Computers & Education xxx (2009) xxx–xxx

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology

Guoyuan Sang *, Martin Valcke, Johan van Braak, Jo Tondeur

Department of Educational Studies, University of Ghent, Dunantlaan 2, 9000 Ghent, Belgium

ARTICLE INFO

Article history:
Received 15 May 2009
Received in revised form 17 July 2009
Accepted 21 July 2009
Available online xxxx

Keywords:
Educational beliefs
Self-efficacy
Computer attitudes
ICT integration
Teacher education

ABSTRACT

Student teachers should be prepared to integrate information and communication technology (ICT) into their future teaching and learning practices. Despite the increased availability and support for ICT integration, relatively few teachers intend to integrate ICT into their teaching activities (e.g., Ertmer, 2005). The available research has thus far mainly focused on isolated teacher related variables to explain the weak level of ICT integration. Also, most of this research was set up in Western settings. The present study centers on the impact of Chinese student teachers' gender, constructivist teaching beliefs, teaching self-efficacy, computer self-efficacy, and computer attitudes on their prospective ICT use. For this purpose, a survey was set up involving student teachers from four Normal Universities in China ($N = 727$). Results show that prospective ICT integration significantly correlates with all teacher related variables, except for gender. Building on the results of a path analysis model, prospective ICT integration could be directly predicted on the base of teacher thinking variables (constructivist teaching beliefs, teacher self-efficacy, computer self-efficacy and computer attitudes in education), and indirectly by the gender of the student teachers. Implications for teacher education and further research are discussed.

1. Introduction and problem statement

The educational potential of ICT is stressed in a variety of ways (Becker, 2000; Cooper & Brna, 2002; Godfrey, 2001). For instance, Godfrey (2001) stresses the potential of ICT to present rich learning environments, allowing learners to adopt multiple perspectives on complex phenomena, to foster flexible knowledge construction in complex learning domains, and to cater for individual differences.

Since the introduction of educational technologies into classroom settings, teacher education has faced the challenge of improving in-service teacher education and preparing pre-service teachers for successful integration of educational technologies into their teaching and learning practices. In recent years, teacher education institutes have made efforts preparing pre-service teachers to integrate technology into their future teaching practices (e.g., Krueger, Hansen, & Smaldino, 2000). The related review of Kay (2006) summarizes key strategies to introduce technology to pre-service teachers: delivering a single technology course; offering mini-workshops; integrating technology in all courses; modeling how to use technology, etc. In the case of China, the government has also paid much attention to prepare student teachers to proficiently integrate ICT into their future teaching practice, by offering ICT courses at the teacher education institutes (Yuan, 2006). However, Marcinkiewicz (1993) has pointed out that 'full integration of computers into the educational system is a distant goal unless there is reconciliation between teachers and computers. To understand how to achieve integration, we need to study teachers and what makes them use computers' (p. 234). Furthermore, Oliver (1993) also argues that beginning teachers who received formal training in the use of ICT did not differ in their future use of computers for teaching from teachers not receiving such training. As Ertmer (2005) has documented, the decision regarding whether and how to use technologies for instruction rests on the shoulders of teachers. Despite the increased availability of ICT hardware (e.g., Ertmer, 1999), school related support for ICT integration (e.g., Baylor & Ritchie, 2002), and a larger consciousness of teachers about the importance of educational ICT use (e.g., Khine, 2001), relatively few teachers are willing to integrate ICT into their teaching activities (e.g., Becker, 2000; Hermans, Tondeur, van Braak, & Valcke, 2008; Wang, Ertmer, & Newby, 2004). Other factors, next to technical knowledge and skills seem to contribute to teachers' successful technology integration. For instance, knowledge, beliefs, and attitudes of teachers were stressed by Cuban (1993), since they 'shape what they choose to do in their classrooms and explain the core of instructional practices that have endured over time' (p. 256).

* Corresponding author. Tel.: +32 92648670; fax: +32 92648688.
E-mail address: guoyuan.sang@ugent.be (G. Sang).

0360-1315/$ - see front matter © 2009 Published by Elsevier Ltd.
doi:10.1016/j.compedu.2009.07.010

Ertmer (1999) has categorized two barriers hampering teachers' ICT implementation efforts: external (first-order) barriers and internal (second-order) barriers. External barriers include those that are often seen as the key obstacles, e.g., issues related to access to the technologies, training, and local support. When these barriers are present, it is almost impossible to talk about technology integration. Ertmer (1999) has documented that even if the first-order (external) barriers were resolved, 'teachers do not automatically use technology to achieve advocated meaningful outcomes' (p. 51). For this reason, we have to consider the second-order (internal barriers) stalling ICT integration by teachers. Internal barriers are related to a teacher's philosophy about teaching and learning; they are veiled and deeply rooted in daily practices (Ertmer 1999, 2005). Examples of these internal barriers are teacher beliefs, teacher self-efficacy and teacher attitudes. Empirical studies underpin the particular impact of (1) educational beliefs on the frequency and successful use of ICT in education (e.g., Higgins & Moseley, 2001; Hermans et al., 2008; Tondeur, van Keer, van Braak, & Valcke, 2008); (2) teaching self-efficacy (e.g., Wang et al., 2004); and (3) computer attitudes (e.g., van Braak, 2001). However, little is known about the combined effect of these processes and variables and about the direct and indirect impact of the complex interplay of teacher thinking processes (i.e., teacher beliefs, teacher efficacy, teacher attitudes toward ICT, etc.) on ICT integration.

2. Theoretical background

2.1. Cultural issues of research on teacher thinking and ICT use

Brennan, McFadden, and Law (2001) emphasize that cultural differences need to be taken into account when studying instructional interventions. Understanding how culture influences instructional behavior and thinking process is a key issue in the research about teacher education (Aguinis & Roth, 2003; Correa, Perry, Sims, Miller, & Fang, 2008). Different cultures generate different educational philosophies and beliefs. Based on this consensus, researchers have studied the appropriateness of transporting Western theories, constructs, and measuring instruments to be used in non-Western cultural contexts (Ho, 1988; Lin & Gorrell, 2001; Sinha, 1993). For instance, Lin and Gorrell (2001) explored pre-service teacher efficacy in Taiwan and clearly argued that teacher efficacy and beliefs are largely shaped by culturally and socially shared experiences and values. Chinese culture is regarded as part of Confucian-heritage and reflecting particularities of a collectivist society (Biggs, 1996; Ho, 1993). If we take teacher self-efficacy as an example, studies of Chinese teachers' personal efficacy might reflect the self-effacing tendency in personal (re)presentation in collectivistic societies as well as the strong emphasis on teacher responsibilities and teacher performance in the Chinese cultural context (Ho & Hau, 2004). Culture and context have also repeatedly been reported as obstacles to the integration of ICT in education (Chai, Hong, & Teo, 2009; Pelgrum, 2001; Tearle, 2003). For instance, Chai et al. (2009) argue that culture plays a mediating factor that influences how teachers relate their beliefs to ICT use.

2.2. Gender issues of research on teacher thinking and ICT use

Gender differences with regard to teacher beliefs, teacher self-efficacy and teacher attitudes toward computers represent an important research area. The literature on educational computing abounds with conflicting findings about the impact of gender (Teo, 2008). Since the introduction of computers, ICT related activities have been viewed as a 'male domain' (Brosnan & Davidson, 1996; Panteli, Stack, & Ramsay, 1999). There is a significant body of evidence supporting the notion that gender plays a role in actual computer integration. For instance, already more than 20 years ago, Loyd and Gressard (1986) found male teachers to be more confident and less anxious toward computers compared to their female counterparts. A study of Blackmore et al., 1992 found similar findings – males appear to be more positive in their attitudes toward computers than females. As predicted, a study of Liao (1998) in Chinese Taiwan showed that male teachers scored significantly higher than females. Significant differences between males and females were observed for technical ICT capabilities, and situational and longitudinal sustainability (Markauskaite, 2006). Since technologies have become a normal part of the workplace setting, a number of researchers argue that computing should no longer be regarded as a male domain (King, Bond, & Blandford, 2002; North & Noyes, 2002). This emphasizes the need to reconsider the potential impact of gender in the context of educational ICT use.

2.3. Teacher thinking processes

2.3.1. Teacher constructivist beliefs

Studying of constructivist beliefs in a Chinese cultural context, recent studies reported a strong emphasis on constructivist teaching and learning approaches and this both in-service teachers (Sang, Valcke, van Braak, & Tondeur, in press) and pre-service teachers (Yuan, 2006). This can be related to the strong emphasis on the adoption of constructivist teaching and learning approaches in Chinese teacher education, when considering the recent New Curriculum Reform (Yuan, 2006). This particular observation makes it more interesting to explore the influence of student teacher beliefs on their prospective ICT use in the Chinese setting.

A definition of Taylor, Fraser, and White (1994) about constructivist teaching refers to five critical components: scientific uncertainty, student negotiation, shared control, critical voice, and personal relevance. The theoretical and actual influences of teachers' constructivist educational beliefs on classroom activities with or without ICT integration have also been explored by a variety of researchers (Higgins & Moseley, 2001; Riel & Becker, 2000; Tondeur et al., 2008). When considering the interrelationship between teacher beliefs and ICT integration, there is evidence that, teachers' constructivist beliefs about teaching and learning are a significant factor in determining patterns of classroom computer use by in-service teachers (Higgins & Moseley, 2001) and pre-service teachers (Wang et al., 2004). Honey and Moeller (1990) found that teachers with student-centered pedagogical beliefs were successful at integrating technology except in cases where anxiety about computers prevented them from appropriating the technology.

2.3.2. Teacher self-efficacy

Bandura (1997) defined self-efficacy as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Self-efficacy beliefs were characterized as major mediators of behavior, and more importantly, behavioral

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

change. Bandura stresses that self-efficacy is strongly related to particular types of action. Therefore, in the current context we focus on teacher self-efficacy.

Consistent with the general definition, Tschannen-Moran and Woolfolk Hoy (2001) defined teacher self-efficacy as 'a teacher's judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated' (p. 783). Teacher efficacy is related to teacher classroom behaviors. Teacher self-efficacy has been identified as a crucial variable that accounts for individual differences in teaching effectiveness. Teachers with a strong sense of self-efficacy are open to new ideas and more willing to experiment with new strategies, seek improved teaching methods, and experiment with instructional materials (Allinder, 1994; Guskey, 1988). Teacher self-efficacy has also been found to be correlated to ICT integration in classroom (Albion, 1996; Compeau, Higgins, & Huff, 1999; Hasan, 2003; Potosky, 2002).

2.3.3. Teacher efficacy about computers

Self-efficacy regarding computers refers to a person's perceptions of and capabilities to apply computers (Compeau & Higgins, 1995). The latter authors state that computer self-efficacy is positively correlated with an individual's willingness to choose and participate in computer-related activities, expectations of success in such activities, and persistence or effective coping behaviors when faced with computer-related difficulties. Teachers with higher levels of self-efficacy about computers used computers more often and experienced less computer-related anxiety. On the other hand, teachers with lower levels of self-efficacy about computers become more frustrated and more anxious, and hesitate to use computers when they encounter obstacles. Ropp (1999) uses the term 'computer self-efficacy' to claim that while many teachers have positive attitudes to the use of educational technologies, they do not necessarily believe in their own abilities to use technology in a classroom. Compeau et al. (1999) conducted a longitudinal study to test the influence of computer self-efficacy beliefs, outcome expectations and anxiety on computer use. Their research findings point out that computer self-efficacy beliefs have a significant positive influence on computer use.

2.3.4. Computer attitudes

According to Ajzen and Fishbein (1977), attitudes refer to the ability to predict a person's behavior toward certain targets. Ajzen (1988) described an attitude as a predisposition to respond favorably or unfavorably to an object, person, or event.

The strong relationship of computer-related attitudes and computer use in education has been emphasized in many studies (e.g., van Braak, 2001). Attitudes towards computers influence teachers' acceptance of the usefulness of technology, and also influence whether teachers integrate ICT into their classroom (Akbaba & Kurubacak, 1999; Clark, 2001). According to Myers and Halpin (2002), a major reason for studying teachers' attitudes is that it is a major predictor of future classroom computer use. Huang and Liaw (2005) also state that among the factors that affect the successful use of computers in the classroom, teachers' attitudes towards computers play a key role. Research of van Braak, Tondeur, and Valcke (2004) also supported that class use of computers was strongly affected by attitudes toward computers in education. Khine (2001) studied 184 pre-service teachers and found a significant relationship between computer attitudes and its use in the institution. Taking the importance of attitudes toward computer into consideration, it is also important to understand what influences pre-service teachers' attitudes towards computers (Fisher, 2000). These attitudes are related to other internal and external variables.

2.4. Towards an integrated theoretical perspective

Adopting a holistic perspective, Mueller, Wood, Willoughby, Ross, and Specht (2008) conclude that seven interacting variables influence computer technology integration among primary school teachers: positive experiences with computers; teachers' comfort with computers; specific beliefs related to the use of computers as an instructional tool; number of workshops attended; the challenge subscale of the work preference inventory; assistance from others; and teaching efficacy. Using the Technology Acceptance Model (TAM) as a research framework, a similar research has been carried out with pre-service teachers in an Asian setting (Teo, Lee, Chai, & Wong, 2009). The study found that the interaction between the key determinants, perceived usefulness and perceived ease of use, and attitude towards computer use influenced behavioral intention. The latter studies clearly exemplify the need to adopt a more holistic approach to describe and explain ICT integration in the context of the present study. Therefore, Fig. 1 represents in a graphical way the integration of the theoretical and empirical base into one model. A number of additional arrows have been added that are explained below.

There is evidence that gender is related to computer attitudes (Wu & Morgan, 1989), computer self-efficacy (Potosky, 2002), and the adoption of constructivist beliefs of teachers (e.g., Beck, Czerniak, & Lumpe, 2000; Cornelius-White, 2007). For instance, Beck et al. (2000) found a significant relationship between teachers' gender and their constructivist beliefs in favor of female teachers. It is suggests that females may have a stronger sense of efficacy than males due to the fact that the teaching profession predominantly is a female

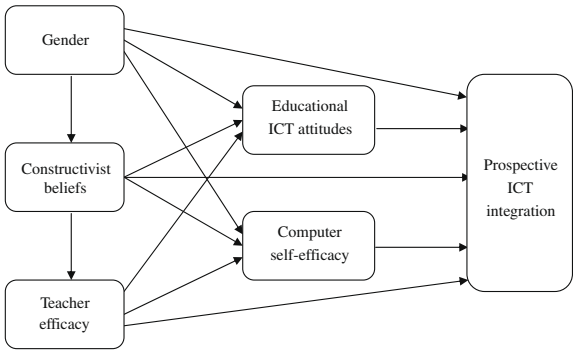

Fig. 1. Integrated model of the impact of gender and student teacher thinking processes on prospective classroom ICT use.

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

profession (Kalaian & Freeman, 1994). Nevertheless, considering the dynamic approach suggested above by North and Noyes (2002). We have to reconsider the potential impact and whether gender differences still play a role in a workplace setting where ICT has become a common provision.

It is argued that student teachers' constructivist beliefs and pedagogical philosophy influence their teaching efficacy (Sung, 2007) and self-efficacy on computers (Potosky, 2002). In the literature, different authors point at the impact of constructivist beliefs on educational computer attitudes (Chai et al., 2009; Ertmer, 2005). Ertmer (2005) has documented that teachers adopting strong constructivist educational beliefs are more likely to use ICT in their classroom practice. However, as mentioned by Chai et al. (2009), how pedagogical beliefs are related to the teachers' attitudes toward computers is a less researched area. Therefore, the relationship between constructivist beliefs and teachers' attitudes toward computers needs to be examined. Furthermore, teachers' teaching efficacy also is related to their attitudes toward efficacy on computers (Olivier & Shapiro, 1993; Wang et al., 2004).

3. Purpose of the study

Most previous studies have centered on the influence of one single or two internal/external teacher thoughts. Therefore, little is known about direct and indirect impact of the variables and processes discussed above, when we focus on their complex interplay to explain classroom ICT integration. Earlier studies tend to ignore the systemic nature of ICT integration. The main objective of the present study is as a consequence to examine the effect of student teachers' gender and their thinking processes (constructivist teaching beliefs, teacher self-efficacy, computer self-efficacy, attitudes toward computers in education) on prospective ICT integration in education. This guiding research question can be stated as follows: to what extent do student teachers' thinking processes (constructivist teaching beliefs, teaching efficacy, computer self-efficacy, attitudes toward computer in education) and/or gender influence their interests to integrate ICT into future teaching practices?

4. Method

In view of the purpose of the study, a survey instrument was designed to gather information from student teachers about the large set of variables. Next to general background questions, five existing scales were used as subsection of the research instrument.

4.1. Sample characteristics

The survey was carried out at the end of the first semester, school year 2008–2009. A total number of 727 respondents, representing a response rate of 97%, completed the survey. Participants were university students majoring in primary education from four teacher education universities in three cities of China (Beijing, Changsha, and Hangzhou). The universities were selected based on the international corporation with a Belgian university. Most of the respondents were juniors (246, 34%). 128 (18%) of respondents were freshmen. A further 154 (21%) were sophomores; the remainder 199 (27%) were senior students. 123 (17%) of them were majoring in Chinese, 80 (11%) in mathematics, 55 (8%) in English, 100 (14%) in science, 51 (7%) in educational technology, 33 (3%) in arts and 286 (40%) in 'other' (187 of them responded 'primary education' or elementary education). Most (351, 48%) of the respondents had 1–5 years of personal computer experience. 326 (45%) of them had more than 6 years of computer experience. 50 (7%) of the respondents reported that they had less than 1 year of computer experience. Looking at the gender characteristics of the sample, 93.5% of the respondents were female. This mirrors the predominance of female student teachers (81.1%) in the Chinese student teacher population (Ministry of Education, 2008). Consequently, we have to study the impact of the gender variable on our object of study: ICT integration.

With permissions of faculty leaders, a paper and pencil questionnaire was distributed among the student teachers. All participants were asked to fill in this questionnaire after they attended a regular course in their class.

4.2. Instruments

Five existing scales were utilized in our study. The recommended translation procedure 'back-translation' (Brislin, 1986) was applied to the development of the instrument. The instruments were translated from English into Chinese; a different translator translated that version back into English, and then an English speaker compared the original instruments with the back-translation (see Behling & Law, 2000). Considering the fact that original scales were translated and applied in a very different educational context, we studied in detail the reliability and validity of each individual instrument.

4.2.1. Constructivist teaching beliefs

Student teachers' constructivist teaching beliefs were measured through the 'constructivist teaching beliefs' (CTB) scale (see Appendix A) of Woolley, Benjamin, and Woolley (2004). The participants were asked to rate their level of agreement with a specific statement (from 1 – strongly disagree to 5 – strongly agree). Internal consistency was measured with Cronbach's alpha ($\alpha = .81$). A one-factor model was confirmed after carrying out a confirmatory factor analysis (CFA), reflecting a good model fit ($\chi^2/df < 3$, AGFI = .967, and RMSEA = .052).

4.2.2. Teacher self-efficacy

Student teachers' teaching self-efficacy was determined on the base of the 'Ohio State teacher efficacy scale' (OSTES, see Appendix B) (Tschannen-Moran & Woolfolk Hoy, 2001). The OSTES contains 12 items. The OSTES is a 5-point Likert scale (from 1 – strongly disagree to 5 – strongly agree). For student teachers, only one construct was suggested by the authors, since 'subscale scores may have little meaning for prospective teachers who have yet to assume real teaching responsibilities' (Tschannen-Moran & Woolfolk Hoy, 2001). Principal-axis factoring revealed one-factor, using the response of the student teachers. The reliability of $\alpha = .84$ was acceptable compared to the original instrument ($\alpha = .90$). A CFA test of a one-factor model resulted in acceptable goodness-of-fit indexes ($\chi^2/df < 4$, AGFI = .931, and RMSEA = .064).

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

4.2.3. Computer self-efficacy

The Computer Self-efficacy Scale (CSE, 14 items) was utilized to explore student teachers' self-efficacy about computers (see Appendix C). It was derived from The Microcomputer Utilization in Teaching Efficacy Beliefs Instrument (MUTEBI) (Enochs, Riggs, & Ellis, 1993). Two items from CSE were suggested to be removed on the base of an exploratory factor analysis, due to low structure coefficients loading below .30. We utilized a 5-point Likert scale format (from 1 – strongly disagree to 5 – strongly agree). Negatively worded items were scored in the opposite direction with strongly agree receiving 1. Cronbach's alpha was calculated to determine internal consistency ($\alpha = .90$). Testing the one-factor model (CFA), resulted in good fit indexes ($\chi^2/df < 3$, AGFI = .962, and RMSEA = .050).

4.2.4. Computer attitudes

The 8-item Attitudes toward Computers in Education Scale (ACE, see Appendix D), designed and by van Braak (2001) was used in the present study. The ACE measures teachers' attitudes toward the effects of computer adoption in the classroom. The scale uses 5-point Likert scale format (from 1 – strongly disagree to 5 – strongly agree). The internal consistency was good ($\alpha = .81$). A CFA test of a one-factor model, resulted in good goodness-of-fit indexes ($\chi^2/df < 4$, AGFI = .957, and RMSEA = .061).

4.2.5. Prospective computer use

Teacher education programs in China require student teachers to be involved in teaching practices for 6–8 weeks during their 4-year academic career (Chen, 2004). Since this offers limited opportunities for student teachers to actually experience classroom computer use, we decided to examine student teachers' reported prospected educational computer use as a dependent measure. The Prospective Computer Use Scale (PCU, see Appendix E) was used that was derived from the 'Computer Use Scale' of van Braak et al. (2004). The Likert items of 'computer use frequency' were changed into 'computer interest' (1 = not at all interested, 2 = some interested, 3 = interested, and 4 = very interested). Cronbach's alpha reflected a good level of internal consistency ($\alpha = .87$). The one-factor model test resulted in acceptable goodness-of-fit indexes ($\chi^2/df < 4$, AGFI = .942, and RMSEA = .064).

4.3. Data analysis

Bivariate correlation analysis procedures were applied to explore the interrelations between the different research variables. In order to be able to consider the complex relationships and direct/indirect effects, path modeling was applied, using AMOS 7.0 (Arbuckle, 2006).

5. Results

5.1. Descriptive results

The mean scores and standard deviations of CTB, OETES, CSE, ACE and PCU are summarized in Table 1. All mean scores are > 3.0, ranging from 3.09 to 4.07. This indicates an overall positive response to the scales.

5.2. Correlation analysis

A first picture of the nature of the relationships between the research variables can be derived from the results of the bivariate correlation analysis (Table 2). For the purpose of this study, the correlations with prospective computer use are of primary interest. The results suggest high interrelationships among computer use variable and the set of teacher thinking variables. Furthermore, teacher thinking variables seem to be significantly to one another. For instance, constructivist teaching is significantly related to all other variables. Teaching efficacy is also related to all the other variables, except for gender.

5.3. Path modelling

Taking computer use as endogenous variable, gender, constructivist teaching beliefs, teaching self-efficacy, computer self-efficacy and computer attitudes toward education as exogenous variables, a path model was tested. A first goal was to estimate the predictive power of the set of independent variables on prospective computer use. Secondly, the strength of the direct and indirect effects of the predictor variables on the dependent variable was assessed. All the indices are in line with recommended benchmarks for acceptable fit ($GFI > .9$, $RMSEA < .04$, $\chi^2/df < 3$). The total explained variance in prospective computer use amounts to 34% ($R^2 = .34$). Table 3 summarizes the fit indices when testing the proposed research model.

Fig. 2 shows the resulting path coefficients in the research model. The figure includes both direct and indirect effects on prospective computer use (represented by path coefficients or β's). Each variable of teaching thinking has a direct effect on prospective computer use: constructivist teaching beliefs ($\beta = .23$), teaching efficacy ($\beta = .06$), attitudes toward computer in education ($\beta = .36$), computer self-efficacy ($\beta = .23$). Furthermore, gender has only an indirect effect on prospective computer use, and affects in a direct way constructivist teaching beliefs ($\beta = .13$).

Table 1
Descriptive statistics and reliability coefficient for each subscale ($n = 727$).

Subscale	Number of items	Mean	SD	α
CTB	10	4.07	.53	.81
OETES	12	3.67	.47	.84
CSE	9	3.92	.79	.90
ACE	8	3.49	.76	.81
PCU	10	3.09	.53	.87

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

Table 2
Correlations coefficients for pairs of variables ($N = 727$).

	1	2	3	4	5
(1) Computer use					
(2) Gender	.02				
(3) Constructivist teaching	.44**	.11**			
(4) Teaching efficacy	.39**	−.01	.48**		
(5) Computer self-efficacy	.28**	.02	.16**	.18**	
(6) Computer attitudes in education	.46**	−.03	.36**	.36**	−.02

**Correlation is significant at the 0.01 level (2-tailed).

Table 3
Summary of goodness-of-fit indices.

Fit index	Recommended level of fit	Proposed research model
χ^2	n.s at $p < .05$	8.353 ($p = .079$)
χ^2/df	<5	2.088
AGFI	>.90	.980
NFI	>.90	.988
CFI	>.90	.994
RMSEA	<.05	.039

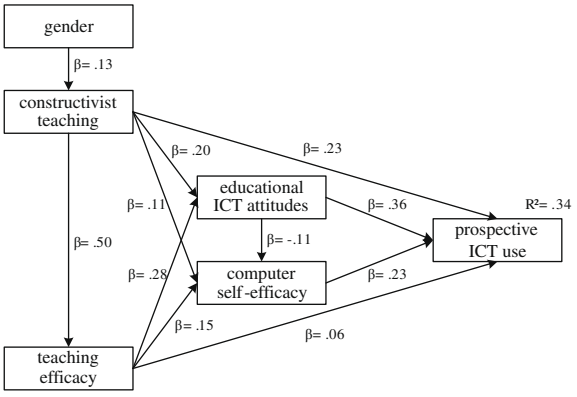

Fig. 2. Path coefficients of the research model.

6. Discussion

Research about educational ICT integration has raised questions about cultural influences on ICT use (Holmes, 1998; Li & Kirkup, 2008). By arguing that Chinese university students reflect a higher confidence level in programming and systems technology than their British counterparts, Li, Kirkup, and Hodgson (2001) exemplify the interaction between culture and computer and Internet technology. It is therefore not a complete surprise that the present study, building on instruments developed in a Western settings, shows certain consistencies and inconsistencies when applied to the Chinese pre-service teacher sample.

6.1. Gender differences of teacher thinking and ICT integration

As discussed earlier, a number of studies report gender differences in relation to computer attitudes, computer self-efficacy, and the adoption of constructivist beliefs of teachers,. In the present study, gender is only significantly correlated with constructivist beliefs. It is interesting to observe that gender plays no further – direct – significant role. This suggests that the impact of gender fades when mediating variables are taken into account. Also other researchers have reported the lesser impact of gender when the interaction between a variety of variables is taken into account; e.g., teacher efficacy, computer efficacy, and computer attitudes of pre-service teachers (Gencer & Cakiroglu, 2007; Liao, 1998; Riggs, 1991).

As reviewed earlier, computer is a 'male domain'. However, given the fact that all the Chinese teacher candidates have to be prepared integrating ICT into their future teaching activities, it is not surprising that gender of student teachers has no direct effect on their prospective ICT integration. This finding is in line with previous findings in Western settings and Eastern settings. For instance, Shapka and Ferrari (2003) did not observe any gender differences in computer-related attitudes of teacher candidates in Canada. Yuen and Ma (2002) who studied 186 pre-service teachers in Hong Kong also found no significant gender differences in undergraduate trainee teachers' attitudes towards computers. The same results were found with in-service teachers. For instance, Hong and Koh (2002) found no significant differences between male and female teachers in overall computer anxiety levels and overall attitudes. The results can also refer to the increased overall acceptance of technology in the workplace as suggested by other authors (e.g., King et al., 2002).

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

6.2. Teacher thinking processes and prospective ICT integration

Our study produced empirical evidence to argue that student teachers: (a) holding stronger constructivist teaching beliefs, (b) strong teaching efficacy and (c) computer self-efficacy, and (d) more favorable attitudes toward computer in education, are more interested to integrate computers into their future teaching practice. Among the teacher thinking variables, attitudes toward computer use in education seem to be the strongest predictor of prospective computer use. This finding is in accordance with previous studies involving in-service teachers (e.g., Wu & Morgan, 1989; van Braak et al., 2004) and with pre-service teachers (e.g., Khine, 2001; Lin, 2008).

Constructivist teaching beliefs of student teachers strongly influence their prospective computer use in a direct and indirect way (mediated by teaching efficacy, computer self-efficacy and attitudes toward computer in education), indicating that student teachers with higher constructivist teaching beliefs are more inclined to integrate technologies into their future teaching. This finding is in line with previous studies that state constructivist beliefs consistently predict student teachers' computer-related behaviors in Western settings (e.g., Becker & Ravitz, 1999; Higgins & Moseley, 2001) and in Eastern settings (e.g., Lin, 2008).

As mentioned earlier, teaching self-efficacy is related to teacher behavior in the classroom. Teachers' self-efficacy has also repeatedly been reported to be a major variable to understand the frequency and success of computer use in education (Albion, 1999; Olivier & Shapiro, 1993), even in Singapore and Malaysia in Asian cultural contexts (Teo et al., 2009). This is strongly supported by our study. Teacher self-efficacy predicts – directly – student teachers' prospective computer use in education, and indirectly via its impact on the mediating variables attitudes towards computers in education and computer self-efficacy. Computer self-efficacy is also a strong predictor of student teachers' prospective computer use. This finding is in line with other studies that emphasize the importance of computer self-efficacy on teachers' computer-related behaviors (e.g., Compeau et al., 1999). This implies that the more confident student teachers are about their capacity to teach or/and to use computers in education, the more likely they are to be interested in teaching with computers. This is consistent with the basic hypothesis of Bandura (1977): people high on both outcome expectancy and self-efficacy would act in an assured, decided manner.

7. Implications, limitations, and conclusions

7.1. Implications for the innovation of teacher preparation

According to our findings, ICT integration is influenced by the complex of student teachers' constructivist teaching beliefs, teaching self-efficacy, computer attitudes in education and their computer self-efficacy. The latter implies that teacher education should reconsider its training approaches. Teacher education should be carried out in constructivist learning environment and provide student teachers with a conducive and non-threatening environment to experience success in using the computers. This will allow them to gain competence and confidence in using computers for teaching and learning (Teo, 2008). In addition, Albion (1999) stresses the need for real life experiences in classroom settings. Wang et al. (2004) claim that this might help to attain vicarious learning experiences increasing student teachers' self-efficacy for technology integration. At the same time, these real life experiences are expected to influence the interrelated set of teacher thoughts (teaching beliefs, self-efficacy, attitudes, etc.) in relation to prospective educational use of technology.

7.2. Limitations and directions for further research

It should be noted that this study has a number of limitations. The quantitative research methodology is mainly based on self-report measures. Future studies could build on classroom observation of internship activities and/or interviews with student teachers. Furthermore, longitudinal studies are recommended that might be helpful to track changes in thinking processes and related teaching practices with and without educational technologies. Since the potential of ICT can differ according to specific curriculum goals and specific knowledge domains, more attention should be paid in future studies to the nature of the curriculum taught with or without ICT. As Lundeberg, Bergland, and Klyczek (2003) suggested, we can additionally carry out action research to develop pre-service teachers' confidence, knowledge and beliefs about technology.

It should also be noted that the findings of the present study have to be interpreted in a careful way since a convenience sampling procedure was applied. Based on a bilateral collaboration between Ghent University and four Chinese Normal universities, all student teachers from these particular institutions were involved in the study. The selection of these four institutions can have caused uncontrolled bias.

7.3. Conclusion

Our study has provided insight into the interrelated nature of student teachers' thinking processes and gender on the potential level of ICT integration in a Chinese context. The findings suggest that successful ICT integration is clearly related to the thinking processes of classroom teachers, such as teacher beliefs, teacher efficacies, and teacher attitudes toward ICT. The results underpin the importance of an integrated and concurrent understanding of teachers' thinking processes. The study also suggests that in order to improve the innovation of classroom activities, teachers' thinking processes should be challenged.

Appendix A

Constructivist belief scale	Factor score (β)
1. I make it a priority in my classroom to give students time to work together when I am not directing them	.64
2. I involve students in evaluating their own work and setting their own goals	.63
3. I believe that expanding on students' ideas is an effective way to build my curriculum	.54

(continued on next page)

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

(*continued*)

Constructivist belief scale	Factor score (β)
4. I prefer to cluster students' desks or use tables so they can work together	.52
5. I prefer to assess students informally through observations and conferences	.49
6. I often create thematic units based on the students' interests and ideas	.49
7. I invite students to create many of my bulletin boards	.43
χ^2/df	<3
AGFI	.967
RMSEA	.052

Appendix B

Teacher self-efficacy scale	Factor score (β)
1. How much can you do to motivate students who show low interest in schoolwork?	.65
2. How much can you do to control disruptive behavior in the classroom?	.60
3. How much can you do to calm a student who is disruptive or noisy?	.59
4. To what extent can you use a variety of assessment strategies?	.56
5. To what extent can you craft good questions for your students?	.55
6. How much can you do to get children to follow classroom rules?	.54
7. How much can you do to get students to believe they can do well in schoolwork?	.54
8. How well can you establish a classroom management system with each group of students?	.53
9. How much can you assist families in helping their children do well in school?	.52
10. How well can you implement alternative strategies in your classroom?	.52
11. How much can you do to help your students value learning?	.51
12. To what extent can you provide an alternative explanation or example when students are confused?	.49
χ^2/df	<4
AGFI	.931
RMSEA	.064

Appendix C

Teacher computer efficacy scale	Factor score (β)
1. When students have difficulty with the computer, I am usually at a loss as to how to help them	.77
2. I wonder if I have the necessary skills to use the computer for instruction	.74
3. I generally employ the computer in my classroom ineffectively	.73
4. Whenever I can, I avoid using computers in my classroom	.68
5. I am not very effective in monitoring students' computer use in my classroom	.68
6. Even when I try very hard, I do not use the computer as well as I do other instructional resources	.68
7. I do not know what to do to turn students onto computers	.68
8. I find it difficult to explain to students how to use the computer	.65
9. Given a choice, I would not invite the principal to evaluate my computer-based instruction	.60
χ^2/df	<3
AGFI	.962
RMSEA	.05

Appendix D

Attitudes toward computers in education scale	Factor score (β)
1. The computer provides opportunity for improving the learning performance	.75
2. The efficiency of the learning process is increased through the use of computers	.72
3. The computer used as a learning tool, increases student motivation	.65
4. Students with learning difficulties can strongly benefit from the didactic possibilities which the use of computers entail	.64
5. The computer increases the level of creativity of students	.60
6. The use of computer helps students to achieve better text writing	.51
7. Computer knowledge and practical experience should be more integrated in the curriculum	.48
8. Computers can help the teacher to apply differentiation among the students	.37
χ^2/df	<4
AGFI	.957
RMSEA	.061

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

Appendix E

Computer use scale	Factor score (β)
1. I would use the computer as a tool for demonstration working with existing presentations, or those someone else has made for me	.70
2. I would use the computer as a tool to teach new subject knowledge, i.e. the pupils acquire knowledge directly from the computer	.68
3. I would encourage pupils in class to search for relevant information on the Internet	.67
4. I would use educational software with my pupils for learning subject knowledge through drill and practice	.64
5. I would teach pupils to consider the implications and opportunities of computer use	.62
6. I would use the computer as a tool for demonstration working with presentations I have made myself (e.g., PowerPoint)	.61
7. I would ask pupils to undertake tasks or follow up classwork at home on the computer	.60
8. I would use the computer to assist with differentiation or implementing individual learning plans	.58
9. I would I encourage pupils to work collaboratively when using a computer	.56
10. I would use e-mail to communicate with pupils out of school (or class time)	.52
χ^2/df	<4
AGFI	.942
RMSEA	.064

References

Ajzen, I. (1988). Attitude structure and behavior relations. In A. R. Partkanis, S. T. Berckler, & A. G. Greenwald (Eds.), *Attitude structure and function*. Hillsdale, NJ: Erlbaum.
Ajzen, I., & Fishbein, M. (1977). Attitude–behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84*, 888–918.
Akbaba, S., & Kurubacak, G. (1999). Teachers' attitudes towards technology. *Computers in the Social Studies, 7*(2), 833–836.
Albion, P. R. (1996). Student–teachers' use of computers during teaching practice in primary classrooms. *Aisa-Pacific Journal of Teacher Education, 24*(1), 63–73.
Albion, P. R. (1999). Self-Efficacy beliefs as an indicator of teachers' preparedness for teaching with technology. *Computers in the Social Studies, 7*(4).
Allinder, R. M. (1994). The relationships between efficacy and the instructional practices of special education teachers and consultants. *Teacher Education and Special Education, 17*, 86–95.
Aguinis, H., & Roth, H. A. (2003). Teaching in China: Culture-based challenges. In I. Alon & J. R. McIntyre (Eds.), *Business and management education in China: transition, pedagogy, and training* (pp. 141–164). Hackensack, NJ: World Scientific Publishing.
Arbuckle, J. L. (2006). *Amos 7.0 s user's guide*. Chicago: SPSS.
Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191–215.
Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.
Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms?. *Computers and Education 39*, 395–414.
Becker, H. J. (2000). Access to classroom computers. *Communications of the ACM, 43*(6), 24–25.
Becker, H. J., & Ravitz, J. (1999). The influence of computer and internet use on teachers' pedagogical practices and perceptions. *Journal of Research on Computing in Education, 31*(4), 356–384.
Beck, J., Czerniak, C. H., & Lumpe, A. (2000). An exploratory study of teachers' beliefs regarding the implementation of constructivism in their classrooms. *Journal of Science Teacher Education, 11*(4), 323–343.
Behling, O., & Law, K. (2000). *Translating questionnaires and other research instruments: Problems and solutions*. Thousand Oaks, London, Delhi: SAGE publications.
Biggs, J. B. (1996). Western misperceptions of the Confucian-heritage learning culture. In D. A. Watkins & J. B. Biggs (Eds.), *The Chinese learner: Cultural, psychological and contextual influences* (pp. 45–67). ACER, Hong Kong: CERC/Camberwell, Victoria, Australia.
Blackmore, M., Stanley, N., Coles, D., Hodgkinson, K., Taylor, C., & Vaughan, G. (1992). A preliminary view of students' information technology experience across UK initial teacher training institutions. *Journal of Information Technology in Teacher Education, 1*(2), 241–254.
Brennan, R., McFadden, M., & Law, E. (2001). *Review of research. All that glitters is not gold: Online delivery of education and training*. Leabrook: National Centre for Vocational Education Research.
Brislin, R. (1986). The wording and translation of research instrument. In W. J. Lonner & J. W. Berry (Eds.), *Field methods in cross-cultural research* (pp. 137–164). Beverly Hills, CA: Sage.
Brosnan, M., & Davidson, M. (1996). Psychological gender issues in computing. *Journal of Gender, Work and Organization, 3*, 13–25.
Chai, C. S., Hong, H. Y., & Teo, T. (2009). Singaporean and Taiwanese pre-service teachers' beliefs and their attitude towards ICT: A comparative study. *The Asia-Pacific Education Researcher, 18*(1), 117–128.
Chen, J. A. (2004). Comparative research on educational practice model of five countries. *Curriculum, Teaching Material and Method, 5*(18), 64–71.
Clark, K. D. (2001). Urban middle school teachers' use of instructional technology. *Journal of Research on Computing in Education, 33*(2), 178–195.
Compeau, D., & Higgins, C. (1995). Computer self-efficacy: Development of a measure and initial test. *MIS Quarterly, 19*(2), 198–211.
Compeau, D., Higgins, C. A., & Huff, S. (1999). Social cognitive theory and individual reactions to computing technology: A longitudinal study. *MIS Quarterly, 23*(2), 145–158.
Cooper, B., & Brna, P. (2002). Supporting high quality interaction and motivation in the classroom using ICT: The social and emotional learning and engagement in the NIMIS project. *Education, Communication and Information, 2*, 113–138.
Cornelius-White, J. (2007). Learner-centered teacher–student relationships are effective: A meta-analysis. *Review of Educational Research, 77*(1), 113–143.
Correa, C. A., Perry, M., Sims, L. M., Miller, K. F., & Fang, G. (2008). Connected and culturally embedded beliefs: Chinese and US teachers talk about how their students best learn mathematics. *Teaching and Teacher Education, 24*, 140–153.
Cuban, L. (1993). *How teachers taught: Constancy and change in American classrooms: 1890–1990* (2nd edition). New York: Teachers College Press.
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. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development, 47*(4), 47–61.
Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development, 53*(4), 25–39.
Fisher, M. (2000). Computer skills of initial teacher education students. *Journal of Information Technology for Teacher Education, 9*(1), 109–123.
Gencer, A. S., & Cakiroglu, J. (2007). Turkish preservice science teachers' efficacy beliefs regarding science teaching and their beliefs about classroom management. *Teaching and Teacher Education, 23*(5), 664–675.
Godfrey, C. (2001). Computers in school: Changing technologies. *Australian Educational Computing, 16*(2), 14–17.
Guskey, T. R. (1988). Teacher efficacy, self-concept, and attitudes toward the implementation of instructional innovation. *Teaching and Teacher Education, 4*(1), 63–69.
Hasan, B. (2003). The influence of specific computer experiences on computer self-efficacy beliefs. *Computers in Human Behavior, 19*, 443–450.
Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' educational beliefs on the classroom use of computers. *Computers and Education, 51*(4), 1499–1509.
Higgins, S., & Moseley, D. (2001). Teachers' thinking about information and communications technology and learning: Beliefs and outcomes. *Teacher Development, 5*(2), 191–210.
Ho, D. Y. F. (1988). Asian psychology: A dialogue on indigenization and beyond. In A. C. Paranjpe, D. Y. F. Ho, & R. W. Rieber (Eds.), *Asian contributions to psychology* (pp. 53–77). New York: Praeger.

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010

Ho, D. Y. F. (1993). Cognitive socialization in Confucian heritage cultures. In P. Greenfield & J. Cocking (Eds.), *Cross-cultural roots of minority children development* (pp. 285–313). Hillsdale, NJ: Erlbaum.
Ho, I. T., & Hau, K. T. (2004). Australian and Chinese teacher efficacy: Similarities and differences in personal instruction, discipline, guidance efficacy and beliefs in external determinants. *Teaching and Teacher Education, 20*(3), 313–323.
Holmes, B. (1998). *Cross-cultural differences of use of information technology in education: A comparative study of the use of computers in Japanese and British classrooms*. Unpublished Ph.D. dissertation, Wolfson College, University of Cambridge.
Honey, M., & Moeller, B. (1990). Teachers' beliefs and technology integration: Different understandings. In *Technical Report Issue, 6*, Washington, D.C.: Office of Educational Research and Improvement.
Hong, K., & Koh, C. (2002). Computer anxiety and attitudes toward computers among rural secondary school teachers: A Malaysian perspective. *Journal of Research on Technology in Education, 35*(1), 27–48.
Huang, H. M., & Liaw, S. S. (2005). Exploring users' attitudes and intentions toward the Web as a survey tool. *Computers in Human Behavior, 21*(5), 729–743.
Kalaian, H., & Freeman, D. (1994). Gender differences in self-confidence and educational beliefs among secondary teacher candidates. *Teaching and Teacher Education, 10*(6), 647–658.
Kay, R. H. (2006). Evaluating strategies used to incorporate technology into preservice education: A review of the literature. *Journal of Research on Technology in Education, 38*(4), 383–408.
Khine, M. S. (2001). Attitudes toward computers among teacher education students in Brunei Darussalam. *International Journal of Instructional Media, 28*(2), 147–153.
King, J., Bond, T., & Blandford, S. (2002). An investigation of computer anxiety by gender and grade. *Computers in Human Behavior, 18*, 69–84.
Krueger, K., Hansen, L., & Smaldino, S. (2000). Preservice teacher technology competencies: A model for preparing teachers of tomorrow to use technology. *TechTrends, 44*(3), 47–50.
Li, N., & Kirkup, G. (2008). Gender and cultural differences in Internet use: A study of China and the UK. *Computers and Education, 48*, 301–317.
Li, N., Kirkup, G., & Hodgson, B. (2001). Cross-cultural comparison of women students' attitudes toward the Internet and usage: China and the United Kingdom. *Cyberpsychology and Behavior, 4*(3), 415–426.
Liao, Y. K. (1998). The comparison of in service and preservice teachers' attitudes toward educational computing in Taiwan. In *proceedings of SITE Conference*, 10–14, Florida, US.
Lin, C. Y. (2008). Preservice teachers' beliefs about using technology in the mathematics classroom. The entity from which ERIC acquires the content, including journal, organization, and conference names, or by means of online submission from the author. *Journal of Computers in Mathematics and Science Teaching, 27*(3), 341–360.
Lin, H. L., & Gorrell, J. (2001). Exploratory analysis of pre-service teacher efficacy in Taiwan. *Teaching and Teacher Education, 17*(5), 623–635.
Loyd, B., & Gressard, C. (1986). Gender and amount of computer experience of teachers in staff development programs: Effects on computer attitudes and perceptions of the usefulness of computers. *AEDS Journal, 19*, 302–311.
Lundeberg, M., Bergland, M., & Klyczek, K. (2003). Using action research to develop preservice teachers' confidence, knowledge and beliefs about technology. *The Journal of Interactive Online Learning, 1*(4).
Marcinkiewicz, H. R. (1993). Computers and teachers: Factors influencing computer use in the classroom. *Journal of Research on Computing in Education, 26*, 220–237.
Markauskaite, L. (2006). Gender issues in preservice teachers' training: ICT literacy and online learning. *Australasian Journal of Educational Technology, 22*(1), 1–20.
Ministry of Education, (2008). 2008 *annual report on national education assessment*. <http://www.moe.gov.cn>.
Mueller, J., Wood, E., Willoughby, T., Ross, C., & Specht, J. (2008). Identifying discriminating variables between teachers who fully integrate computers and teachers with limited integration. *Computers and Education, 51*(4), 1523–1537.
Myers, J. M., & Halpin, R. (2002). Teachers' attitudes and use of multimedia technology in the classroom: Constructivist-based professional development training for school districts. *Journal of Computing in Teacher Education, 18*(4), 133–140.
North, A. S., & Noyes, J. M. (2002). Gender influences on children's computer attitudes and cognitions. *Computers in Human Behavior, 18*, 135–150.
Oliver, R. (1993). The influence of training on beginning teachers' use of computers. *Australian Educational Computing, 189*(July), 196.
Olivier, T., & Shapiro, F. (1993). Self-efficacy and computers. *Journal of Computer Based Instruction, 20*(3), 81–85.
Panteli, N., Stack, J., & Ramsay, H. (1999). Gender and professional ethics in the IT industry. *Journal of Business Ethics, 22*(1), 93–101.
Pelgrum, W. J. (2001). Obstacles to the integration of ICT in education: Results from a worldwide educational assessment. *Computers and Education, 37*(2), 163–178.
Potosky, D. (2002). A field study of computer efficacy beliefs as an outcome of training: The role of computer playfulness, computer knowledge, and performance during training. *Computers in Human Behavior, 18*(3), 241–255.
Riel, M., & Becker, H. (2000). The beliefs, practices, and computer use of teacher leaders. In *Paper presented at the annual meeting of the American Educational Research Association*, New Orleans, LA.
Riggs, I. M. (1991). Gender differences in elementary science teacher self-efficacy. In *Paper presented at the Annual Meeting of the American Educational Research Association* (Chicago, IL, April 3–7, 1991). ERIC Document Reproduction Service No. ED 340 705.
Ropp, M. (1999). Exploring individual characteristics associated with learning to use computers in preservice teacher preparation. *Journal of Research on Computing in Education, 31*(4), 402–424.
Sang, G. Y., Valcke, M., van Braak, J., & Tondeur, J. (in press). Investigating teachers educational beliefs in Chinese primary schools: Socio-economical and geographical perspectives. *Asia-pacific Journal of Teacher Education*.
Shapka, J. D., & Ferrari, M. (2003). Computer-related attitudes and actions of teacher candidates. *Computers in Human Behavior, 19*, 319–334.
Sinha, D. (1993). Indigenization of psychology in India and its relevance. In U. Kim & J. W. Berry (Eds.), *Indigenous psychologies: Research and experience in cultural context*. London, UK: Sage.
Sung, Y. K. (2007). Are pre-service teachers constructivists in the constructivist teacher education program? *Korean Journal of Educational Policy, 4*(1), 9–24.
Taylor, P. C. S., Fraser, B. J., & White, L. R. (1994). A classroom environment questionnaire for science educators interested in the constructivist reform of school science. In *A paper presented at the annual meeting of the National Association for Research in Science Teaching*, Anaheim, CA.
Tearle, P. (2003). ICT implementation: What makes the difference? *British Journal of Educational Technology, 34*(5), 567–583.
Teo, T., (2008). Pre-service teachers' attitudes towards computer use: A Singapore survey. *Australasian Journal of Educational Technology, 24*(4), 413–424.
Teo, T., Lee, C. B., Chai, C. S., & Wong, S. L. (2009). Assessing the intention to use technology among pre-service teachers in Singapore and Malaysia: A multigroup invariance analysis of the Technology Acceptance Model (TAM). *Computers and Education, 53*(3), 1000–1009.
Tondeur, J., van Keer, H., van Braak, J., & Valcke, M. (2008). ICT integration in the classroom: Challenging the potential of a school policy. *Computers & Education, 51*, 212–223.
Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*(7), 783–805.
van Braak, J. (2001). Individual characteristics influencing teachers' class use of computers. *Journal of Educational Computing Research, 25*(2), 141–157.
van Braak, J., Tondeur, J., & Valcke, M. (2004). Explaining different types of computer use among primary school teachers. *European Journal of Educational Psychology, 19*(4), 407–422.
Wang, L., Ertmer, A. P., & Newby, J. T. (2004). Increasing preservice teachers' self-efficacy beliefs for technology integration. *Journal of Research on Technology in Education, 36*(3), 231–250.
Woolley, S. L., Benjamin, W-J. J., & Woolley, A. W. (2004). Construct validity of a self-report measure of teacher beliefs related to constructivist and traditional approaches to teaching and learning. *Educational and Psychological Measurement, 64*, 319–331.
Wu, Y. K., & Morgan, M. (1989). Computer use, computer attitudes, and gender: Differential implications of micro and mainframe usage among college students. *Journal of Research on Computing in Education, 22*(2), 214–228.
Yuan, M. X. (2006). The theory of constructivism and the reform of teacher education. *Journal of Yangzhou Teacher College, 24*(2), 41–49.
Yuen, A. H., & Ma, W. W. (2002). Gender differences in teacher computer acceptance. *Journal of Technology and Teacher Education, 10*(3), 365–382.

Please cite this article in press as: Sang, G., et al. Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* (2009), doi:10.1016/j.compedu.2009.07.010