negative, affect how teachers react to technology in an instructional setting. Yildrim (2000) also stressed that it is unlikely for teachers with negative attitudes toward computers to be able to encourage their students to use computers. Suffice to say, no matter how sophisticated and powerful the state of technology is, the extent to which it is employed for teaching and learning depends on teachers having a positive attitude toward it (Huang & Liaw, 2005).

INTENTION TO USE (ITU)

The TAM implies that two behavioral beliefs, PU and PEU, have influence on the intention to use technology. In contrast to PU and PEU, which refer to outcome expectancy and process expectancy respectively (Liaw, 2002), ITU leads to the actual use of technology. The validity of this claim has been demonstrated across a variety of contexts where technology was used (e.g. Chau, 2001; Fusilier & Durlabhji, 2005). With sufficient research support of a strong link between intention to use and actual usage (e.g. Mathieson, 1991; Hu, Clark, & Ma, 2003), ITU is used as the dependent variable in this study. The student teachers in this study have used technology for personal and academic reasons, but most of them possess little or no experience in using technologies in the classrooms. As such it is deemed more accurate to measure respondents' intention rather than their actual use. The practice of using ITU on student teachers is widely reported in the literature (e.g. Hu, et al., 2003; Liaw & Huang, 2003). From the above discussion, the five hypotheses were formulated:

H1: Perceived Ease of Use has a significant positive influence on Perceived Usefulness
H2: Perceived Ease of Use has a significant positive influence on Attitude Towards Computer Use
H3: Perceived Usefulness has a significant positive influence on Attitude Towards Computer Use
H4: Perceived Usefulness has a significant positive influence on Intention to Use
H5: Attitude Toward Computer Use has a significant positive influence on Intention to Use

This study aims to answer the following research questions:

1. To what extent is the TAM a valid model to explain the intention to use technology among student teachers?
2. To what extent does each construct in the TAM affect the intention to use technology among student teachers?

METHOD

PARTICIPANTS AND PROCEDURES

Participants were 159 student teachers who were enrolled at the National Institute of Education (NIE) in Singapore. An invitation to participate in this study was made to students enrolled in a nine-month Postgraduate Diploma in Education Primary (PGDE-P) program. The participants in this study form about 40% of the student population in this program. Among them, 57.2% were female. The mean age of all participants was 27.05 (*SD*=4.86). Participants who volunteered were briefed on the purpose of this study and told of their rights to withdraw from the study before, during or after they had completed the questionnaire. On average, each participant took no more than 20 minutes to complete the questionnaire.

INSTRUMENT

A survey questionnaire comprising previously validated items was used. These items had undergone exploratory and confirmatory factor analyses and found to be valid and reliable in other studies such as Teo (2008, 2009) and Wong and Teo (2009). The list of items and their sources are shown in the Appendix. Participants were asked to give their demographic information and respond to 12 statements on the four constructs in his study. They are: perceived usefulness (PU) (three items), perceived ease of use (PEU) (three items), attitudes towards computer use (ATCU) (three items), and intention to use (ITU) (three items). Each statement was measured on a five-point Likert scale with 1 = strongly disagree to 5 = strongly agree.

DATA ANALYSIS METHOD

This study employs a structural equation modeling (SEM) approach to develop a model that represents the relationships among the four variables in this study: behavioral intention to use, attitudes towards computer use, perceived usefulness, and perceived ease of use. Data was collected through the use of a survey questionnaire that comprises questions on participants' characteristics and multiple items for each variable in the study. In this study, structural equation modeling was chosen over the usual regression analysis that has been used for this kind of study. Structural equation modeling allows for simultaneous analysis to be performed for assessing the relationships among variables and errors for each variable to be independently estimated, something that traditional regression technique cannot do.

The usual steps for doing SEM are followed in this study: (a) data were screened for missing data and outliers, (b) convergent and discriminant validities of the data were established, (c) issues pertinent to structural equation modeling were addressed. For example, to ensure a fair level of normality in the data, Kline (2005) recommends that the skew and kurtosis indices should not exceed an absolute value of 3 and 10 respectively. To get reliable results in structural equation modeling, researchers recommend that a sample size of 100 to 150 cases (e.g. Hair, Black, Babin, Anderson, & Tatham, 2006; Kline, 2005). The sample size of this study is 159 and meets the recommended guidelines.

RESULTS

The statistical analyses in this section include examining the descriptive statistics of the measurement items and assessing the reliability and validity of the measure used in this study. This is followed by testing for model fit and hypotheses by using various fit indices.

DESCRIPTIVE STATISTICS

The descriptive statistics of the constructs are shown in Table 1. All means are above the midpoint of 3.00. The standard deviations range from .61 to .71 and this indicate a narrow spread around the mean. The skew index ranges from -.37 to .16 and kurtosis index ranges from -.62 to .46. Following Kline's (2005) recommendations that the skew and kurtosis indices should not exceed an absolute value of 3 and 10 respectively, the data in this study is regarded as normal for the purposes of structural equation modeling.

Table 1. Descriptive Statistics of the Study Constructs

Construct	Item	Mean	Standard Deviation	Skewness	Kurtosis
PU	3	3.82	.69	-.37	.46
PEU	3	3.59	.71	-.26	.48
ATU	3	3.73	.62	.13	.14
ITU	3	3.95	.61	.16	-.62

PU= Perceived Usefulness; PEU= Perceived Ease of Use; ATCU= Attitude Towards Computer Use; ITU= Intention to Use

CONVERGENT VALIDITY

In assessing for convergent validity of the measurement items, the item reliability of each measure, composite reliability of each construct, and the average variance extracted are examined. The item reliability of an item was assessed by its factor loading onto the underlying construct. In this study, the composite reliability was used instead of the Cronbach's alpha because the latter tends to understate reliability (Hair et al., 2006). For composite reliability to be adequate, a value of .70 and higher was recommended (Nunnally & Bernstein, 1994). The third indicator of convergent validity, average variance extracted, is a measure of 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. From Table 2, the average variance extracted and composite reliability met the recommended guidelines, indicating that the convergent validity for the proposed items and constructs in this study are adequate.

Table 2. Results for the Measurement Model

Latent Variable	Item	Factor loading	[a]Average variance extracted (> .50)*	[b]Composite reliability (> .70)*
Perceived Usefulness			.71	.96
	PU1	.82		
	PU2	.89		
	PU3	.81		
Perceived Ease of Use			.64	.92
	PEU1	.79		
	PEU2	.86		
	PEU3	.74		
Attitude Towards Computer Use			.60	.93
	ATCU1	.75		
	ATCU2	.87		
	ATCU3	.69		
Intention to Use			.53	.95
	ITU1	.57		
	ITU2	.87		
	TIU3	.72		

* Indicates an acceptable level of reliability or validity

[a]AVE: Average Variance Extracted. This is computed by adding the squared factor loadings divided by number of factors of the underlying construct.

[b]Composite Reliabilty= $(\sum\lambda)^2/ (\sum\lambda)^2+(\sum\delta)$

DISCRIMINANT VALIDITY

Discriminant validity is present when the variance shared between a construct and any other construct in the model is less than the variance that construct shares with its indicators (Fornell, Tellis, & Zinkhan, 1982). To assess for discriminant validity, the square root of the average variance extracted (AVE) for a given construct was compared 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, this suggests that a construct is more strongly correlated with its indicators than with the other constructs in the model. In Table 3, the diagonal elements in the correlation matrix have been replaced by the square roots of the average variance extracted. Discriminant validity appears satisfactory at the construct level in the case of all constructs.

Table 3. Discriminant Validity for the Measurement Model

Construct	PU	PEU	ATCU	ITU
PU	(.84)			
PEU	.49*	(.80)		
ATCU	.56*	.47*	(.77)	
ITU	.57*	.47*	.73*	(.73)

(1) **p*< .01
(2) Diagonal in parentheses: square root of average variance extracted from observed variables (items); Off-diagonal: correlations between constructs

TEST OF THE MEASUREMENT MODEL

The research model in this study was tested using the structural equation model approach, using the computer software program AMOS 7.0 (Arbuckle, 2006). A variety of indices was used in this study. Hair et al., (2006) suggested using fit indices from various categories. These are absolute fit indices that measure the degree of the overall discrepancy between the implied and observed covariance matrices. They include the χ^2 statistic, and the standardized root mean residual (SRMR). The next category, parsimonious indices is similar to the absolute fit indices except that it takes into account the model's complexity. The root mean square error of approximation (RMSEA) is widely used as a parsimonious fit index. Finally, the incremental fit indices assess how well a specified model fit relative to an alternative baseline model. Examples of incremental fit indices are the comparative fit index (CFI) and Tucker-Lewis index (TLI).

Table 4 shows the level of acceptable fit and the fit indices for the proposed research model in this study. Except for the χ^2, all values satisfied the recommended level of acceptable fit. In the case of the χ^2, it has been found to be too sensitive an increase in sample size and the number of observed variables (Hair et al. 2006). For these reason, the ratio of χ^2 to its degree of freedom be computed (χ^2 /df) was used, with a ratio of three or less being indicative of an acceptable fit between the hypothetical model and the sample data (Carmines & McIver, 1981).

Table 4. Fit Indices for the Research Model

Model fit indices	Values	Recommended guidelines	References
$\chi 2$	85.709 p <.001	Non-significant	Klem, 2000; Kline, 2005; McDonald and Ho, 2002
$\chi 2$ /df (deg. of freedom)	1.905	< 3	Kline, 2005
TLI	.951	=> .90	Klem, 2000; McDonald and Ho, 2002
CFI	.967	=> .90	Klem, 2000; McDonald and Ho, 2002
RMSEA	.076 (.051, .100)	< .05	McDonald and Ho, 2002
SRMR	.045	< .05	Klem, 2000; McDonald and Ho, 2002

TEST OF THE STRUCTURAL MODEL

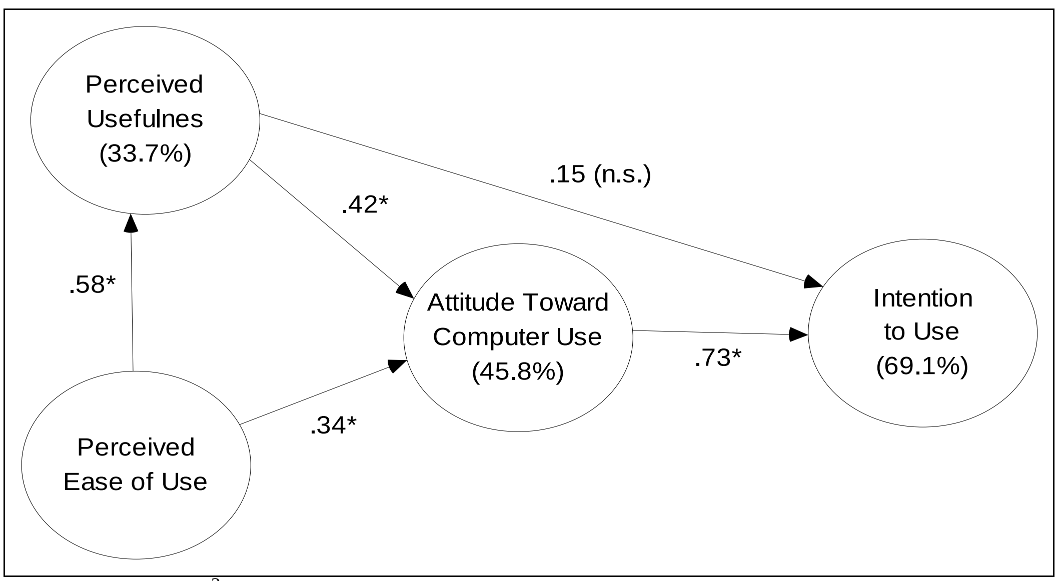
Table 5 shows the results of the hypothesis test and path coefficients of the proposed research model. Overall, four out of five hypotheses were supported by the data. Three endogenous variables were tested in the research model. Intention to use was found to be predicted by perceived usefulness, perceived ease of use, and attitude towards computer use, resulting in an R^2 of 0.691. This means that PU, PEU, and ATCU explained 69.1 percent of the variance in ITU. The other two endogenous variables, perceived usefulness and attitude towards computer use, had their variances explained by their determinants in amounts of 33.7% and 45.8% respectively (Figure 2).

Table 5. Hypothesis Testing Results

Hypotheses	Path	Path coefficient	t- value	Results
H1	PEU → PU	.619	6.473*	Supported
H2	PEU → ATCU	.326	3.331*	Supported
H3	PU → ATCU	.376	4.180*	Supported
H4	PU → ITU	.120	1.778	Not Supported
H5	ATCU → ITU	.640	6.133*	Supported

* $p < .001$

Figure 2. Standardised Path Coefficients in the TAM.



Note: * $p < .01$; R^2 values are shown in parentheses.

DISCUSSION

This paper examines the extent to which the TAM is a valid model to explain the intention to use technology among student teachers and the degree each construct in the TAM influences the intention to use technology among student teachers. The results of this study suggest that TAM is a useful tool in evaluating the intention to use technology. Overall, the three variables contributed to 69.1% of the variance in the intention to use technology among student teachers. The constructs in the TAM, perceived usefulness, perceived ease of use, and attitude towards computers were instrumental in determining the intention to use technology. Student teachers' intention to use technology was influenced by a positive attitude towards computer use. Positive attitudes towards computer use were developed when student teachers believe that technology would improve their work performance and make them more efficient, and that technology is easy to use. The results are consistent with current research that suggests that a positive feeling towards the use of technology was associated with factors that foster continued and sustained use of technology (e.g. Teo, 2006; Yildirim, 2000).

Of the five hypotheses in this study, one was not supported. Unlike others in the research model, the path from perceived usefulness to intention to use is not significant. However, perceived usefulness influenced intention to use indirectly through attitude towards computer use. Winters, Chudoba, and Gutek (1998) and Teo, Lee and Chai (2008) suggested that attitude was a significant predictor of the intention to use technology when users have the freedom of choice whether or not to use computers. It is possible that the student teachers in this study were volitional users who had the freedom to decide when to use technology and how technology was used in their teacher training. This being the case, the path from attitude towards computer use to intention to use was greater than the other paths (.73). To the participants in this study, a positive attitude towards computer use was a stronger driver than their perceived usefulness for the intention to use technology.

Three other hypotheses were significant: perceived usefulness → attitude towards computer use (.42), perceived ease of use → perceived usefulness (.58), and perceived ease of use → attitude towards computer use (.34). It is noteworthy that, although perceived ease of use has a significant influence on attitude towards computer use, the former exerted a greater influence on perceived usefulness. Also, the influence on attitude towards computer use by perceived usefulness is stronger than that by perceived ease of use. Although perceived usefulness and perceived ease of use are core belief constructs in the TAM, Davis et al. (1989) noted that as users become more experienced with technology, perceived usefulness would be stronger than perceived ease of use in the development of a positive attitude towards computer use. It appeared in this study that the significance of perceived ease of use on attitude towards computer use was mediated by perceived usefulness.

In the present study, most of the participants were familiar with technology used in an educational setting. These include MS PowerPoint, MS Word, MS Excel, Internet, and Learning Management Systems. As such, it may explain why the relationship between perceived ease of use and attitude was not as strong as that of perceived usefulness and attitude. However, it is reasonable to suspect that when the technology become more complex and the stimuli more diverse, the perceived ease of use construct may be more significant than that was found in this study.

A contribution of this study is the use of the TAM in understanding behavioral intention to use technology among student teachers. The TAM was conceptualized under conditions more akin to the business settings. Establishing its usability allows educational researchers to take a step towards theory and model expansion towards a greater understanding of technology acceptance issues in education. This study also used SEM to examine the interaction among the four constructs in the TAM. In contrast to multiple regression techniques that measure mainly the direct relationships between the independent variables and the dependent variables, SEM allows the examination of direct and indirect effects among the exogenous and endogenous variables.

IMPLICATIONS FOR PRACTICE

The above section suggests that perceived usefulness, perceived ease of use, and attitude towards computer use do not remain static. In education, users who perceive technology to be useful and easy to use may soon experience limitations if they do not participate in professional development with a view to upgrade their technical and pedagogical skills. For practicing teachers, they may soon feel insecure when they have to teach students, who are mostly digital natives, how to use technology for learning. These students are likely to be more savvy in using technology than the teachers (Sugar, Crawley and Fine, 2004). From the perspective of attitude formation, when teachers are supported by effective support structures to provide them with successful experiences in technology, they would develop positive attitudes toward computer use which in turn reinforces their intention to use technology over time.

Perceived usefulness and perceived ease of use are two belief constructs that have been shown to be significant determinants of attitude towards usage and subsequently intention to use technology. As teachers' beliefs drive the way they think, teaches, and learn, it is important to understand what teachers believe about technology. To support teachers in their use of technology, school administrators should devise implementation strategies and ensure the presence of effective support structures that foster successful experiences in the use of technology for teachers that are likely to lead to the development of positive attitudes toward technology use, leading to a strong intention to use technology. Zayim, Yildirim, and Saka (2006) suggested that such strategies could include giving incentives such as release time for training, providing funds for materials development, and supporting participations at training workshops or conferences.

For teacher educators, student teachers should be given as much access as possible to technology that they will use in the schools to before they are posted to the schools. It is probable that student teachers who were expose to relevant technologies as part of their training may emerge effective users of technology who could facilitate and adjust their instructional strategies in ways to optimize their students' learning.

LIMITATIONS

Despite the care given to this study, there are limitations. Firstly, the use of self-reports to collect data may lead to the common method variance, a situation where true associations between variables are inflated. Secondly, it was possible that pre-service teachers may hold different views about technology integration from that of the practicing teachers. Thirdly, the variance of the dependent variable, behavioural intention was explained by the six variables by a mere 69%, leaving 31% unexplained. It is possible that this other significant constructs should have been included. Finally, the use of intention as a measure for actual use may have weakened and contributed to the loss of explanatory power of the model in this study. This study had only dealt with the prediction of use, rather than actual use. Although intention to use technology as a construct has been reported to be a suitable proxy for actual technology use, it is possible that this construct may be non-invariant across different contexts and samples.

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APPENDIX

List of constructs and their items

Construct	Item	
Perceived Usefulness (adapted from Davies, 1989)	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 (adapted from Davies, 1989)	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.
Attitudes Toward Computer Use (adapted from Compeau and Higgins, 1995)	ATCU1	Computers make work more interesting.
	ATCU2	Working with computers is fun.
	ATCU3	I look forward to those aspects of my job that require me to use the computer.
Intention to Use (Davis et al. 1989)	ITU1	I will continue to use computers
	ITU2	I will use computers in future.
	ITU3	I plan to use the computer often.