EXAMINING THE RELATIONSHIP BETWEEN STUDENT TEACHERS' SELF-EFFICACY BELIEFS AND THEIR INTENDED USES OF TECHNOLOGY FOR TEACHING: A STRUCTURAL EQUATION MODELLING APPROACH

Timothy TEO
Nanyang Technological University, Singapore
timothy.teo@nie.edu.sg

ABSTRACT
This study examines the relationship between computer self-efficacy and intended uses of technology of student teachers (N=1094) at a teacher training institute in Singapore. Self-efficacy was assessed by three factors: Basic Teaching Skills (BTS), Advanced Teaching Skills (ATS), and Technology for Pedagogy (TP), and intended use of technology was measured by two factors: Traditional Use of Technology (TUT) and Constructivist Use of Technology (CUT). Participants responded to a 7-point Likert-type scale for each factor. Analysis was conducted using the structural equation modelling approach and a good model fit was found for both the measurement and structural models. Results showed that significant relationships exist among BTS, TP, TUT, and CUT. However, ATS did not influence TUT and CUT in a significant way. Overall, the results of this study offer some evidence that student teachers' self-efficacy is a significant influence on whether they use technology in a traditionalist or constructivist way.

Keywords: student teachers, structural equation modelling, self-efficacy, use of technology.

INTRODUCTION

In many educational systems, teachers are expected to use ICT in their teaching (Haydn & Barton, 2008) and to act as change agents for technology integration in the schools (Zhao, Tan, & Mishra, 2001). However, technology adoption by teachers has been slow and below expectations in many parts of the world (Selwyn, 2003). This is despite evidence that suggest teachers want to teach well and are open-minded about infusing technology into their teaching (Zhao & Frank, 2004). As such, it is important to understand the factors that drive teachers' use of technology for teaching and instructional purposes. Research has found that many factors influence teachers' use of technology. Broadly, these factors arise from the external environments where the teachers work (Ertmer, 2005) or teachers' attitude towards computer use (Teo, 2008a; 2008b). However, Ertmer (2005) argued that although the environmental conditions affecting technology use, such as infrastructures to enable technology integration, have improved, how personal factors such as teachers' beliefs affect technology use in teaching, are yet to be resolved. Employing a Perceptual Control Theory (PCT) perspective, Zhao and Cziko (2001) identified one condition that is necessary for teachers to use technology to be their perceived ability and availability of resources to use technology. Also known as computer self-efficacy, teachers' judgements of their ability has been found to be a significant predictor of technology usage and intention to use technology (Teo, 2009). In other words, teachers' beliefs about using ICT play an important part in shaping their responses to instructional reforms, including technology integration (Selwyn, Dawes, & Mercer, 2001). Some examples of teachers' beliefs include their beliefs about how technology should be used in teaching and beliefs about their ability to use technology.

REVIEW OF THE LITERATURE

Uses of technology in teaching

Teachers integrate technology for teaching in different ways. Some use technology for mainly presentation purposes while others allow students to use a full range of technology resources. It is possible that teachers' use technology for instructional purposes is influenced by their beliefs about teaching and learning. As such, a teacher who believes that students learn content best through teacher-led instruction will be less inclined to encourage students to explore a technology tool for learning. This view was supported by previous research that found teachers' beliefs to have an influence on the way they organized their classrooms, interacted with students, and how they act in the classroom (Hannafin & Savenye, 1993). The strategies employed by teachers to integrate technology in the classroom were examined by Tubin (2006) who found that teachers use technology in two ways. One way is to use technology to attain the same traditional goals under the same conditions, without significant changes to the classroom activities. The second way if to use technology to expand classroom boundaries, connect students to real-world events, and guide students to become independent learners. These two ways of using technology for teaching was supported by Brawner and Allen (2006) who asked 462 students teachers how they had used technology during their internship. The authors found that the responses could be grouped according to Type 1 (drill and practice) and Type 2 (user-centred) uses of technology (Maddux, et al., 1997). Research has found a positive relationship between teachers' beliefs and uses of technology. For example, Becker (2000) found that teachers who hold constructivist beliefs about teaching are more aligned to the Type II application of computers. A study on student teachers' beliefs about teaching and learning and technology use found a positive and strong correlation between a belief in constructivist teaching and constructivist (or user-centred) use of technology (Teo, Chai, Hung, & Lee, 2008).

Computer Self-efficacy

Bandura (1986) defined self-efficacy as one's judgments of their capabilities to organize and execute courses of action in alignment with desired goals. The focus is not on the skills one has but on the judgments one has of what one can do with whatever skills one possesses. Bandura also affirmed that self-efficacy beliefs develop in response to four sources of information. Self-efficacy beliefs can be used to explain technology usage behaviours. For instance, Compeau and Higgins (1995) examined the factors that affect an individual's use of technology and found that participants with higher self-efficacy beliefs used computers more often and experienced less computer-related anxiety. Compeau and Higgins also noted that individuals with higher computer self-efficacy beliefs tend to see themselves as able to use computer technology. On the other hand, individuals with lower computer self-efficacy beliefs become more frustrated and more anxious working with computers and hesitate to use computers when they encounter obstacles.

However, few studies have investigated the nature of self-efficacy beliefs in technology for teaching (Wang, Ertmer, & Newby, 2004). An early study on self-efficacy beliefs and its relationship with technology use in teaching and learning was conducted by Enoch, Riggs, and Ellis (1993). This study focused on the development and validation of a survey instrument that would provide insight into the self- efficacy beliefs of in-service teachers toward the use of computer technology in classroom teaching practices. Later research examining self-efficacy beliefs toward technology use have focused on their influence on attitudes toward computers (Torkzadeh, Koufteros, & Pflughoeft, 2003) or intention towards use (Teo, 2009). These studies have, however, provided insight into the relationship between self-efficacy beliefs toward technology in predicting usage behaviour. Albion (1999) noted that teachers' self-efficacy or belief in their capacity to work effectively with computers was a significant factor in determining their patterns of computer use. This implied that decisions to use computers in classrooms or in schools are likely to be influenced by teacher beliefs. That is, teachers' beliefs about their ability to use computers effectively significantly influence the patterns of classroom computer usage.

PURPOSE OF THIS STUDY

While past research have supported the role of computer self-efficacy as a predictor or antecedent of computer usage or attitude towards computer use, its relationship with how technology is used (type 1 or type 2) in teaching remains unclear. The literature contains research that reveals the factors which influence teachers' technology use in education, few have examined the ways in which teachers use technology in teaching. The purpose of this study is to examine the relationship between student teachers' self-efficacy beliefs and their intended use of technology for teaching. Figure 1 shows the research model. In the model, teachers' self-efficacy beliefs are hypothesized to comprise three beliefs: beliefs in their (1) Basic Technology Skills, (2) Advanced Technology Skills, and (3) Technology for Pedagogy. The intended uses of technology for teaching are organised according to the Type 1 and Type 2 uses of technology as mentioned above. In this study, Type 1 (drill & practice) is denoted as Traditional Use of Technology (TUT) and Type 2 (user-centred) denoted as Constructivist Use of Technology (CUT). Implicit in figure 1 are six hypotheses:

H1: Student teachers' beliefs in their basic technology skills (BTS) will significantly influence their use of technology for teaching in a traditional way (TUT).
H2: Student teachers' beliefs in their basic technology skills (BTS) will significantly influence their use of technology for teaching in a constructivist way (CUT).
H3: Student teachers' beliefs in their advanced technology skills (ATS) will significantly influence their use of technology for teaching in a traditional way (TUT).
H4: Student teachers' beliefs in their advanced technology skills (ATS) will significantly influence their use of technology for teaching in a constructivist way (CUT).
H5: Student teachers' beliefs in their ability to use technology for pedagogy (TP) will significantly influence their use of technology for teaching in a traditional way (TUT).
H6: Student teachers' beliefs in their ability to use technology for pedagogy (TP) will significantly influence their use of technology for teaching in a constructivist way (CUT)

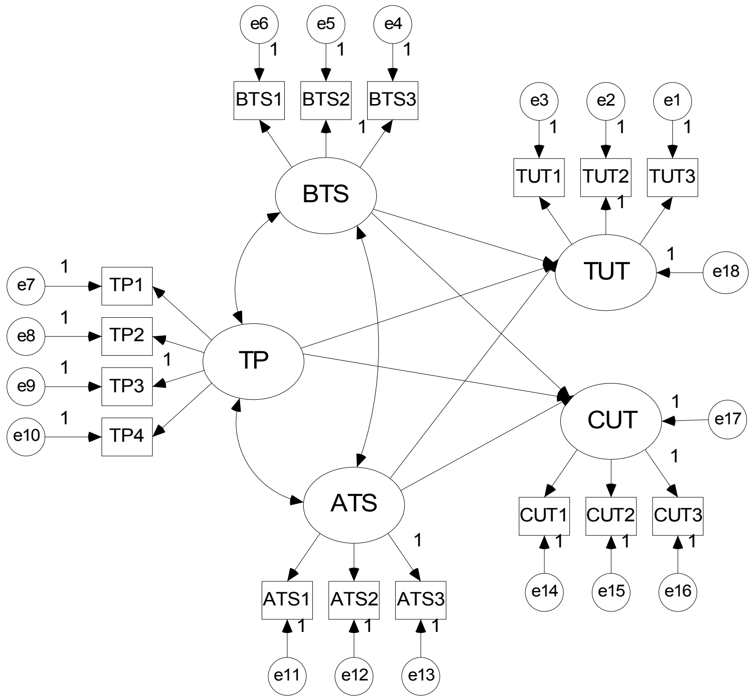

Figure 1: Research Model

METHODOLOGY

Research Design

This study employs a structural equation modelling (SEM) approach to analyze the relationship between student teachers' self-reported self-efficacy beliefs and use of ICT in teaching. Data was collected through a survey questionnaire comprising questions on demographics and multiple items for each construct in the study. Normal procedures for SEM analysis were applied in this study. Data were screened for missing data and outliers. This was followed by establishing the convergent and discriminant validities of the data. To obtain reliable results in structural equation modelling, researchers recommend that a sample size of 100 to 150 cases (e.g. Kline, 2005). In addition, Hoelter (1983) 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 critical N for the model in this study is 199, and given the sample size of this study is 547 for both the model development and validation samples, they are considered adequate for the purpose of structural equation modelling.

Research Participants and Data Collection

Participation in this study was voluntary and 1094 student teachers were recruited. These were student teachers enrolled in either the one-year Postgraduate Diploma in Education (PGDE) (n=708, 64.7%) or the two-year Diploma in Education programme (n=486, 35.3%) at the National Institute of Education (NIE) in Singapore. The participants in this study represent about 90% of the population in each programme. They 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 survey questionnaire. The mean age of all participants was 25.8 (SD=5.15). All participants 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 not more than 10 minutes to complete the questionnaire. In structural equation modelling, it is recommended that proposed models be validated with another sample that is not used in the initial model development (Schumacker & Lomax, 2004). For this reason, the sample of this study (n=1094) was randomly split into two (n=547). However, the ratio of participants in the two programmes was retained to ensure that the characteristics of both samples remain similar.

Measures

A 16-item survey questionnaire was developed to measure participants' self-efficacy and uses of technology, in addition to demographic information. The scale for self-efficacy beliefs include three constructs: Basic Technology skills (BTS) (three items), Advanced Technology Skills (ATS) (three items), and Technology for

Pedagogy (TP) (four items). The scale for uses of technology includes Traditional Use of Technology (TUT) (three items) and Constructivist Use of Technology (CUT) (three items). The items in this survey reflect the use of specific technology tools or actual use of technology for instructional purposes. Examples of self-efficacy items include "I am able to use the internet to search for information and resources" and "I am able to use digital media collection tools (e.g., digital camera, digital video camera) for teaching or administration purposes".

The items that measure uses of technology include **"**In my lessons, I would teach my students to use ICT to "find out ideas and information" and "Communicate electronically with other people." Relative to the computer self-efficacy scales that are found in the literature (e.g. Murphy et al., 1989), this author has chosen to include the actual technology tools (e.g. powerpoint) and situations (e.g. "to use ICT to express themselves in writing") in the questionnaire items with a view to allow participants to take reference from their personal experiences when responding to these items. In addition, as a faculty member in the institutions where the participants in this study was selected, this author has a good understanding of the technology tools that students are exposed to. Each item was measured on a seven-point Likert scale with 1=strongly disagree to 7=strongly agree. A total of 10 items were used to measure self-efficacy and 6 items to measure the use of ICT in teaching. These items are listed in the Appendix.

RESULTS

Analysis of the measurement model

The research model in this study was tested using the structural equation model approach, using AMOS 7.0 (Arbuckle, 2006) and the parameters were estimated using the Maximum Likelihood (ML) estimator. Data was tested for reliability and validity using confirmatory factor analysis (CFA). The model in this study includes 16 items loading on five constructs. To establish the reliability, convergent and discriminant validities of the constructs in this study were measured.

Following the recommendations from the literature, the item reliability of each measure, composite reliability of each construct, and the average variance extracted were computed. To examine the reliability of each item, Hair, Black, Babin, Anderson, & Tatham (2006) recommended a factor loading of .70 and the R^2 value to be at least 0.50. At the construct level, composite reliability was used instead of the Cronbach's alpha as the latter tends to understate reliability. For composite reliability to be adequate, a value of .70 and higher was recommended (Hair et al.). Finally, the average variance extracted (AVE) was computed as a measure the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error. Convergent validity is judged to be adequate when average variance extracted equals or exceeds 0.50, when the variance captured by the construct exceeds the variance due to measurement error (Hair et al.). Table 1 shows the result of the analysis of the measurement model. All values, except the R^2 for item TUT3, appear to provide support for convergent validity. Because the other values for TUT3 are acceptable, it was not removed from further analyses.

Table 1: Results for the measurement model

Latent Variable	Item	FL[a] (> .70)*	SE	t-value[b]	[c] R^2 (=> .50)*	CR[d] (= > .70)*	AVE[e] (=> .50)*
Basic Technology Skill						.89	.74
	BTS1	.831	.938	22.036	.627		
	BTS2	.904	.844	26.407	.879		
	BTS3	.840	.890	---[f]	.713		
Advanced Technology Skill						.89	.73
	ATS1	.878	.822	20.038	.676		
	ATS2	.798	.712	17.616	.507		
	ATS3	.892	.890	---[f]	.792		
Technology for Pedagogy						.88	.65
	TP1	.752	.783	19.063	.612		
	TP2	.836	.892	21.740	.795		
	TP3	.839	.780	---[f]	.609		
	TP4	.783	.729	17.535	.531		
Traditional Use of Technology						.86	.67
	TUT1	.836	.808	18.559	.652		
	TUT2	.849	.886	---[f]	.786		
	TUT3	.762	.614	14.394	.377		
Constructivist Use of Technology						.89	.73
	CUT1	.877	.883	23.169	.697		
	CUT2	.830	.824	23.550	.679		
	CUT3	.848	.835	---[f]	.780		

SE: Standardised Estimate
*Indicates an acceptable level of reliability or validity.
[a] Factor Loading
[b] Known as a *critical value*, this value tests whether a parameter is significantly different from zero. All values were significant at $p < .01$
[c] This represents the proportion of variance in the latent variable that explained by this item.
[d] Composite Reliability= $(\sum\lambda)^2/(\sum\lambda)^2+(\sum(1-\lambda^2))$
[e] AVE: Average Variance Extracted=$(\sum\lambda^2)$ / n
[f] This value was fixed at 1.00 in the model for estimation purposes.

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 et al., 1982). Discriminant validity was assessed by comparing the square root of the average variance extracted for a given construct with the correlations between that construct and all other constructs. If the square roots of the AVEs are greater than the off-diagonal elements in the corresponding rows and columns, it suggests that the given construct is more strongly correlated with its indicators than with the other constructs in the model. In Table 2, the diagonal elements in the correlation matrix have been replaced by the square roots of the average variance extracted. The values suggest that discriminant validity was present at the construct level or all the variables in the research model. From the information given in tables 1 and 2, the data obtained in this appear to be reliable and valid for the purpose of structural equation modelling.

Table 2: Discriminant validity for the measurement model

Construct	BTS	ATS	TP	TUT	CUT
BTS	(.86)				
ATS	.16**	(.85)			
TP	.45**	.39**	(.81)		
TUT	.25**	.09*	.28**	(.82)	
CUT	.39**	.05	.28**	.47**	(.85)

Notes:
(1) *p< .05; **p< .01
(2) Diagonal in parentheses: square root of average variance extracted from observed variables (items);
Off-diagonal: correlations between constructs

In testing for model fit, it is usual to use variety of fit indices. Hair et al. (2006) suggested using fit indices from various categories: absolute fit indices that measure how well the proposed model reproduces the observed data, parsimonious indices that is similar to the absolute fit indices but take into account the model's complexity, and incremental fit indices that assess how well a specified model fit relative to an alternative baseline model. In this study, Tucker-Lewis index (TLI), comparative fit index (CFI), root mean square error of approximation (RMSEA), and standardized root mean residual (SRMR) will be used. Because the χ^2 has been found to be too sensitive to an increase in sample size and the number of observed variables (Hair et al. 2006), the ratio of χ^2 to its degree of freedom (χ^2/df), was used, with a range of not more than 3.0 being indicative of an acceptable fit between the hypothetical model and the sample data (Carmines & McIver, 1981).

As part of confirmatory factor analysis, several models were computed to allow comparisons of different conceptualization of the factor structure to be made. First, a null model that assumes all the factors to be unrelated. Second, a one-factor model that tests whether all the factors load on one overall factor. Support for the one-factor model suggests that participants do not differentiate among the factors and that all items are representative of a unidimensional construct. Third, an uncorrelated factor model that tests whether all the five factors in the model are independent. Support for this suggests that these five factors are not related to one another and are indeed five different constructs. Fourth, a correlated factor model that tests whether the five factors are related to one another. Support for this model indicates that participants had discriminated between the five factors but they are intercorrelated with one another. Fifth, a hierarchical model that tests the idea that a second-order factor exist to account for the relationships among the five factors. Support for this model suggests that while all five factors are related, they are also related to a higher order factor. A series of CFA were conducted to test the five models described above. Table 3 shows the fit indices for each model. Results indicate that the correlated model has the best fit and on this basis, it was the retained as the model of best fit.

Table 3: Confirmatory Factor Analysis of alternative models

Model	χ^2	df	χ^2/df	TLI	CFI	RMSEA	SRMR
Null	5119.895*	120	42.666	---	---	.276	---
One-factor	2990.197*	104	28.759	.334	.423	.225	.164
Uncorrelated factor	775.563*	104	7.457	.845	.866	.109	.218
Correlated factor	323.622*	94	3.443	.941	.954	.067	.049
Hierarchical	420.979*	99	4.252	.922	.936	.077	.084

*p <.001

Analysis of the structural model
The same fit indices used for testing the measurement model are applied to the structural model. 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. The results of the model fit for both the initial and validation samples are listed in Table 3, indicating that the research model has a good fit.

Table 4: Good-of-Fit measures

Model fit index	Initial Sample (n=547)	Validation Sample (n=547)	Acceptable fit*
$\chi2$	247.669, p < .001	217.273, p < .001	Non-significant
$\chi2$ /df	2.752	2.414	< 3
TLI	.958	.971	=> .95
CFI	.968	.978	=> .95
RMSEA	.057 (.048, .065)	.051 (.042,.060)	< .08
SRMR	.048	.043	< .05

*References were taken from: Hair et al., 2006; Kline, 2005; McDonald & Ho, 2002, Browne & Cudeck, 1983.

Hypothesis testing
Table 5 shows the results of the hypothesis test and path coefficients of the proposed research model. All hypotheses, except H3 and H4 were supported by the data. The hypotheses relating the BTS and TP (H1, H2, H3, and H4) were significant. Two endogenous variables were tested in the research model. Traditional use of technology (TUT) was found to be predicted by BTS and TP, resulting in an R^2 of 0.129. This means that BTS and TP explained 12.9 percent of the variance in TUT. The variance in constructivist use of technology (CUT) was explained by BTP and TP in amount of 21.5%.

Table 5: Hypothesis testing results

Hypotheses	Path	Path coefficient	t- value	Results
H1	BTS → TUT	.169	3.017*	Supported
H2	BTS → CUT	.353	6.563*	Supported
H3	ATS → TUT	-.044	-.858	Rejected
H4	ATS → CUT	-.074	-1.532	Rejected
H5	TP → TUT	.253	4.070*	Supported
H6	TP → CUT	.185	3.183*	Supported

* $p < .001$

DISCUSSION

The aim of this study is to examine the relationship between student teachers' self-efficacy beliefs and their intended use of technology for teaching. Using structural equation modelling, the results show that four out of six hypotheses were support. Student teachers' perception of their basic technology skills and ability to use technology for pedagogy were significant predictors of their intention to use in either a traditional (i.e. drill and practice) or constructivist (i.e. student-centred) way. However, student teachers' perception of their advanced technology was not significant influences of their intended uses of technology.

While teachers' perception of their ability has been shown to affect their technology usage, this study goes a step further to examine the relationship between perceived ability and ways in which technology will be used in the classroom. It is possible that the student teachers did not perceive the advanced technology skills as important relative to the basic technology skills for use in teaching. This is supported by the weak correlation between ATS and TUT and CUT (Table 2). In contrast, basic technology skills and technology for pedagogy are significantly correlated with TUT and CUT with effect sizes greater that that between ATS with TUT and CUT. However, it should be noted that ATS correlated significantly with BTS and TP.

The results of this study also show that a significant correlation exists between TUT and CUT. This suggests that the student teachers in this study do not view the two uses of technology in teaching (type 1 and type 2) as separate but complementary. The connection between traditional and constructivist beliefs held by student teachers and how these beliefs influence their uses of technology was examined by Author, Chai, Hung, and Lee (2008) who found that traditional and constructivist uses of technology for teaching has a positive significant relationship (r= .771). The profile of the sample in Author et al. study was similar to the one used in this study.

This study contributes to theory by highlighting the relationship between teachers' beliefs about their ability to use technology and how they would use technology in teaching. In an age where many education systems advocate the use of technology in a more constructivist and learner-centred way, it is important to understand the drivers that motivate teachers to move in this direction. This study provides empirical evidence for a significant relationship between the perception of one's ability to use technology and how a person plans to use technology in teaching. This study also contributes methodologically by using items that require the participants to respond to the use of actual tools ("I am able to use word processor to create, edit and format documents for specific purposes (e.g. Microsoft Word)" and situations where technology are used (In my lesson, I use technology to teach my student to work collaboratively). In contrast, many studies on self-efficacy had employed scale items that were worded in very general terms (e.g., I could complete a job or task using the computer if I could call someone for help if I got stuck.).

LIMITATIONS OF THE STUDY

Although the use of self-reports to collect data has benefits, it may lead to the common method variance, a situation that may inflate the true associations between variables. Next, using students teachers may not present the true picture of the association among the variables examined in this study. This is because the experiences of the student teachers in using technology may use may differ from that of the practicing teachers. It is also possible that student teachers engage in more volitional uses of technology than the practicing teachers, and such opportunities to exercise one's volition in sing technology may have shaped their self-efficacy beliefs. Finally, the variance of the dependent variables, TUT and CUT, were explained by the BTS, ATS, and TP by a mere 12.9%, and 21.5% respectively. In pursuing model parsimony, it is possible that other significant variables that may impact significantly on student teachers' intended uses of technology have been excluded.

IMPLICATIONS FOR PRACTICE

The results of this study suggest that teacher educators and administrators should place emphasis on building student teachers' perception of their ability to use technology with a view to transform classroom practices. In order to encourage teachers and teacher-to-be to integrate technology into teaching and learning, teacher educators need to ensure that opportunities are given the former to acquire basic technology skills such as the use of presentation and word processing tools and at the same time, organize courses on the strategies to infuse technology for pedagogical purposes. For example, Yuen, Law, & Chan (1999) found that, in order for teachers to facilitate and adjust their instructional strategies that will optimize their students' learning, they need to be provided with the relevant skills and possess successful experiences in technology use at the teacher training stage. Finally, bbecause perceptions do not remain static, student teachers who perceive themselves as adept users of technology may soon experience limitations if they do not keep abreast with advances in the technologies relevant to them. In the case of in-service teachers, they may soon develop feelings of insecurity when they students, who might mostly be digital natives, appear to be more technologically savvy than them (Sugar, Crawley, & Fine, 2004). From the perspective of self-efficacy, it is possible that teachers, who are surrounded by effective support structures that provide them with successful experiences in technology, would develop more positive judgments about their ability to use technology for teaching. Over time, such feeling of being able to use technology may motivate the teacher to apply technology in ways that are described in this study as traditional or constructivist uses of technology. Finally, the role of teacher education to ensure timely and effective integration cannot be over-stated. Teachers must not only be able to use the technology of the day but be prepared to handle tools of the future (Hunt, 1997).

REFERENCES

Albion, P. R. (2001). Some factors in the development of self-efficacy beliefs for computer use among teacher education students. *Journal of Technology and Teacher Education, 9*(3), 321-347.

Arbuckle, J. L. (2005). *AMOS* (version 6.0) [Computer software]. Chicago: SmallWaters

Bandura, A. (1986). *Social foundations of thought and action: A Social Cognitive Theory*. Englewood Cliffs, New Jersey: Prentice-Hall.

Becker, H. J. (2000). Findings from the teaching, learning, and computing survey: Is Larry Cuban right? *Education Policy Analysis Archives, 8* (51), Retrieved September 26, 2008, from http://epaa.asu.edu/epaa/v8n51/

Brawner, C., & Allen, R. (2006). Future teachers' classroom applications of technology. *Computers in the Schools*, *23*(1/2), 33-44.

Carmines, E. G., & McIver, J. P. (1981). *Analyzing models with unobserved variables: Analysis of covariance structures*. Thousand Oaks, California: Sage.

Compeau, D. R., & Higgins, C. A. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly*, *19*(2), 189-211.

Cudeck, R., & Browne, M. W. (1983). Cross-validation of. covariance structures, *Multivariate Behavioral Research*. *18*, 147–167.

Enochs, L. G., Riggs, I. M., & Ellis, J. D. (1993). The development and partial validation of microcomputer utilization in teaching efficacy beliefs instrument in a Science setting. *School Science and Mathematics, 93*(5), 257-263.

Ertmer, P. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology, Research and Development. 53* (4), 25-39.

Fornell, C., Tellis, G. J., & Zinkhan, G. M. (1982) *Validity assessment: a structural equations approach using partial least squares*. Proceedings, American Marketing Association Educators' Conference.

Hair, J. F. Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006) *Multivariate data analysis* (Sixth Edition). New Jersey: Prentice-Hall International.

Hannafin, R. D., & Savenye, S. (1993). Technology in the classroom: The teacher's new role and resistance to it. *Educational Technology, 33*(6), 26-31.

Haydn, T., & Barton, R. (2008). 'First do no harm': Factors influencing teachers' ability and willingness to use ICT in their subject teaching. *Computers and Education*, *51*(1), 439-447.

Hoelter, J. W. (1983). The effects of role evaluation and commitment on identity salience. *Social Psychology Quarterly*, *46*, 140-147.

Hunt, N. P. (1997). Using technology to prepare teachers for the twenty-first century. *Asia-Pacific Journal of Teacher Education*, *25*(3), 345-350.

Kline, R. B. (2005) Principles and practice of structural equation modeling (2nd Ed.). New York: Guilford Press.

McDonald, R. P., & Ho, R. H. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods, 7,* 64-82.

Maddux, C. D., Johnson, D. L., & Willis, J. W. (1997). *Educational computing: Learning with tomorrow's technologies*. Boston: Allyn & Bacon.

Schumacker, R.E. and Lomax, R.G. (2004). *A Beginner's Guide to Structural Equation Modeling*. Mahwah, NJ: Lawrence Erlbaum.

Selwyn, N. (2003). Exploring patterns of computer use in schools. *Welsh Journal of Education*, *12*(1), 75–97.

Selwyn, N., Dawes, L., & Mercer, N. (2001). Promoting Mr. 'Chips': The construction of the teacher/computer relationship in educational advertising. *Teaching and Teacher Education*, *17*, 3–14.
Sugar, W., Crawley, F., & Fine, B. (2004). Examining teachers' decisions to adopt new technology. *Educational Technology and Society,* 7(4), 201-213.
Teo, T. (2008a). Pre-service teachers' attitude towards computer use: A Singapore survey. *Australasian Journal of Educational Technology*, *24*(4), 413-424.
Teo, T. (2008b). A path analysis of pre-service teachers' attitudes toward computer use: applying and extending the Technology Acceptance Model in an educational context. *Interactive Learning Environment*. DOI: 10.1080/10494820802231327
Teo, T. (2009). Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education*, *52*(1), 302-312.
Teo, T., Chai, C. S., Hung, D., & Lee, C. B. (2008). Beliefs about teaching and uses of technology among pre-service teachers. *Asia Pacific Journal of Teacher Education*, *36*(2), 165-176.
Tubin, D. (2006). Typology of ICT implementation and technology application. *Computers in the Schools*, *23*(1/2), 85-98.
Wang, L., Ertmer, P. A., & Newby, T. J. (2004). Increasing preservice teachers' self-efficacy beliefs for technology integration. *Journal of Research on Technology in Education,36*(3), 231-250.
Yuen, H. K., Law, N., & Chan, H., (1999) Improving IT training for serving teachers through evaluation. In G. Cumming, T. Okamoto & L. Gomez (Eds.), *Advanced Research in Computers and Communications in Education.* Amsterdam: IOS Press, Vol. 2, 441-448.
Zhao, Y. & Cziko, G. A. (2001). Teacher adoption of technology: A perceptual control theory perspective. *Journal of Technology and Teacher Education*, *9*(1), 5-30.
Zhao, Y., & Frank, K. (2003). Factors affecting technology use in schools: An ecological perspective. *American Educational Research Journal*, *40*(1), 807–840.
Zhao, Y., Tan, S. H., & Mishra, P. (2001). Teaching and learning: Whose computer is it? *Journal of Adolescent & Adult Literacy*. 44(4), 348-355.

APPENDIX

List of items used in this study

Item No.	Item
BTS1	I am able to use the internet to search for information and resources
BTS2	I am able to use word processor to create, edit and format documents for specific purposes. (e.g. Microsoft Word)
BTS3	I am able to use Presentation Software (e.g. Microsoft Powerpoint) for classroom delivery
ATS1	I am able to use website Editors (e.g. Microsoft FrontPage, Macromedia Dreamweaver) to create and/or modify web pages.
ATS2	I am able to use video editing software (e.g. Microsoft MovieMaker, Adobe Premier, Ulead VideoStudio)
ATS3	I am able to use animation software (e.g. Macromedia Flash, Authorware, Director) to create animations.
TP1	I search, evaluate and select appropriate IT resources to support lesson activities
TP2	I am able to adopt and adapt given IT-based learning activities.
TP3	I can manage IT-based learning activities in a computer laboratory.
TP4	I am able to adopt and adapt activities that incorporate the use of IT to assess pupils' learning and provide immediate and constructive feedback
In my lesson, I use technology to teach my student to …	
TUT1	Master skills just taught.
TUT2	Remediate of skills not learned well.
TUT3	Practice on multiple choice questions
CUT1	work collaboratively.
CUT2	work independently.
CUT3	find out ideas and information.