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The Relationships among Chinese Practicing Teachers' Epistemic Beliefs, Pedagogical Beliefs and Their Beliefs about the Use of ICT

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ABSTRACT

This study aimed to investigate the relationships among practicing teachers' epistemic beliefs, pedagogical beliefs and their beliefs about the use of ICT through survey methodology. Participants were 396 high school practicing teachers from mainland China. The path analysis results analyzed via structural equation modelling technique indicated that the systemic relationships among these three types of beliefs were nested. Specifically, teachers' sophisticated beliefs about the source of knowledge were aligned with constructivist pedagogical beliefs and constructivist use of ICT, with one belief highly related to another.

Keywords

Teachers' beliefs, Information and communication technology (ICT), Constructivism

Introduction

The developments of information and communication technology (ICT) have brought forth many affordances that can be of great pedagogical relevance (Jonassen, Howland, Marra, & Crismond, 2008; Tsai, 2001). In the hands of skillful teachers, these affordances could enable constructivist-oriented student-centered learning, which is the focus of many current education reforms. However, while access to ICT both in school and at home has improved considerably in most developed countries, and teachers have been reported to be using ICT more frequently (Greenhow, Robelia, & Hughes, 2009), the change in pedagogical practices has yet to be established. Many research studies continue to highlight the challenges in reforms towards ICT supported constructivist teaching which include the need for time to prepare ICT-based lessons, the examination requirements, and the teachers' personal beliefs (Ertmer, 2005; Hermans, Tondeur, van Braak, & Valcke, 2008). In recent years, researchers tended to use the belief profiles or beliefs system to examine teachers' various aspects of educational belief. For example, regarding to teachers' science teaching, Tsai (2002) found that teachers' beliefs about teaching science, learning science, and their understanding about nature of science are closely aligned, and he called these closely aligned beliefs as "nested epistemologies." Such studies may help us to understand how teachers' various beliefs intertwined and also provide potential insight for teacher educators when they design courses. In the field of historical education, Stoddard (2010) found that teachers' epistemic beliefs affect their pedagogy with historical media through qualitative study. However, in the field of ICT enhanced instruction, studies regarding how teachers' belief systems may be related to their pedagogy of integrating ICT are still few. Teaching with ICT, teachers' beliefs about knowing and knowledge (i.e., epistemic beliefs), teaching (pedagogical beliefs), and ICT use (beliefs about the ICT use) may play important roles in the ICT use in the classroom. In this paper, we study the relationships between Chinese practicing teachers' epistemic beliefs, pedagogical beliefs and their views about the constructivist or traditional use of ICT. The paper aims to contribute to the literature by examining this set of beliefs through structural equation modeling (SEM).

Most studies on how epistemic beliefs are related to other forms of beliefs and how various types of beliefs are connected have been proposed by researchers, especially among practicing teachers in Western countries (Hofer, 2010). In addition, reports of Eastern Chinese practicing teachers' beliefs, especially for teachers' epistemic beliefs, are arguably rare (e.g., Chai, Deng, Qian, & Wong, 2010; Sang, Valcke, van Braak, Tondeur, 2009; 2010). Hofer (2008) and Feucht and Bendixen (2010) argued that personal epistemology is sensitive to the cultural context. Recent research studies on Chinese teachers' epistemic beliefs were targeted at preservice teachers (Chai et al., 2010). Sang et al.'s (2009; 2010) studies on Chinese teachers were targeted at primary school teachers' and preservice teachers' pedagogical beliefs and their relationships with teachers' views about the use of ICT. However, very few studies have investigated the relationships among teachers' epistemic beliefs, pedagogical beliefs, and their views about the

use of ICT, especially by involving Chinese high school teachers. In mainland China, the teaching practices in high school generally differ from those in either primary school or college, at least in terms of the class size, the number of subjects taught, the pressure from the national examinations, the professional development of the teachers themselves, etc. This study thus examines Chinese high school teachers' epistemic and pedagogical beliefs and how they are related to their beliefs about ICT use. It may also expand our current understanding of the various aspects of personal beliefs, given the differences in the cultural context and how these beliefs are connected.

Literature review

In the following sections, we provide a brief overview of teachers' beliefs and how relevant aspects of teachers' beliefs may be connected to the use of ICT, either for constructivist teaching or traditional teaching. The review helps us to form the hypothesized model of how these beliefs are interrelated, which is tested empirically using SEM.

Teachers' epistemic beliefs

Teachers' beliefs have been an important area of research for teacher educators as they are generally viewed as the core mental structure that influences what teachers learn and how teachers make instructional decisions (Nespor, 1987). Owing to their complex nature, there are numerous ways of conceptualizing teachers' beliefs. For example, Woolfolk-Hoy, Davis and Pape (2006) articulated an ecological model that organizes the different aspects of teachers' beliefs into broad categories of self (e.g., self-efficacy), immediate context (e.g., beliefs about students), state and national context (e.g., beliefs about assessment), and cultural norms and values (e.g., beliefs about the meaning of schooling). How the many aspects of teachers' beliefs are interconnected structurally to form a belief system that facilitates teachers' decisions has continuously attracted researchers' attention to this day (Nespor, 1987; Sang et al., 2010).

Among the myriad beliefs, we argue that teachers' epistemic beliefs are one of the core beliefs that need to be taken into consideration when studying teachers' beliefs in the current context of education reforms, which emphasize cultivating the ability of knowledge creation (Bereiter & Scardamalia, 2006). This is essentially a shift in the epistemology and it calls for a constructivist/relativist epistemological stance (Windschitl, 2002). The study of personal epistemology or epistemic beliefs from a psychological perspective is concerned with individuals' views about the nature of knowledge and knowing (Hofer & Pintrich, 1997). Common dimensions for the nature of knowledge include certainty and simplicity of knowledge. As for the nature of knowing, viewing knowing as receiving knowledge passed down by authorities and experts, as contrasted against viewing knowing as constructing understanding based on personal experience and contextual evidence, is commonly employed as the key dimension (Chan & Elliott, 2004; Feucht & Bendixen, 2010). Generally, the epistemic positions that one adopts can be broadly classified as dualist, multiplist/relativist and evaluativist (Greene, Azevedo, & Torney-Purta, 2008). The dualist sees knowledge as either true or false and it mainly comes from authority such as experts or textbooks. A relativist, however, sees knowledge as evolving in nature, constructed by self, and anyone's claim of knowledge may be as good as another. The evaluativist sees knowledge as constructed by the self and assesses knowledge claims based on contextual evidence (Feucht & Bendixen, 2010).

Studies of teachers' epistemic beliefs, which are more common among preservice teachers, indicate that most teachers hold a relativist position, with fewer teachers holding dualist/naïve or evaluativist/sophisticated beliefs. This pattern is common to both preservice teachers in the East and the West (Cheng, Chan, Tang, & Cheng, 2009). Schraw and Olafson (2002) surveyed 24 Caucasian teachers (22 females) and they reported that 23 of them adopted a contextualist epistemological worldview, which is akin to the evaluativist position. Other studies of practicing teachers' epistemic beliefs are mostly carried out from a domain-specific perspective, in conjunction with their practice of instruction. They are reported together with teachers' pedagogical beliefs in a later section.

Recent research of Chinese preservice teachers from Guangzhou indicates that while they are disinclined towards relying on authority/expert as source of knowledge, their views on certainty of knowledge are largely neutral (Chai et al., 2010). For the authority/expert aspect, their views are similar to those of their Asian counterparts from Hong Kong and Taiwan. For the aspect of certainty of knowledge, they are different from those of Hong Kong and Taiwanese preservice teachers who view knowledge as clearly evolving (Chai, Hong, & Teo, 2009; Cheng et al.,

2009). Specifically, they expressed a “compromise” viewpoint that knowledge is changeable but also highly stable (e.g., Good & Shymansky, 2001). With regards to the epistemic profile of Chinese practicing teachers, we were unable to locate any literature.

To a certain extent, how teachers view knowledge is related to how they see teaching (Maggioni & Parkinson, 2008; Sinatra & Kardash, 2004; Tsai, 2006). Teachers’ pedagogical views of teaching are reviewed next.

Teachers’ pedagogical beliefs

Studies of teachers’ pedagogical beliefs generally portray these beliefs as either traditional or constructivist. The traditional pedagogical beliefs are characterized by teacher-centeredness with its theoretical foundations more associated with behaviorism. The constructivist pedagogical beliefs, on the other hand, are characterized by child-centeredness with constructivism and social constructivism as its theoretical grounding (e.g., Chan & Elliott, 2004; Sinatra & Kardash, 2004). Teachers holding the traditional beliefs tend to see teaching as a process of transmitting knowledge to the students. To achieve that, they assume control of the classroom environment as well as students’ behavior and the instructional content and sequences. They act as the authority to assess the correctness of students’ learning outcomes. The students are treated as passive recipients of verified knowledge. Teachers who are inclined towards constructivist teaching would see teaching as a process of facilitating students’ construction of meaning and understanding of the phenomena they experience. These teachers structure the learning environment to promote active sense-making among the students and they are responsive rather than prescriptive in deciding what and how to learn. Assessment in such a setting is formative rather than summative. While the above literature shows the popularity of conceptualizing teaching in a dichotomous way, which seems to be theoretically consistent, empirical studies challenge such dichotomous views.

Many studies showed that while some teachers’ pedagogical beliefs can be classified as either traditional or constructivist, many teachers are reporting eclectic beliefs (Cheng et al., 2009; Sang et al., 2009; Tondeur, Hermans, van Braak, & Valcke, 2008). In particular, both Sang et al. (2009) and Tondeur et al. (2008) employ cluster analysis and report four broad groups of teachers with different belief profiles among Chinese and Flanders elementary school teachers. They are: constructivist; constructivist and traditional; traditional; and neither constructivist nor traditional. Recent developments in the study of personal beliefs suggest that there is a possibility that teachers could see beliefs as cognitive resources and activate different forms of beliefs for different contents and students to be taught (Maggioni & Parkinson, 2008).

The connections between teachers’ epistemic beliefs and their pedagogical beliefs have been investigated by several researchers. Generally, when teachers view knowing as an accumulation of facts, they tend to adopt the traditional pedagogy. On the other hand, when teachers see knowing as construction of progressive understanding, they are more inclined towards the constructivist approach (Maggioni & Parkinson, 2008). Most studies investigating teachers’ epistemic beliefs and their instructional approaches are qualitative in nature and they adopt domain specific epistemology (Maggioni & Parkinson, 2008; Tsai, 2007). Quantitative studies adopting the domain general approach to the study of personal epistemology and its relation with teachers’ pedagogical beliefs are more common among preservice teachers. Chan and Elliott (2004) and Wong, Chan and Lai (2009) reported that preservice teachers who believe in authority as sources of knowledge and certainty of knowledge tended to believe in traditional teaching. In short, most research indicates that naïve epistemic beliefs are associated with traditional pedagogical beliefs, while sophisticated epistemic beliefs are more associated with constructivist views of teaching. However, Cheng et al.’s (2009) study indicates that preservice teachers who view knowledge as uncertain but believe that authority can transmit knowledge can also be inclined towards constructivist teaching.

Teachers’ beliefs about the use of ICT

As a pedagogical tool, ICT can be deployed under different teaching approaches. Many electronic drill-and-practice and tutorial software packages have been created to support traditional teaching (Chen, 2010). Application software such as spreadsheets and discussion forums, on the other hand, can be used as cognitive tools to support the constructivist/social constructivist approach in teaching (Jonassen et al., 2008). Ertmer (2005) suggest that teachers’ use of ICT is influenced by their beliefs. Research to date indicates that teachers may use ICT in both ways (Tubin,

2006). There are studies that associate teachers who are inclined towards constructivist teaching with use of ICT in support of students' sense making (Hermans et al., 2008). However, constructivist-oriented teachers also seem to support the traditional use of ICT (Chai, 2010; Lee, Chai, Teo, & Chen, 2008; Peeraer & Van Petegem, 2011). Sang et al.'s (2010) recent investigation indicates that Chinese preservice teachers' constructivist beliefs predict their computer self-efficacy and positive attitudes towards ICT, which in turn predict prospective use of ICT. Constructivist beliefs also have a direct effect on the preservice teachers' prospective use of ICT. However, for Sang et al.'s study, the scale depicting prospective ICT use merges both constructivist and traditional use of ICT. Teacher use of ICT to support traditional teaching may run contrary to the intended outcomes of education reforms.

In summary, it seems reasonable to assume that teachers holding a relativistic epistemic belief may be more inclined towards the constructivist pedagogy. They also tend to use the computers as cognitive tools to support students' personal construction of knowledge. On the other hand, teachers who view knowledge as certain and unchanging and that knowing can be achieved through knowledge transmission are more likely to practice traditional teaching. They would use computers, mainly the tutorial software and drill-and-practice packages, to support students' acquisition of knowledge (Chen, 2010; Jonassen et al., 2008). While such depiction may be theoretically sound, in practice, other contextual variables may interact with and influence the teachers' beliefs. The teaching practices that are manifested in the classroom are the outcome of the complex interplay between the various forms of beliefs and contexts.

Aim of the present study

This study aims to study the profile of Chinese practicing teachers' beliefs about knowledge, pedagogy and their preferred use of ICT. It will also examine the relationships among Chinese teachers' epistemic beliefs, pedagogical beliefs and their preferred use of ICT to support either traditional teaching or constructivist teaching. A concurrent examination of these beliefs is to our knowledge very rare. In relation to the literature reviewed, the hypothesized framework is shown in Figure 1.

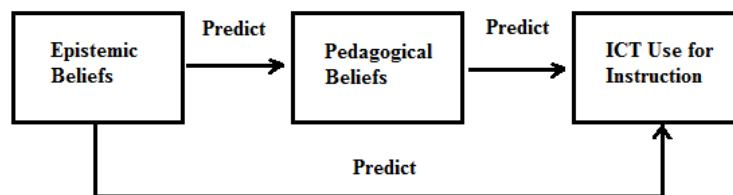


Figure 1. A hypothesized framework for the relationships among epistemic beliefs, pedagogical beliefs and ICT use for instruction

Figure 1 illustrates the hypothesized relationships among the teachers' epistemic beliefs, pedagogical beliefs and their beliefs about the use of ICT. Similar to Tsai's (2002) "nested epistemologies," this study also suggested that, regarding to teaching with ICT, teacher's beliefs about knowledge, pedagogy and their preferred use of ICT were closely aligned.

Method

Participants

A total of 396 high school teachers (Chinese, English, Mathematics, Sciences, Arts, Social Science subjects) from Guangdong province of China participated in this study. About 60% of the participants were female. Of these teachers, 106 had taught for less than 5 years; 101 between 5-10 years; 93 between 10-15 years; and 96 of them more than 15 years. The sample can be regarded as being comprised of beginning and experienced teachers. The samples were selected based on convenience. After obtaining the permission from the three school principals through personal connection, the authors went to the school to distribute the questionnaires. Participation was voluntary and the response rate was around 90%. Regarding the ICT provision issue, every classroom in the three high schools is equipped with one computer for teachers' uses. Similar to many other regions in China, the participants have been greatly encouraged to integrate ICT into their daily teaching practices.

Procedure and Instruments

A composite paper-based survey questionnaire in Chinese was created and the teachers were invited to respond to it. The translation of the items was subjected to review by Chinese language experts. Demographic data such as gender, age, subject and level taught were asked, but the survey was anonymous. The items were scored based on 5-point Likert scales with 1 indicating “strongly disagree” and 5 indicating “strongly agree”. Higher scores indicate that the participants are inclined to agree with the subscales. The scales involved are:

Teachers’ epistemic beliefs scale (TEBS)

This scale consists of two subscales: authority/expert knowledge (AEK) and certainty of knowledge (CK). Six items were selected for AEK (e.g., “Advice from experts should not be questioned”) while the CK dimension has 3 items (e.g., “Scientific knowledge is certain and does not change”). These items, which were created by Chan and Elliott (2004) were selected based on reported studies for Chinese preservice teachers (Chai et al., 2010). Higher scores in these two subscales suggested more dualist-aligned and less evaluativist-oriented epistemic beliefs. On the contrary, lower scores indicated a more evaluativist or relativistic position for epistemic beliefs.

Teachers’ pedagogical beliefs scale (TPBS)

The TPBS measures teachers’ pedagogical beliefs in terms of Traditional Pedagogical Beliefs (TPB) (5 items) and Constructivist Pedagogical Beliefs (CPB) (5 items). The items were created initially by Chan and Elliott (2004). Only 10 items were selected from the original 30 items based on the two main reasons. First, these 10 items were reported to demonstrate satisfactory reliability by a previous study (Chai, 2010). Second, it has been suggested about 4-5 indicators are enough for one latent construct (e.g., Kline, 2005). Sample items in the TPB and CPB subscales are “Learning occurs primarily through drill and practice” and “The ideas of students are important and should be carefully considered” respectively.

Instructional use of ICT scale (IUICTS)

The IUICTS represents two ways of using ICT in the classroom: The traditional use of ICT (TUI) and the constructivist use of ICT (CUI). Comprising nine items, there are five items of how teachers would employ ICT in a traditional manner (e.g., “I prefer to use ICT to remediate skills not learned well”) and four items in a constructivist manner (e.g., “I prefer to use ICT to analyze information critically”). These nine items were selected from a previous study that had documented satisfactory psychometric properties (Chai, 2010).

Reliability of the scales

To obtain the factor loadings, a principal axis factoring analysis was conducted. As shown in Table 1, the eigenvalues of all constructs were greater than 1.00 and these six constructs jointly explained about 69.02% of the cumulative variance. The factor loadings (in bold) of all the items exceed .50, and this indicates an acceptable convergent validity at the item level. As shown in Table 2, the Cronbach’s alpha values for the scales were all above .70, indicating adequate internal consistency of all scales.

An average variance extracted (AVE) of .50 or higher, or a CR of .70 or above, can be a good rule of thumb suggesting adequate convergence at the construct level (Hair et al., 2006). According to Table 2, all scales consistently demonstrate satisfactory convergent validity.

Considering that very few cross-loadings were observed, a satisfactory level of discriminant validity at the item level was established. At the construct level, it is regarded as adequate when the square root of the average variance extracted (AVE) for a specific construct is greater than the correlation estimates between that construct and all other constructs (Fornell & Larcker, 1981). Table 3 shows the correlation matrix for the six constructs. The diagonal elements (i.e., square roots of AVE) were larger than the off-diagonal elements (i.e., correlation coefficients) in the

corresponding rows and columns. This demonstrates that each construct shared more variance with its items than it does with other constructs. That is, discriminant validity was also acceptable at the construct level.

Table 1. Results of principal axis factor analysis

	CPB	AEK	TUI	TPB	CK	CUI
CPB4	.895					
CPB5	.887					
CPB2	.805					
CPB1	.688					
CPB3	.683					
AEK2		.879				
AEK4		.842				
AEK3		.831				
AEK6		.812				
AEK1		.799				
AEK5		.784				
TUI2			.910			
TUI3			.907			
TUI1			.802			
TUI5			.798			
TUI4			.769			
TPB3				.830		
TPB2				.804		
TPB4				.799		
TPB1				.727		
TPB5				.682		
CK2					.939	
CK3					.899	
CK1					.796	
CUI4						.828
CUI3						.822
CUI2						.691
CUI1						.628
Eigenvalue	6.585	5.366	3.671	2.289	2.004	1.203
% Variance	22.377	18.087	12.113	6.940	6.341	3.165

Notes. Extraction method: principal axis factoring; rotation method: Oblimin with Kaiser Normalization. AEK: Authority/Expert Knowledge; CK: Certainty of Knowledge; TPB: Traditional Pedagogical Beliefs; CPB: Constructivist Pedagogical Beliefs; TUI: Traditional Use of ICT; CUI: Constructivist Use of ICT. Factor loadings less than .50 were not presented.

Table 2. Index of reliabilities for all scales

Factor	α	AVE ^a	CR ^b
Authority/Expert Knowledge (AEK)	.93	.68	.93
Certainty of Knowledge (CK)	.91	.77	.91
Traditional Pedagogical Beliefs (TPB)	.88	.59	.88
Constructivist Pedagogical Beliefs (CPB)	.92	.64	.90
Traditional Use of ICT (TUI)	.92	.70	.92
Constructivist Use of ICT (CUI)	.87	.56	.83

Notes. ^a AVE: Average Variance Extracted= $(\sum\lambda^2)/n$; ^b CR: Construct Reliability= $(\sum\lambda^2)/((\sum\lambda^2)+\sum(1-\lambda^2))$

Table 3. Inter-factor zero-order correlations (2-tailed)

	1	2	3	4	5	6
1. Authority/Expert Knowledge (AEK)	(.83)					
2. Certainty of Knowledge (CK)	.18**	(.88)				
3. Traditional Pedagogical Beliefs (TPB)	.41**	.08	(.77)			
4. Constructivist Pedagogical Beliefs (CPB)	-.04	.26**	-.17**	(.80)		

5.Traditional Use of ICT (TUI)	-0.02	-.01	-.08	.13**	(.84)
6.Constructivist Use of ICT (CUI)	-.14*	.30**	-.14*	.63**	.15* (.75)

Note. Diagonal (in brackets): square root of average variance extracted from observed variables (items); Off-diagonal: correlations between constructs.

** $p < .001$. * $p < .01$.

In general, the above results indicate acceptable convergent validity and discriminant validity at both the item and construct levels. Therefore, the measurements of the six constructs in the proposed research model are considered to be adequate.

Results

The descriptive data of the scales used, such as mean, standard deviation, skewness and kurtosis, are presented in Table 4. No items show a skewness or kurtosis value greater than the cutoffs of |3.0| or |8.0| (Kline, 2005), respectively, and this supported univariate normality in the items. In the following paragraphs, we mainly report (a) the results of testing the measurement model comprising all scales, and (b) the structural model proposed in the study.

Table 4. Descriptive data for the scales measured in the study

	Mean	SD	Skewness	Kurtosis	No. of items
AEK	2.00	.85	1.10	.92	6
CK	3.15	1.06	-.16	-.98	3
TPB	2.31	.86	.61	-.17	5
CPB	4.24	.78	-1.74	3.72	5
TUI	2.90	.97	.16	-.89	5
CUI	3.89	.78	-.71	.28	4

Notes. AEK: Authority/Expert Knowledge; CK: Certainty of Knowledge; TPB: Traditional Pedagogical Beliefs; CPB: Constructivist Pedagogical Beliefs; TUI: Traditional Use of ICT; CUI: Constructivist Use of ICT.

Test of the measurement model

According to Anderson and Gerbing (1988), testing the originally specified theory (structural model) may not be meaningful unless the measurement model holds. Thus, a confirmatory factor analysis (CFA) with AMOS 7.0 was conducted to validate the measurement model (see Figure 2) consisting of the aforementioned six scales. The CFA results imply a model fit. The fit indices revealed $\chi^2 = 825.12$, $df = 333$, $\chi^2/df = 2.48$; GFI = .873; TLI = .931; CFI = .939; RMSEA = .061; SRMR = .046. The values of these indices were regarded by most researchers as indicative of a good model fit to the data (Hair et al., 2006; Kline, 2005). All items were found to have significant parameter estimates with standardized estimates greater than .50. This also suggests a satisfactory convergent validity of each scale, since each scale can explain the items it measures better than the items from another scale (Fornell & Larcker, 1981).

Test of the structural model

The test of the structural model includes examining the statistical significance of the path coefficients from one latent variable to another. In the current study, a structural model (see Figure 3) based on the hypothesized framework of this study (i.e., Figure 1) with six latent variables was specified to ascertain the relationships among epistemic beliefs, pedagogical beliefs, and beliefs about the use of ICT. The overall goodness of fit can be considered satisfactory for this structural model ($\chi^2 = 838.74$, $df = 335$; GFI = .872; TLI = .930; CFI = .938; RMSEA = .062; SRMR = .055). As shown in Figure 3, a total of seven path coefficients are significant at the .05 level (AEK→TPB; AEK→CPB; AEK→CUI; CK→CPB; CK→CUI; CPB→CUI; CPB→TUI). These significant path coefficients are also highlighted by the bold lines in Figure 3. The R^2 values of TUI and CUI are .028 and .543, respectively. This indicates that the four exogenous variables (AEK, CK, TPB, and CPB) explained 2.8% and 54.3% of the variance of TUI and CUI respectively. Meanwhile, the AEK and CK jointly accounted for 19.6% and 8.2% of the variance of TPB and CPB respectively.

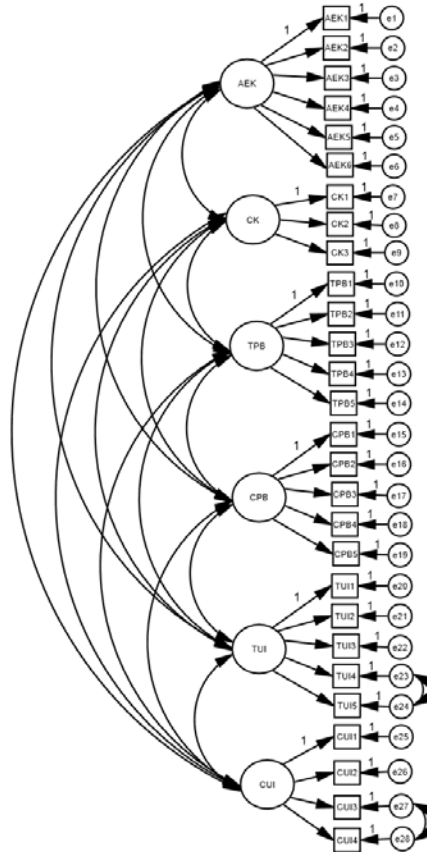


Figure 2. The measurement model among the constructs in the study

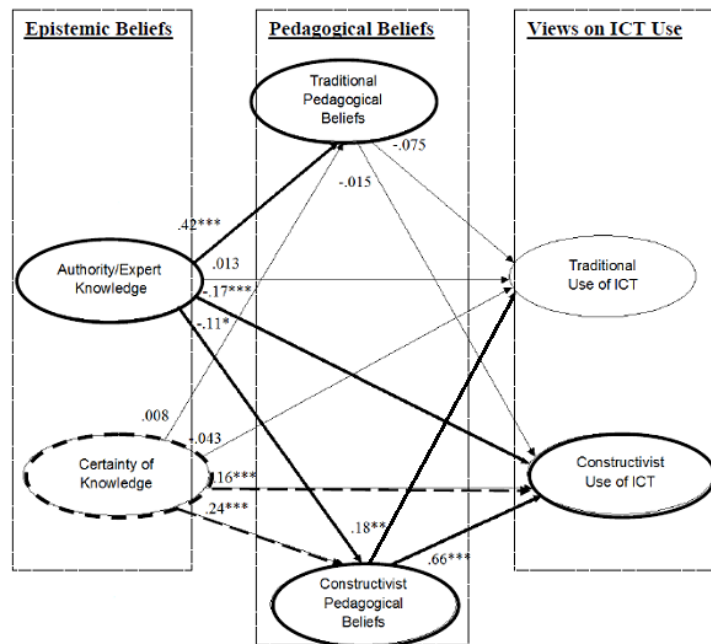


Figure 3. Path coefficients of the proposed research model for the constructs considered in this study

* $p < .05$. ** $p < .01$. *** $p < .001$

Notes. Both the bold and dotted lines represent the significant path coefficients. The bold lines indicate the anticipated predictions which supported the hypothesized framework, while the dotted lines also support the hypothesized framework but with alternative predictions.

Discussion and conclusion

Generally, the structural equation model obtained in this study attests that the systemic relationships between the teachers' epistemic beliefs, pedagogical beliefs and their beliefs about ICT use, to a certain extent, are nested. That is, the model is consistent with other models in two Asian studies (e.g., Chai, 2010; Lee et al., 2008). This implies that while China teachers work in a rather different sociopolitical environment, the underlying cultural beliefs about teaching (e.g., originated from the Confucius philosophy) is shared. Besides, the model also supports findings from other Western studies (e.g., Ertmer, 2005; Maggioni & Parkinson, 2008; Stoddard, 2010). This suggests that the difference between the East and West may be insignificant for the variables we have investigated in this study. The rhetoric for the inclusion of ICT in classrooms is similar regardless of sociocultural differences. This study found that teachers' sophisticated beliefs about AEK, constructivist pedagogical beliefs (CPB), and constructivist use of ICT (CUI) are aligned, which one belief was highly related to another. As shown in Figure 3, the relationships between teachers' beliefs about CK, CPB, and CUI were also identified in this study. However, the positive path coefficients between naive CK and CPB and CUI were obtained in this study. This finding indicates that more theorizing and empirical testing of the model of beliefs is necessary, especially for teachers working in different sociocultural contexts (Hofer, 2008). Such work would enable educators to have deeper knowledge of the various ways in which the investigated beliefs are related. In the following paragraphs, we examine and compare the results of this study in more detail.

The profile of AEK we obtained among the participants (mean = 2.00, Table 4) is consistent with previous research on Chinese preservice teachers (mean = 2.20) from the same region (Chai et al., 2010). It also seems to be consistent with Schraw and Olafson's (2002) study that indicates that many practicing teachers are evaluativist. Both preservice and practicing teachers in China are not inclined to rely on authorities and experts as the sole source of knowledge. The relationships between AEK and the teachers' pedagogical beliefs are comparable with those reported by Wong et al. (2009) who employed a similar instrument with Hong Kong preservice teachers. However, another study (Chai, Teo, & Lee, 2010) which also employed a similar instrument for Singaporean preservice teachers revealed a different pattern of relationships, with sophisticated AEK being positively related to CUI and negatively related to TUI. The Singaporean preservice teachers were inclined towards AEK (mean = 3.46), which is different from the current study. According to figure 3, the Chinese practicing teachers who believe in AEK are inclined towards traditional pedagogy and are less inclined towards constructivist teaching. AEK is also negatively related to constructivist use of ICT, although its association with traditional use of ICT is insignificant. On the whole, it suggests that AEK is an important variable that is likely to influence teachers' pedagogical practices related to ICT. Moreover, the results of this study also imply that teachers' beliefs about knowing, rather than beliefs about knowledge (i.e., CK), may play an important role on their teaching. Teachers believed knowing as constructing understanding based on personal experience and contextual evidence may have constructivist beliefs about teaching and teaching with ICT constructively.

The teachers' beliefs about CK (mean = 3.15, Table 4) in this study are also consistent with the profile of Chinese preservice teachers obtained by Chai et al. (2010) (mean = 3.33). Chinese practicing teachers' profiles of AEK and CK, as compared to the Chinese preservice teachers' profile, seems to suggest that the teachers become more relativistic in their epistemic outlook when they enter the service. In this study, we obtained positive path coefficients between naive CK and CPB and CUI. This may be due to the fact that the teachers' belief of CK is close to a neutral position. Greene and his colleagues (2008) have pointed out that one problem of adopting a domain general stance in personal epistemology research could be the difficulty involved in interpreting such neutral responses. Chai et al.'s (2010) study reported a similar CK mean score (mean = 3.12) among Singaporean preservice teachers, and a significant negative path coefficient was obtained from CK to TPB with no significant relations between CK and CPB. Wong et al.'s (2009) study, however, reported a lower mean score for CK among Hong Kong preservice teachers (mean = 2.79), and a significant positive path coefficient was obtained from CK to TPB, while a non-significant negative relationship was reported between CK and CPB. All three studies indicated some significant relationships between CK and CPB or TPB, which affirm CK as an important variable within this system of beliefs. As for the relation between teachers' beliefs about the nature of knowledge and their use of ICT, teacher's naïve beliefs about CK are positively associated with constructivist use of ICT.

A re-interpretation of the construct CK may provide a possible alternative interpretation of the positive significant relationships that we have obtained between CK and CPB and CUI. The three items of CK are (a) If scientists try hard enough, they can find the truth to almost anything; (b) Scientists will ultimately get to the truth if they keep searching for it; and (c) Scientific knowledge is certain and does not change. Out of the three items, two may be interpreted as the attainability of scientific truth. If this is how the teachers interpreted the items, then the positive path coefficients may indicate that the teachers are in favour of employing the constructivist pedagogy and the use of computers for students to construct scientific models. In other words, the teachers are advocating that constructivist use of computers can help students to attain scientific truth. While such a stance may not be consistent with the epistemic positions of the constructivist philosophy, the teachers may be seeing the items from a pragmatist's point of view. The dominance of Marxism in China, which advocates that objective scientific laws of nature can be discovered through scientific research, could provide further support for this interpretation (Chai et al., 2010). This also shows that further research adopting the qualitative method is needed to test whether this alternative interpretation corresponds to the participants' views. It also indicates that further item refinement and development with more precise use of language is needed (see also Hofer, 2010).

The profile of pedagogical beliefs of the Chinese practicing teachers is comparable with the preservice teachers in Asia. In most studies conducted in Asia, the preservice teachers surveyed are inclined to subscribe to constructivist teaching beliefs (CPB) rather than traditional teaching beliefs (TPB) (see Chai et al., 2010; Cheng et al., 2009; Sang et al., 2010; Wong et al., 2009). One possible explanation of such a similarity between preservice and inservice teachers in China may be attributed to the explicit promotion of the constructivist pedagogy in recent years. This however does not seem to be in total agreement with Sang et al.'s (2009) study among Chinese practicing elementary teachers. Sang et al.'s study indicates that around 60% of the teachers they surveyed are inclined towards constructivist or constructivist and traditional pedagogical beliefs. The other 40% are less inclined towards constructivist teaching. The difference may be due to the instrument employed, the different statistical procedures and the grade level that the teachers are teaching (primary vs. secondary). We suggest that the current study could be re-analyzed employing cluster analyses as used by Sang et al. (2009).

The path coefficients obtained supported the relationships between pedagogical beliefs and views of ICT use, and the results are in general agreement with recent studies in that constructivist beliefs are more compatible to promoting the use of ICT (Chai, 2010; Teo, Chai, Hung, & Lee, 2008; Hermans, et al., 2008; Tubin, 2006). In particular, Chai (2010) has also obtained positive significant path coefficients from CPB to CUI and TUI. The current study, along with others reported in the literature, affirms that teachers' constructivist-oriented pedagogical beliefs are a significantly positive predictor for their use of computers across different cultures. This implies that it is desirable to foster a constructivist view of teaching in teacher professional development activities for the integration of ICT in classrooms. The teachers may see the traditional use of ICT as a means of enhancing students' grasp of basic facts before they embark on more adventurous knowledge construction activities.

Traditional pedagogical beliefs in this study are not related in any significant way to the use of ICT. Given that traditional pedagogy was developed without any reference to the use of ICT, this is a probable outcome. While traditional pedagogic views are at times reported to be significantly related to traditional use of ICT (Tondeur et al., 2008), studies have also reported negative or no relations between TPB and the use of computers (Hermans et al., 2008; Teo et al., 2008).

In conclusion, this study has contributed to the current literature studying how teachers' beliefs may play a role in their use of ICT. This study confirms that teachers' beliefs about knowing, knowledge and teaching are related to their preference of the teaching practice with ICT. The associations between epistemic beliefs about the nature of knowing and knowledge and teachers' views about the use of ICT have been found to be significant, with AEK negatively associated with CUI and CK positively associated with CUI. It seems that epistemic beliefs are related to the constructivist use of ICT, but they are not related to the traditional use of ICT. The associations between Chinese practicing teachers' pedagogical beliefs (CPB) and their views of use of ICT (TUI and CUI) have also been established. We suggest that future research can further confirm the findings through both qualitative and quantitative methods. Studies focusing on how contextual variables influence the evolution of teachers' beliefs are particularly valuable. In addition, given China's population and size, numerous studies would be necessary to ascertain our findings. Furthermore, we believe that employing a domain-specific approach (such as in the domain of science or language) to the study of teachers' beliefs could contribute to more refined recommendations for teacher education.

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References

- Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*, 411-423.
- Bereiter, C., & Scardamalia, M. (2006). Education for the knowledge age: Design-centered models of teaching and instruction. In P. A. Alexander, & P. H. Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 695-713). Mahwah, NJ: Lawrence Erlbaum.
- Chai, C. S. (2010). The relationships among Singaporean preservice teachers' ICT competencies, pedagogical beliefs and their beliefs on the espoused use of ICT. *The Asia-Pacific Education Researcher*, *19*, 387-400.
- Chai, C. S., Hong, H. Y., & Teo, T. (2009). Singaporean and Taiwanese preservice teachers' beliefs and their attitude towards ICT use: A comparative study. *The Asia-Pacific Education Researcher*, *18*, 117-128.
- Chai, C. S., Deng, F., Qian, Y., & Wong, B. (2010). South china education majors' epistemological beliefs and their conceptions of the nature of science. *The Asia-Pacific Education Researcher*, *19*, 111-125.
- Chai, C. S., Teo, T., & Lee, C. B. (2010). Modelling the relationships among beliefs about learning, knowledge, and teaching of pre-service teachers in Singapore. *The Asia-Pacific Education Researcher*, *19*, 25-42
- Chan, K. W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education*, *20*, 817-831.
- Chen, V. D.-T. (2010). ICT integration of learning theories. In C. S. Chai & Q. Wong (Eds.), *ICT for self-directed and collaborative learning* (pp. 15-38). Singapore, Singapore: Pearson.
- Cheng, M. M. H., Chan, K.-W., Tang, S. Y. F., & Cheng, A. Y. N. (2009). Pre-service teacher education students' epistemological beliefs and their conceptions of teaching. *Teaching and Teacher Education*, *25*, 319-327.
- Ertmer, P. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*(4), 25-39.
- Feucht, F. C., & Bendixen, L. D. (2010). Exploring similarities and differences in personal epistemologies of U.S. and German elementary school teachers. *Cognition and Instruction*, *28*, 39-69.
- Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *48*, 39-50.
- Good, R., & Shymansky, J. (2001). Nature-of-science literacy in benchmarks and standards: Post-modern/relativist or modern/relativist. *Science & Education*, *10*, 173-185.
- Greene, J. A., Azevedo, R., & Torney-Purta, J. (2008). Modeling epistemic and ontological cognition: Philosophical perspectives and methodological directions. *Educational Psychologist*, *43*, 142-160.
- Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Web 2.0 and classroom research: What path should we take now? *Educational Researcher*, *38*, 246-259.
- Hair, J. F. Jr., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Englewood Cliffs, NJ: Prentice-Hall International.
- Hermans, R., Tondeur, J., van Braak, J., & Valcke, M. (2008). The impact of primary school teachers' education beliefs on the classroom use of computers. *Computers & Education*, *51*, 1499-1509.
- Hofer, B. (2008). Personal epistemology and culture. In M. S. Khine (Ed.), *Knowing, knowledge and beliefs: Epistemological studies across diverse cultures* (pp. 3-24). Netherland: Springer. doi: 10.1007/978-1-4020-6596-5_1
- Hofer, B. K. (2010). Personal epistemology in Asia: Burgeoning research and future directions. *The Asia-Pacific Education Researcher*, *19*, 179-184.

- Hofer, B. K., & Pintrich, P. R. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research, 67*, 88-140.
- Jonassen, D., Howland, J., Marra, R., & Crismond, D. (2008). *Meaningful learning with technology* (3rd ed.). Upper Saddle River, NJ: Pearson.
- Kline, R. B. (2005). *Principles and practice of structural equation modeling* (2nd ed.). New York, NY: Guilford Press.
- Lee, C. B., Chai, C. S., Teo, T., & Chen, D. (2008). Preparing pre-service teachers for the integration of ICT based student-centred learning (SCL) curriculum. *Journal of Education, 13*, 15-28.
- Maggioni, L., & Parkinson, M. M. (2008). The role of teacher epistemic cognition, epistemic beliefs, and calibration in instruction. *Educational Psychology Review, 20*, 445-461.
- Nespor, J. (1987). The role of beliefs in the practice of teaching. *Journal of Curriculum Studies, 19*, 317-328.
- Peeraer, J., & Van Petegem, P. (2011). ICT in teacher education in an emerging developing country: Vietnam's baseline situation at the start of 'The Year of ICT.' *Computers & Education, 56*, 974-982.
- Sang, G., Valcke, M., van Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education, 54*, 103-112.
- Sang, G., Valcke, M., van Braak, J., & Tondeur, J. (2009). Investigating teachers' educational beliefs in Chinese primary schools: Socioeconomic and geographical perspectives. *Asia-Pacific Journal of Teacher Education, 37*, 363-377.
- Schraw, G., & Olafson, L. (2002). Teachers' epistemological world views and educational practices. *Issues in Education 8*, 99-149.
- Sinatra, G. M., & Kardash, C. (2004). Teacher candidates' epistemological beliefs, dispositions, and views on teaching as persuasion. *Contemporary Educational Psychology, 29*, 483-498.
- Stoddard, J. D. (2010). The role of epistemology and ideology in teachers' pedagogy with historical 'media.' *Teachers and Teaching, 16*, 153-171.
- 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*, 165-176
- Tondeur, J., Hermans, R., van Braak, J., & Valcke, M. (2008). Exploring the link between teachers' educational profiles and different types of computer use in the classroom. *Computers in Human Behavior, 24*, 2541-2553.
- Tsai, C.-C. (2001). The interpretation construction design model for teaching science and its applications to Internet-based instruction in Taiwan. *International Journal of Educational Development, 21*, 401-415.
- Tsai, C.-C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education, 24*, 771-783
- Tsai, C.-C. (2006). Reinterpreting and reconstructing science: Teachers' view changes toward the nature of science by courses of science education. *Teaching & Teacher Education, 22*, 363-375.
- Tsai, C.-C. (2007). Teachers' scientific epistemological views: The coherence with instruction and students' views. *Science Education, 91*, 222-243.
- Tubin, D. (2006). Typology of ICT implementation and technology application. *Computers in the Schools, 23*, 85-98.
- Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research, 72*, 131-175.
- Wong, A. K., Chan, K-W., & Lai, P-Y. (2009). Revisiting the relationships of epistemological beliefs and conceptions about teaching and learning of preservice teachers in Hong Kong. *The Asia-Pacific Education Researcher, 18*, 1-19.
- Woolfolk-Hoy, A., Davis, H., & Pape, S. J. (2006). Teacher knowledge and beliefs. In P. A. Alexander & P. H. Winne (Eds.), *Handbook of educational psychology* (2nd ed., pp. 715-737). Mahwah, NJ: Lawrence Erlbaum.