Title: Factors influencing teachers' intention to use technology: Model development and test

Authors: Timothy Teo

PII: S0360-1315(11)00137-0
DOI: 10.1016/j.compedu.2011.06.008
Reference: CAE 1910

To appear in: Computers & Education

Received Date: 29 December 2010
Revised Date: 14 June 2011
Accepted Date: 14 June 2011

Please cite this article as: Teo, T. Factors influencing teachers' intention to use technology: Model development and test, Computers & Education (2011), doi: 10.1016/j.compedu.2011.06.008

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.
Factors influencing teachers’ intention to use technology: Model development and test

Timothy TEO*
Nanyang Technological University
Singapore

Abstract

Among the key players in any effective integration of technology in teaching and learning is the teacher. Despite the research that has been conducted to examine the factors that explain teachers’ intention to use technology, few have developed a model to statistically explain the interactions among these factors and how they influence teachers’ intention to use technology. Five variables (perceived usefulness, perceived ease of use, subjective norm, facilitating conditions, and attitude towards use) and behavioural intention to use technology were used to build a research model in this study and structural equation modelling was used for parameter estimation and model testing. Self-reported data were gathered from 592 teachers from schools in Singapore. Results revealed a good model fit and of the nine hypotheses formulated in this study, eight were supported. Subjective norm was not found to be a significant influence on teachers’ intention to use technology while the other four variables were.

Keywords: human-computer interface; pedagogical issues; country-specific developments

*Timothy Teo, Ph.D.
Associate Professor
National Institute of Education
Nanyang Technological University
1 Nanyang Walk
Singapore 637616
Email: timothy.teo@nie.edu.sg
Factors influencing teachers’ intention to use technology:

Model development and test

Abstract

Among the key players in any effective integration of technology in teaching and learning is the teacher. Despite the research that has been conducted to examine the factors that explain teachers’ intention to use technology, few have developed a model to statistically explain the interactions among these factors and how they influence teachers’ intention to use technology. Five variables (perceived usefulness, perceived ease of use, subjective norm, facilitating conditions, and attitude towards use) and behavioural intention to use technology were used to build a research model in this study and structural equation modelling was used for parameter estimation and model testing. Self-reported data were gathered from 592 teachers from schools in Singapore. Results revealed a good model fit and of the nine hypotheses formulated in this study, eight were supported. Subjective norm was not found to be a significant influence on teachers’ intention to use technology while the other four variables were.

Keywords: human-computer interface; pedagogical issues; country-specific developments

1. Introduction

Among the key players in any effective integration of technology in teaching and learning is the teacher. As part of their job requirements, teachers are expected to use technology tools in many cases. As technology continue to impact on teaching and learning, expectations on teachers to exploit technological advantages will rise, leading teachers to experience the pressures of having to toggle between pedagogy and technology in a seamless way (Pelgrum, 2001). The extent to which this is well-executed depends on a teachers’ willingness to
employ technology in teaching and learning. From the literature, much effort has gone into examining the reasons for teachers’ lacklustre response towards using technology for teaching and learning. For example, Becker (2001) found that teachers in the United States had used computer infrequently and when they did, they had used computers for only games and drills in the classroom. In the United Kingdom, Jones (2004) attributed the barriers to effective integration of technology in teaching and learning to the lack of technical support, teacher’s lack of confidence, and lack of realization of the advantages of using technology in their teaching among reasons. Among Australian academics, Birch and Burnett (2009) cited a lack of clear institutional direction concerning course design and delivery time as major inhibitors to the development of e-learning environments. From Singapore, Lim & Khine (2006) found that teachers’ use of technology in the classrooms remained peripheral and minimal and that teachers do not use technology effectively.

The above-mentioned results were obtained despite considerable capital investments by their governments for infrastructure building and innovations to facilitate the use of information communication technology (ICT) in schools. A proposed reason for this situation is the low level of teachers’ technology acceptance (Legris, Ingham, & Collerette, 2003). When teachers do not use technology the way it was designed to serve, the affordances of technology cannot be maximised for effective teaching and learning to take place. For this reason, many studies on technology acceptance have been conducted over the years. From the literature, it appeared that many acceptance studies had focused on the identification of factors that influenced technology acceptance among teachers and students. These included personal factors such as attitudes towards computers (Author, 2008; Authors, 2011), computer self-efficacy (Tsai, Tsai, & Hwang, 2010), technical factors such as technological complexity (Thong, Hong, & Tam, 2002), and environmental factors such as facilitating conditions (Ngai, Poon, Chan, 2007).
The purpose of this study is to propose and test a model to explain teachers’
behavioural intention to use technology. The variables contained in this model were drawn
from acceptance studies that mainly focused on the intention to use technology in the
business setting. This is followed by the formulation of hypotheses prior to testing the
measurement and structural models.

2. Theory and Literature Review

Arising from the interests to understand users’ intention to use technology, researchers have
turned to several theories and models with their origins from social psychology. Among these,
the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989), Theory of
Planned Behaviour (TPB) (Ajzen, 1991), and Unified Theory of Acceptance and Use of
Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) are widely used and
validated (Sugar, Crawley, & Fine, 2004).

Proposed by Davis (1989), the TAM was fashioned after the Theory of Reasoned
Action (TRA) by Ajzen and Fishbein (1980). Among its uses, researchers have employed the
TAM to predict users’ acceptance of information systems. The TAM holds that perceived
usefulness and perceived ease of use are key constructs in determining users’ acceptance of
technology. A few years later, the Theory of Planned Behaviour (TPB) was proposed by
Ajzen (1991) as an improvement to the TRA by adding a third antecedent of intention,
perceived behavioural control, to the theory. The TPB holds that attitudes, subjective norms,
and perceived behavioural control are direct determinants of intentions, which in turn
influence behaviour. The Unified Theory of Acceptance and Use of Technology (UTAUT)
was proposed by Venkatesh, Morris, Davis, and Davis (2003) after a review and
consolidation of the constructs of eight models that earlier research had employed to explain
information systems usage behaviour. In the UTAUT, user intentions to use an information
Factors influencing teachers’ intention to use technology are posited to be influenced by four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. Table 1 shows the three models, constructs, and their operational definitions.

--- Insert Table 1 here ---

2.1 Acceptance Models

The Technology Acceptance Model (TAM) has been found to be efficient in explaining user behaviour across a broad range of end-user computing technologies and user populations. It specifies the relationships among perceived usefulness, perceived ease of use, attitude towards use, and behavioural intention to use technology. Behavioural intention is posited to be affected by attitude towards 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 use, whilst perceived ease of use has a direct impact on perceived usefulness. In addition, perceived ease of use was hypothesized to have a direct effect on perceived usefulness but the reverse is not true. Davis (1993) posited that this was because perceived usefulness was concerned with the expected overall impact of system use on job performance (outcome), whereas perceived ease of use pertained only to those performance impacts related to the process of using the system per se (process). In other words, no matter how useful a system is, it will not be used if potential users perceive it to be difficult to use. From the TAM, perceived usefulness refers to the degree to which a person believes that using a system would enhance his/her productivity. On the other hand, perceived ease of use has to do with the extent to which a person thinks that using a system will be relatively free of effort (Davis et al., 1989).

Proposed by Ajzen in 1991, the theory of planned behaviour (TPB) was an extension of the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980). In the TPB, behavioural
intention is hypothesised to be the most influential predictor of behaviour and it determines how hard people are willing to try to perform a behaviour (Ajzen 1991). Behavioural intention is influenced by an attitude towards the behaviour, subjective norm, and perceived behavioural control. Armitage and Conner (2001) examined empirical 185 studies published up to the end of 1997 and found that attitude towards the behaviour, subjective norm, and perceived behavioural control in the TPB accounted 27% and 39% of the variance in behaviour and intention, respectively. In a study of pre-service teachers, Author and Lee (2010) found that the same three constructs had explained about 40% of the variance in the behavioural intention to use technology. In the TPB, attitude toward the behaviour is defined as one’s positive or negative feelings about performing a behaviour (e.g., using technology) and subjective norm refers to one’s perception of the extent to which people important to the individual think the behaviour should be performed. For example, a teacher may think that using technology for teaching and learning is important because the school leaders are explicit about the benefits of integrating technology in the curriculum. Perceived behavioural control is defined as a person’s perception of how easy or difficult it would be to perform a behaviour (Ajzen 1991). It is similar to the perceived ease of use construct in the TAM and also refers to an individual’s beliefs about the presence of factors that may facilitate or hinder performance of the behaviour (Ajzen, 2002). For this reason, the items for facilitating conditions were used to measure perceived behavioural control as a variable in this study.

The Unified Theory of Acceptance and Use of Technology (UTAUT) contains four core determinants of technology usage intention (Venkatesh et al., 2003). These are performance expectancy, effort expectancy, social influence, and facilitating conditions and the UTAUT posits that they may be moderated by age, gender, experience, and voluntariness to use technology. For example, the strength between performance expectancy and intention to use may vary with age and gender in a way that it is more significant for male and younger
workers. According to Venkatesh et al. (2003), the UTAUT model accounted for 70 percent of the variance in usage intention although many studies using the UTAUT had largely focused on large organizations in the business environment.

2.2 Research Model and Hypotheses

The relationships among the variables in TAM, TPB, and UTAUT have been described in the preceding section and shown in Table 1. These relationships are encapsulated in the research model (Figure 1). Although the TAM, TPB, and UTAUT have been tested separately in research, Figure 1 embodies the variables from all three models/theory while keeping their relationships with each other intact. From these relationships, the following hypotheses were formulated. In addition, additional hypotheses were included (FC $\rightarrow$ PEU, SN $\rightarrow$ PU) in the research model on account of evidence obtained from previous research (e.g., Author & van Schaik, 2009).

$H_1$: Attitude towards use will significantly and positively influence teachers’ behavioural intention to use technology

$H_2$: Perceived usefulness will significantly and positively influence teachers’ attitude towards use

$H_3$: Perceived usefulness will significantly and positively influence teachers’ behavioural intention to use technology

$H_4$: Perceived ease of use will significantly and positively influence teachers’ attitude towards use

$H_5$: Perceived ease of use will significantly and positively influence teachers’ perceived usefulness
H₆: Facilitating conditions will significantly and positively influence teachers’ behavioural intention to use technology

H₇: Facilitating conditions will significantly and positively influence teachers’ perceived ease of use

H₈: Subjective norm will significantly and positively influence teachers’ behavioural intention to use technology

H₉: Subjective norm will significantly and positively influence teachers’ perceived usefulness

--- Insert Figure 1 here ---

In this study, intention to use was used as the dependent variable because of its close link to actual behaviour (Hu, Clark, & Ma, 2003; Kiraz, & Ozdemir, 2006). Behavioural intention is a factor that captures how hard people are willing to try to perform a behaviour (Ajzen, 1991). Using intention to use as a dependent variable in this study has practical advantages because access to information on the actual use of technology in schools may be too sensitive and thus discourage participation from schools. In addition, when asked to report their actual technology use (e.g., number of hours spent or lessons conducted in the computer lab), teachers may respond in a socially desirable way, a situation where participants responded in ways they perceive they should and what the researcher wants. Finally, intention to use is more progressive compared to actual use as a dependent variable, which is more static and retrospective (Yi, Jackson, Park, & Probst, 2006).
3. Method

3.1 Participants and procedure

Participants were 592 school teachers who responded affirmatively to an invitation issued by this author through the school principals. A total of 60 schools (30 primary and 30 secondary) were invited and 31 schools (18 primary and 13 secondary) agreed to participate, making a participation rate of 51.6%. A url for the questionnaire used in this study was emailed to all participants. Among them, 76.4% (45.2) were females and the mean age was 35.3 (SD=8.83) years. The mean length of teaching service among the participants was 9.26 (SD=8.29) years. Nearly all the participants owned a computer at home (97%) and the mean years of computer usage was 14.79 (SD=5.04). On average, participants spent 4.48 (SD=2.70) hours using the computer for work purposes.

3.2 Measures

A self-report questionnaire was used for this study. In addition to providing their demographic information, participants responded to 20 items on Perceived Usefulness (PU) (four items), Perceived Ease of Use (PEU) (five items), Subjective Norm (two items), Facilitating Conditions (three items), Attitude Towards Use (ATU) (three items), and Behavioural Intention to Use (BIU) (three items). These items were rated on a seven-point Likert scale, ranging from 1 – strongly disagree to 7 – strongly agree. All items were presented in English. The items used in this study were adapted from published sources (e.g., Davis et al. 1989; Taylor and Todd 1995; Thompson et al. 1991). Majority of these items have been used in previous studies on pre-service teachers from the same country and were found to be reliable and valid (e.g., Author, 2009; Author & Lee, 2010; Author & Noyes, 2011; Author & van Schaik, 2009). For example, three items measuring perceived usefulness were employed in Author (2009) and they yielded a coefficient H of .96. The two items
measuring subjective norm appeared in Author and van Schaik (2009), with an alpha value of .83. The 20 items in this study are shown in the Appendix.

3.3 Data Analysis

Data were analysed using the structural equation modelling (SEM) approach. In addition to testing for data normality, a variance-covariance matrix was used to test a proposed model that represents the relationships among the six variables in this study (behavioural intention, attitudes towards computer use, perceived usefulness, perceived ease of use, subjective norm, and facilitating conditions). At the same time, all free parameters in the model were estimated and evaluated for statistical significance.

Structural equations modelling (SEM) was employed in this study for its ability to analyze relationships between latent and observed variables. Additionally, SEM models random errors in the observed variables which results in more precise measurements. Another affordance of SEM includes the measurement of each latent variable by multiple indicators (Bollen, 1989). Using the standard two-step approach to SEM (Schumacker & Lomax, 2010), the first phase involves estimating the measurement model for all latent variables in the model. The measurement model, also known as the confirmatory factor analysis (CFA) model, describes how well the observed indicators measure the unobserved (latent) variables. In the second step, the structural part of the SEM is estimated. This part specifies the relationships among the exogenous and endogenous latent variables.

To obtain reliable results in SEM, researchers recommend a sample size of 100 to 150 cases (e.g., Kline, 2005). In addition, Hoelter’s critical N, which refers to the sample size for which one would accept the hypothesis that the proposed research model is correct at the .05 level of significance, was examined. The Hoelter’s critical N for the model in this study is
214 and, given that the sample size of this study is 592, it is considered adequate for the purpose of structural equation modelling.

4. Results

4.1 Descriptive Statistics

All 20 items were examined for their mean, standard deviation, skewness, and kurtosis. All means scores, except that for facilitating conditions, were above the mid-point of 4.0 and they indicated an overall positive response to the variables in the model. The standard deviations reflect a fairly narrow spread of participants’ responses, ranging from 1.01 to 1.41. Skewness and kurtosis indices were small and well within the recommended level of $|3|$ and $|10|$ respectively (Kline, 2005).

4.2 Evaluation of the Measurement Model

The measurement model was assessed using confirmatory factor analysis (CFA). This was conducted with AMOS 7.0 using the maximum likelihood estimation (MLE) procedure. The MLE is a popular and robust procedure for use in SEM (Schumacker & Lomax, 2010). Because the MLE procedure assumes multivariate normality of the observed variables, the data in this study were examined using the Mardia’s normalized multivariate kurtosis value. The Mardia’s coefficient (Mardia, 1970) for the data in this study was 402.35, which is lower than the value of 440 computed based on the formula $\frac{p(p+2)}{2}$ where $p$ equals the number of observed variables in the model (Raykov & Marcoulides, 2008). As such, multivariate normality of the data in this study was assumed. Table 2 shows the results of the CFA. All parameter estimates were significant at the $p < .05$ level, as indicated by the $t$-value (greater than 1.96). The standardized estimates ranged from .624 to 1.00 and these were regarded as acceptable (Hair et al., 2010). In addition, most of the $R^2$ values were above .50, suggesting that each item had explained more than half the amount of variance of the latent variable.
Factors influencing teachers’ intention to use technology

(construct) that they belong. The internal consistency (alpha) of all constructs was above .90 and these are regarded as high (Nunnally & Bernstein, 1994). There was an acceptable level of model fit for the measurement model \( \chi^2 = 445.240; \chi^2/df = 3.00; \text{TLI} = .974; \text{CFI} = .980; \text{RMSEA} = .058; \text{SRMR} = .027 \). The adequacy of the measurement model indicated that all items were reliable indicators of the hypothesized constructs they were purported to measure.

--- Insert Table 2 here ---

4.3 Convergent and Discriminant Validities

In assessing for convergent validity of the measurement items, the item reliability of each measure, the reliability of each construct, and the average variance extracted were examined. The item reliability of an item was assessed by its factor loading onto the underlying construct and construct reliability was reflected by the Cronbach’s alpha. The third indicator of convergent validity, average variance extracted, measured the overall amount of variance that was 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 (Hair et al., 2010). In addition, the t-value indicates if an item parameter of a specified construct was significant, with a value of 1.96 or greater being significant at the .05 level. The \( R^2 \) value refers to the percent of variance in the construct explained by the item, with a value of .50 or greater considered appropriate (Hair et al., 2010). From Table 3, all values met the recommended guidelines, indicating that the convergent validity for the measurement items and constructs in this study was adequate.

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 root of the AVE of a construct was 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 thus suggesting the presence of discriminant validity. 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.

--- Insert Table 3 here ---

4.4 Evaluation of the Structural Model

In structural equation modelling (SEM), the match between any particular model and the data is assessed by using several goodness-of-fit indexes. In addition to the use of the chi-square test, which is highly sensitive to sample size, the ratio of the chi-square to its degrees of freedom and other fit indices are also considered when making deciding on model fit. Following the recommendations by Hu and Bentler (1999), the root mean square error of approximation (RMSEA) and Standardized Root Mean Residual (SRMR) were used as measures of absolute fit and the Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) as indices of incremental fit. From the literature (e.g., Hair et al., 2010), values of .90 or more for the CFI and TLI, and values of .08 or less for RMSEA and SRMR are reflective of a good fit. From the results, the proposed research model has a good fit [$\chi^2=499.235$; $\chi^2$/df=3.306; TLI=.970; CFI=.976; RMSEA=.062; SRMR= .065].

4.5 Testing of Hypotheses

Overall, eight out of nine hypotheses were supported by the data. All hypotheses (H1 to H6, H8) pertaining to the relationship among the variables from TAM, TPB, and UTAUT (Table 1) were supported in this study. The hypothesis that was not supported was not reflected in any of the theory/model in Table 1.
Four endogenous variables (behavioural intention to use, attitude towards use, perceived usefulness, and perceived ease of use) were tested in the model. Overall, a high percentage of the variance in the dependent variable in this study, behavioural intention to use technology, was explained by perceived usefulness, attitude towards use, subjective norm, and facilitating conditions with a $R^2$ of 0.613. This means that together, these four variables accounted for 61.3% of the variance found in the behavioural intention to use technology. In addition, perceived ease of use and perceived ease of use accounted for 54.8% ($R^2 = 0.548$) of the variance in attitude towards use. Subjective norm and perceived ease of use accounted for 40.2% ($R^2 = 0.402$) of the variance in perceived usefulness and facilitating conditions accounted for 17.2% ($R^2 = 0.172$) of the variance in perceived ease of use. A summary of the hypotheses testing results is shown in Table 4.

--- Insert Table 4 here ---

4.6 Mediational Analysis

From Figure 1, perceived usefulness (PU) and attitude towards use (ATU) also acted as mediator variables in explaining behavioural intention to use (BIU). Table 5 shows the results of the mediation analysis. Following the guidelines by Cohen (1988), effect sizes with values less than 0.1 were considered small, those with less than 0.3 are medium, and values with 0.4 or more are considered large. From Table 5, although all indirect effects from the meditational analysis are statistically significant, they range from small to medium (.027 to .213).

--- Insert Table 5 here ---
5. Discussion

The aim of this study is to develop and test a model to explain the intention to use technology among school teachers. Overall, the data in this provide empirical support to the selected five variables being capable of explaining more than half (61.3%) the amount of variance in the behavioural intention to use technology among school teachers in Singapore. The results also suggested that the proposed model has a good fit in that it serves as an adequate representation of relationships among the factors that influenced teachers’ intention to use technology.

From the results, perceived usefulness, attitude towards use, and facilitating conditions have direct influences on behavioural intention to use technology. These are consistent with the relationship postulated in the TAM (Davis, 1989) and UTAUT (Venkatesh et al., 2003). On the other hand, perceived ease of use and subjective norm influence behavioural intention to use technology indirectly through attitude towards use and perceived usefulness respectively. From the direct influences, it is clear that when teachers perceived technology to be useful and that using technology would increase their productivity, their intention to use will be significantly increased. A positive attitude also has a positive and direct influence on behavioural intention. This finding is consistent with current research (e.g., Author, 2010) and consistent with the relationships explained in the models described above (e.g., Ajzen, 1991). It is reasonable to infer that when teachers have positive feelings towards the use of computers, these feelings reinforce their intentions to use technology. Noteworthy is the fact that attitude towards use was significantly influenced by perceived usefulness and perceived ease of use, suggesting that when the use of technology is perceived to be an enhancement to one’s productivity and is relatively free of effort (Davis et al. 1989; Venkatesh et al., 2003), teachers are likely to develop a positive attitude towards its use (Author, Lee, Chai, & Wong, 2009).
Subjective norm did not have a significant influence on teachers’ intention to use technology. It is possible that the participants in this study, with a mean teaching experience of 9.26 (SD=8.29) years and a mean computer usage of 14.79 (SD=5.04) years did not rely on institutional mandate (e.g., principal or department head) to decide whether they should use technology or not (Robert & Henderson, 2000). Instead, they may have depended on their sense of professional duty or personal interest to engage technology for teaching and learning.

In this study, subjective norm had a significant influence on perceived usefulness. This is contrary to Author and van Schaik (2009) who found that pre-service teachers’ perception of subjective norm did not have a significant influence on perceived usefulness. It is possible that because teachers in this study had to use technology for teaching and learning within a more regulated and formal environment (schools), their perceived usefulness was significantly influenced by subjective norm. Comparatively, the pre-service teacher participants in Author and van Schaik’s (2009) study were students who were able to exercise more volition in terms of their technology use thus explaining the lack of statistical significance of the influence of subjective norm on perceived usefulness. However, results of the meditational analysis (Table 5) revealed that subjective norm had exerted a significant indirect effect on behavioural intention through perceived usefulness which acted as a mediator. This supports the above-mentioned proposition that the teachers’ intention to use technology had been influenced by perceived usefulness in a stronger way than subjective norm.

Facilitating conditions was both a direct and indirect (through perceived ease of use) influence on behavioural intention to use technology. When teachers perceived adequate support (e.g., technical) to be available, accessible, and timely, they also perceived the use of technology to be relatively free from effort and this cold have strengthened their intention to technology. In this study, facilitating conditions had a greater influence on teachers’ intention
to use technology than subjective norm, suggesting that the environment in which teachers engaged technology was more important than their beliefs about whether the people whom they perceived to be significant thought they should use technology or not. It was also possible that the teachers in this study had moved beyond a reliance on the mandate from their school leaders to use technology. Instead they were affected by the practical aspects of technology use such as whether technical support was available and accessible.

Although six distinct variables were considered in this study, they should not be seen in isolation. An advantage of using structural equation modelling is that it allows variables to act as both an exogenous (independent) and endogenous (dependent) variable in the model. For example, we could assess the influence of attitude towards use (as an exogenous variable) on behavioural intention to use technology and at the same time, measure the influence of other variables on attitude towards use (as an endogenous variable), suggesting that the variables in the research model interact with each other in ways that directly or indirectly influence teachers’ intention to use technology.

5.1 Implications for Education

School administrators have immense influence on teachers’ intention to use technology for instructional purposes. Among other things, the former are responsible for planning, implementing and monitoring technology integration in the curriculum. As such, the findings of this study may be useful to them. First, teachers’ perceptions on the usefulness and ease of technology use are dynamic and do not remain static. Also, these perceptions do not remain invariant across factors such as gender, years of teaching service, and computer experience. For example, due to rapid technological advancements, teachers will soon experience limitations if they do not participate in continuing professional development to keep abreast with more advanced skills and knowledge on the use of technology. Consequently, such
teachers will soon perceive technology to be difficult to use, not contributing to their productivity, and a chore to use, resulting in the development of avoidance behaviours with respect to technology use for teaching and learning. Second, teacher professional development should be central in the management of technology integration for teaching and learning. This was highlighted by Sugar, Crawley, and Fine (2004) who found that students who have experienced the affordances of technology in their learning were likely to expect teachers to continue to employ technology in their teaching. As a result, this may be a cause of anxiety among teachers who do not actively upgrade and advance their skills and knowledge in using technology in education. Finally, as successful experiences lead to positive feeling towards technology use, school administrators could manage the teaching environment in ways that teachers would feel supported in terms of technical and human resources to provide training and guidance on technology usage and troubleshooting.

5.2 Limitations of the study

Several limitations are found in this study. First, the use of self-reports in this study may have resulted in the common method variance, a situation where true associations between variables are inflated. Future studies could employ the multitrait multi-method (MTMM) technique (Campbell & Fiske, 1959). In MTMM, each variable is operationalized by multiple traits and measured using different methods (e.g., paper and pencil test, an independent rating and a self rating). By doing so, the variances attributed to the constructs and method can be separated thus producing more accurate measurements in the process.

Second, because an online questionnaire was used, it was possible that only teachers who were confident technology users had responded and this may have resulted in a lack of inclusiveness among the teachers in each school thus affecting the generalizability of the results in this study. One way to improve the inclusiveness is to collect data using the pen and
paper method alongside online data collection. This would cater to potential participants who prefer to give their responses on paper or have limited access to the computer. Third, although the variance accounted for in behavioural intention to use technology was explained by five variables by 61.3%, an amount of 39.7% of the variance was unexplained. Future studies could include other variables that may influence behavioural intention to use technology. For example, Park (2009) and Author (2009) found that self-efficacy and technological complexity were significant in influencing users’ intention to use technology. Other variables may include self-esteem, computer anxiety, and beliefs about technology (Paraskeva et al., 2008; Saade & Kira, 2007).

6. Conclusion and future research

The results of this study demonstrate that the proposed model has a good fit to the data. However, all models should be subject to further validations to strengthen its predictive ability and explanatory powers in order to be valid and useful under different contexts thus increasing its usefulness to researchers. Using different samples, future research could test for model invariance across personal (e.g., gender, computer experience), organisational (e.g., school size, types of schools), and technological factors (e.g., types of tools). Given the close links between in-teachers and pre-service teachers, this model could be tested on the two groups to examine the degree to which it is invariant in explaining in-service and pre-service teachers’ intentions to use technology. The results of such study would inform policy makers and teacher educators for planning and curriculum development purposes. Finally, with technology use in education becoming pervasive globally, comparative studies across countries or cultures could be conducted to identify the culture-invariant variables that influence teachers’ intention to use technology.
References


Author (2008).

Author (2009).

Author (2010).


Author, & Schaik, P. van (2009).


Appendix

Perceived Usefulness (PU)
PU1: Using technology enables me to accomplish tasks more quickly.
PU2: Using technology improves my performance.
PU3: Using technology increases my productivity.
PU4: Using technology enhances my effectiveness.

Perceived Ease of Use (PEU)
PEU1: Learning to use technology is easy for me.
PEU2: I find it easy to use technology to do what I want to do.
PEU3: My interaction with technology does not require much effort.
PEU4: It is easy for me to become skilful at using technology.
PEU5: I find technology easy to use.

Subjective Norm (SN)
SN1: People who influence my behaviour think that I should use technology.
SN2: People who are important to me think that I should use technology.

Facilitating Conditions (FC)
FC1: When I encounter difficulties in using technology, a specific person is available to provide assistance.
FC2: When I encounter difficulties in using technology, I know where to seek assistance.
FC3: When I encounter difficulties in using technology, I am given timely assistance.

Attitude Towards Use (ATU)
ATU1: Once I start using technology, I find it hard to stop.
ATU2: I look forward to those aspects of my job that require the use of technology.
ATU3: I like working with technology.

Behavioural Intention to Use (BIU)
BIU1: I intend to continue to use technology in the future.
BIU2: I expect that I would use technology in the future.
BIU3: I plan to use technology in the future.
Figure Caption

Figure 1: Research Model
A model was developed to explain teachers’ intention to use technology. Variables from the TAM, TPB, and UTAUT were combined in the research model. Structural equation modelling was used for model testing.
Table 1: Various models and their constructs (relationship between constructs)

<table>
<thead>
<tr>
<th>Construct</th>
<th>Operational Definition</th>
<th>TAM</th>
<th>TPB</th>
<th>UTAUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Usefulness (PU)*</td>
<td>The degree to which a teacher believes that using technology would enhance his or her job performance (Adapted from Davis, 1989).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Perceived Ease of Use (PEU)**</td>
<td>The degree to which a teacher believes that using technology would be free of effort (Adapted from Davis, 1989).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Subjective Norm (SN)</td>
<td>The extent to which a teacher perceives that most people who are important to him think he should or should not use technology (Adapted from Fishbein &amp; Ajzen, 1975)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Perceived Behavioural Control (PBC)</td>
<td>The degree to which person perceives how easy or difficult it would be to perform a behaviour (Ajzen, 1991)</td>
<td>✓</td>
<td>⬛</td>
<td>⬛</td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>The extent to which a teacher believes that factors in the environment influence his or her decision to use technology (Adapted from Thompson et al., 1991).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Attitude Towards Use</td>
<td>The extent to which a teacher possesses positive feelings about using technology (Adapted from Fishbein &amp; Ajzen, 1975).</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Behavioural</td>
<td>The degree of a teacher’s willingness to</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Intention to Use use technology (Adapted from Davis, 1989)

* Similar to Performance Expectancy in UTAUT; ** Similar to Effort Expectancy in UTAUT
Table 2: Results for the measurement model

<table>
<thead>
<tr>
<th>Item</th>
<th>SE</th>
<th>t-value</th>
<th>$R^2$</th>
<th>AVE (&gt; .50)*</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU1</td>
<td>.893</td>
<td>---</td>
<td>.797</td>
<td>.72</td>
<td>.96</td>
</tr>
<tr>
<td>PU2</td>
<td>.922</td>
<td>36.151</td>
<td>.849</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU3</td>
<td>.944</td>
<td>38.646</td>
<td>.892</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU4</td>
<td>.958</td>
<td>40.295</td>
<td>.918</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEU1</td>
<td>.948</td>
<td>52.205</td>
<td>.899</td>
<td>.77</td>
<td>.98</td>
</tr>
<tr>
<td>PEU2</td>
<td>.936</td>
<td>49.092</td>
<td>.877</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEU3</td>
<td>.956</td>
<td>54.727</td>
<td>.915</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEU4</td>
<td>.957</td>
<td>54.968</td>
<td>.916</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEU5</td>
<td>.955</td>
<td>---</td>
<td>.911</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN1</td>
<td>.771</td>
<td>7.552</td>
<td>.595</td>
<td>.89</td>
<td>.91</td>
</tr>
<tr>
<td>SN2</td>
<td>1.00</td>
<td>---</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC1</td>
<td>.912</td>
<td>---</td>
<td>.832</td>
<td>.79</td>
<td>.93</td>
</tr>
<tr>
<td>FC2</td>
<td>.929</td>
<td>35.714</td>
<td>.862</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC3</td>
<td>.870</td>
<td>31.330</td>
<td>.756</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATU1</td>
<td>.792</td>
<td>---</td>
<td>.628</td>
<td>.55</td>
<td>.91</td>
</tr>
<tr>
<td>ATU2</td>
<td>.904</td>
<td>25.631</td>
<td>.818</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATU3</td>
<td>.936</td>
<td>26.659</td>
<td>.875</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIU1</td>
<td>.935</td>
<td>---</td>
<td>.874</td>
<td>.65</td>
<td>.96</td>
</tr>
<tr>
<td>BIU2</td>
<td>.960</td>
<td>48.050</td>
<td>.921</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIU3</td>
<td>.938</td>
<td>44.228</td>
<td>.880</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* indicates an acceptable level of reliability or validity
--- This value was fixed at 1.00 for model identification purposes
a AVE: Average Variance Extracted. This is computed by adding the squared factor loadings divided by number of factors of the underlying construct.
SE: Standardised Estimate
Table 3: Discriminant validity for the measurement model

<table>
<thead>
<tr>
<th>Construct</th>
<th>PU</th>
<th>PEU</th>
<th>SN</th>
<th>FC</th>
<th>ATCU</th>
<th>BIU</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEU</td>
<td>.61*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>.19*</td>
<td>.11*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC</td>
<td>.39*</td>
<td>.39*</td>
<td>.12*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ATCU</td>
<td>.60*</td>
<td>.64*</td>
<td>.21*</td>
<td>.47*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIU</td>
<td>.62*</td>
<td>.59*</td>
<td>.20*</td>
<td>.48*</td>
<td>.71*</td>
<td></td>
</tr>
</tbody>
</table>

**p < .01

Diagonal in parentheses: square root of average variance extracted from observed variables (items); Off-diagonal: correlations between constructs
Table 4. Hypothesis testing results

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Path</th>
<th>Path coefficient</th>
<th>t-value</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁</td>
<td>ATU → BIU</td>
<td>.504</td>
<td>11.710**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₂</td>
<td>PU → ATU</td>
<td>.301</td>
<td>7.928**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₃</td>
<td>PU → BIU</td>
<td>.221</td>
<td>6.398**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₄</td>
<td>PEU → ATU</td>
<td>.423</td>
<td>11.842**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₅</td>
<td>PEU → PU</td>
<td>.532</td>
<td>17.199**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₆</td>
<td>FC → BIU</td>
<td>.130</td>
<td>5.082**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₇</td>
<td>FC → PEU</td>
<td>.439</td>
<td>10.271**</td>
<td>Supported</td>
</tr>
<tr>
<td>H₈</td>
<td>SN → BIU</td>
<td>.022</td>
<td>.972</td>
<td>Not supported</td>
</tr>
<tr>
<td>H₉</td>
<td>SN → PU</td>
<td>.123</td>
<td>4.228**</td>
<td>Supported</td>
</tr>
</tbody>
</table>

**p < .001
Table 5: Results of the Mediation Analysis

<table>
<thead>
<tr>
<th>From</th>
<th>Mediator</th>
<th>β</th>
<th>To</th>
<th>Mediator</th>
<th>β</th>
<th>Indirect Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEU</td>
<td>PU</td>
<td>.532</td>
<td>.221</td>
<td>BIU</td>
<td></td>
<td>.116*</td>
</tr>
<tr>
<td>SN</td>
<td>PU</td>
<td>.123</td>
<td>.221</td>
<td>BIU</td>
<td></td>
<td>.027*</td>
</tr>
<tr>
<td>PU</td>
<td>ATU</td>
<td>.301</td>
<td>.504</td>
<td>BIU</td>
<td></td>
<td>.152*</td>
</tr>
<tr>
<td>PEU</td>
<td>ATU</td>
<td>.423</td>
<td>.504</td>
<td>BIU</td>
<td></td>
<td>.213*</td>
</tr>
</tbody>
</table>

*p < .01 (Sobel Test)
Figure 1: Research Model