

# Factors associated with the integration of ICT into Chinese primary school classrooms: an interplay of teacher-related variables

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**Abstract:** Available research is helpful to list a wide variety of factors influencing ICT adoption and integration in classroom teaching. But, existing studies hardly center on the combined impact of these variables. In addition, little research is available set up in the Chinese context. The latter is important given the rather limited extent ICT is currently being used in China and given the different cultural context in which the interplay between teacher beliefs and educational practices has yet been little documented. The present study centers on the complex interplay of a number of internal teacher variables to explain ICT classroom integration. These variables comprise “teachers’ constructivist teaching beliefs”, “teacher attitudes towards computers in education”, “teachers’ computer motivation”, “teacher perception of ICT-related policy”. A survey was set up, involving 820 Chinese primary school teachers. Path modeling was used to explore the direct and indirect effects of the teacher related variables on their level of classroom ICT integration. Firstly, two distinctive types of ICT use can be distinguished in this Chinese context: (a) Teacher supportive use of ICT that refers to the use of ICT for e.g., student administration, preparing worksheets, developing evaluation activities, keeping track of pupils’ learning progress, (b) Classroom use of ICT to support and enhance the actual teaching and learning process. The results show that classroom use of ICT directly depends on teachers’ computer motivation and the supportive use of ICT. Teachers’ constructivist beliefs, their attitudes towards computers in education and perceptions about the ICT-related school policy influence ICT integration in an indirect way. The results demonstrate how a the complex interplay between teacher related variables and ICT integration in the classroom is partly in line with findings in non-Asian contexts. A number of differences can be explained by the particular Chinese context. In particular an indirect relationship was found between teachers’ constructivist beliefs and their level of ICT integration. This is partly explained by the Chinese educational tradition, based on the Confucian philosophy emphasizing “a group-based, teacher-dominated, and centrally organized pedagogical culture”.

**Keywords:** ICT integration; teacher beliefs; computer attitude; computer motivation

## 1. Introduction

Among other factors, teacher related variables are the most powerful predictors of technology integration (Becker, 2000). Teachers should therefore be at the core of ICT integration projects. Marcinkiewicz (1993) stresses consequently that the full integration of computers into the education will remain a distant goal unless there is reconciliation between teachers and computers. Studies have produced an extensive overview of teacher related factors (Ely, 1999; Mumtaz, 2000, Tondeur, Hermans, van Braak, & Valcke, 2008). Some of these factors cannot be influenced or changed, such as age, teaching experience, etc. Others can be influenced, such as teacher attitudes towards ICT, ICT related knowledge and skills, and motivation to use ICT (Afshari, Bakar, Su-Luan *et al.*, 2009).

In the literature, two types of barriers are described currently hampering the integrated use of ICT by teachers: external (first-order) barriers and internal (second-order) barriers (Ertmer, 1999). External barriers comprise variables that are perceived as key obstacles, e.g., adequate access to the technology, Internet access, bandwidth, technology related

training (see e.g., Galanouli, Murphy, & Gardner, 2004). However, as observed by Ertmer (1999), even when first-order (external) barriers are resolved, “teachers would not automatically use technology to achieve the kind of meaningful outcomes advocated” (p.51). The technology adoption seems to remain limited when there is no focus on teachers’ own theories and beliefs about teaching and learning (Mumtaz, 2000). This introduces the need to consider internal barriers stalling ICT integration by teachers. Internal barriers are - among others - related to a teacher’s philosophy about teaching and learning, their conception of knowledge, etc. A critical issue is that these are veiled and deeply rooted in daily practices of teachers (Ertmer, 1999, 2005).

The present study presents a relational model embracing a wide variety of internal teacher variables related to ICT integration. Building on available research, this list comprises: teachers’ constructivist beliefs (Higgins & Moseley, 2001, Sang, Valcke, van Braak, & Tondeur, 2010), teachers’ computer motivation (e.g., Marcinkiewicz, 1996), teachers’ attitudes toward computers in education (e.g., van Braak, 2001), teachers’ perceptions on ICT-related policy (e.g., Barron, Kemker, Harmes, & Kalaydjian, 2003). Few studies have explored how these factors influence in a direct and/or indirect way the level of ICT integration in classrooms. This introduces the key research question for the present study.

Though the question about ICT integration in education is of global significance, cultural variables have to be taken into account. The research of Zhu *et al.* pointed at cultural differences in the educational use of ICT (Zhu, Valcke, Schellens & Li, 2009). Cultural perceptions need to be considered as an important element in the implementation of ICT (Albirina, 2006) and culture may play an important role influencing how teachers relate their beliefs to ICT use (Chai, Hong & Teo, 2009). Cultural variations were identified in teacher perspectives on the use of ICT in teaching and learning (Zhu, Valcke & Schellens, in press) and differences were observed in student perceptions, attitudes and satisfaction with the educational use of ICT (Zhu, Valcke & Schellens, 2008). Cultural differences have been identified when comparing Chinese and Flemish teacher perspectives on the use of ICT in teaching and learning (Zhu *et al.* in press). More in particular Chinese teachers express more doubts about the constructivist principles underlying many ICT applications (e.g., collaboration, independent learning, self-directed learning). They point in this context to the lack in prior knowledge of learners. Other research points out that there is a need to focus on the target audience (e.g. teacher) when considering the educational use of ICT (Aykin, 2005). This research asks to centre to a larger extent on teacher related variables and processes. Next to individual differences in attitudes, motivation, etc. the cultural context of the teacher can play a role. The concept of culture points in this context to “the shared way of life of a group of people” (Berry, poortinga, Segall & Dasen, 2002), which influences people’s behaviour, perspectives, values and understanding. It is widely accepted that culture shapes individuals’ perceptions of innovations that bear directly on their lives (Williams-Green, Holmes, & Sherman, 1997; Chen, Mashhadi, Ang, & Harkrider, 1999). For instance, Chen *et al.* (1999) claim that the pervasive influence of culture should be considered as a significant concern in the development of technology-enhanced learning systems. “The social and cultural contexts in which ICT resources are perceived and used by teachers are key influences in the development of a range of personal and professional practices” (Loveless, 2003, p314). This research enriches previous studies and tests the interplay between teacher variables and the ICT integration into classroom teaching in the Chinese context. As will be discussed in the theoretical setting, we especially centre on teacher beliefs, perceptions, attitudes and motivation to study teachers’ adoption of ICT. The study of (Zhu *et al.* in press) point in this context to potential differences due to the Chinese context. In this

qualitative study, involving 60 teachers, differences are identified in ideas of Chinese teachers – as compared to Flemish teachers – about teacher-student and student-student interactions. This is linked to differences in the cultural dimensions: power distance, collaboration and competition. Chinese teachers put a larger emphasis on competition. Chinese teachers stress to a larger extent the teacher as an expert, an authority and a model as compared to Flemish teachers. This explains why e.g., only a small proportion of Chinese staff – in her study - supports the social-constructivist principles and applies it extensively during teaching. Others express their agreement with such principles, but they apply them only in a limited way. Others explicitly refute these principles. This affects in a direct way their choices for specific didactical approaches, such as lecture versus collaborative works, teacher-led versus student-led instruction, and the extent to which they are willing to adopt ICT and e-Learning.

## **2. Theoretical background**

Next to a review of the available research about the internal teacher variables and ICT use in education, an integrated model is presented bringing together these variables to explain and predict the educational use of ICT.

### *2.1. Internal teacher related variables and ICT integration*

#### *2.1.1. Constructivist beliefs*

Constructivist beliefs about teaching and learning have gained acceptance as a viable framework to understand learning processes and to develop effective teaching models. Researchers state that these teacher beliefs play a critical role in the selection and organization of classroom activities (Kagan, 1992; Nespor, 1987; Pajares, 1992). Teachers adopting constructivist educational beliefs, seem to be more willing to adopt student-centered approaches and other innovative instructional approaches (Higgins & Moseley, 2001; Pajares, 1992), while teachers adopting traditional beliefs are more likely to adopt teacher centered instructional practices (Isikoglu, Basturk, and Karaca, 2009).

The way teachers integrate computers into their classroom instruction seems to be strongly mediated by their belief systems (Windschitl & Sahl, 2002). Researchers have explored the particular impact of constructivist educational beliefs on ICT integration (Higgins & Moseley, 2001; Riel & Becker, 2000; Tondeur *et al.*, 2008a). For instance, Tondeur *et al.* (2008a) argue that teachers adopting constructivist beliefs are active ICT users.

#### *2.1.2. ICT motivation*

Motivation encompasses a multitude of factors driving the selection, the persistence, and the engagement of particular activities to attain an objective (Dweck & Elliott, 1983). Motivation refers to the process whereby goal-directed behavior is instigated and sustained (Schunk, 1990). Motivational factors are therefore considered to be part of one's goal structures and beliefs about what is important (Ames, 1992). Sufficient levels of motivation in teachers are seen to be related to the innovative role of technology. Empirical research has successfully linked motivation to teacher computer use (Marcinkiewicz, 1996; Sheingold & Hadley, 1990).

#### *2.1.3. Attitudes towards ICT in education*

Ajzen (1988) describes “attitude” as a predisposition to respond favorably or unfavorably to an object, person, or event. The strong relationship between computer related attitudes

and computer use in education has been emphasized in many studies (e.g., Sang *et al.*, 2010; van Braak, Tondeur, & Valcke, 2004). Attitudes toward computers influence teachers' acceptance of the usefulness of technology, and also influence whether teachers integrate ICT into their classroom (Akbaba & Kurubacak, 1998; Clark, 2001; Huang and Liaw, 2005). According to Mumtaz (2000), schools can go only so far to encourage educational technology use without taking a consideration of teacher attitudes.

#### *2.1.4. Perceptions of ICT-related school policy*

As ICT continues to drive changes in present and future society, school policies need to define upfront their organizational vision and actions in view of planned change (Senge, 2000). A number of studies (e.g., Barron *et al.*, 2003; Tearle, 2003) present evidence that an increase in classroom use of ICT in classroom can be linked to a favorable policy environment. School-level policy produces the desirability to build a coherent and supportive community of practice associated with effective, regular, and consistent ICT use (Dawes 2001; Hennessy, Ruthven & Brindley, 2005).

Since the Chinese educational system is highly centralized, ICT-related school policies are linked to national policies as developed by the Ministry of Education (MOE). The Ministry promotes ICT use, but links this explicitly to the prescribed national curriculum, the central examination system and teacher-led didactical strategies. This does not invite a thorough reflection on school-based policies. The question arises to what extent the definition and implementation of these ICT policies is sufficiently linked to the educational practices in the school and the classroom. However, an ICT policy in itself does not automatically result in the adoption of innovations unless all actors involved are clearly aware of this policy. Innovation research of Fullan (1991) shows that the innovation adoption in schools depend on the democratic process of planning change by involving all school related actors. If teachers share the values expressed within a school policy and understand the implications, this policy is more likely to influence practice (Kennewell, Parkinson, & Tanner, 2000). Recent research of Tondeur *et al.* (2008) shows in this context that it is the actual level of awareness about an ICT-policy determining the adoption and integration of educational ICT use.

#### *2.2. Teacher ICT use in education*

Researchers have mapped a range of definitions, classifications and typologies about educational computer use. For instance, Niederhauser and Stoddart (2001) distinguished between two main types of educational ICT use: "skill-based transmission use" and "open-ended constructivist use". Educational computer use is also categorized as "computers as information resource tools", "computers as authoring tools" and "computers as knowledge construction tools" (Ainley, Banks, & Fleming, 2002). On the base of an empirical study, involving a large number of teachers, Tondeur, van Braak, and Valcke (2007) have delineated two main categories of ICT use by teachers: supportive ICT use, classroom ICT use; these categories replicate in an empirical way typologies developed by e.g., Hogarty, Lang, & Kromrey (2003), and van Braak *et al.*, (2004). The first category, supportive ICT use, refers to the use of ICT for pro-active and administrative teaching tasks, such as student administration, preparing worksheets, developing evaluation activities, keeping track of pupils' learning progress, etc. The second, classroom ICT use, aims to support and enhance the actual teaching and learning process, such as the use of computers for demonstration purposes, drill and practice activities, modeling, representation of complex knowledge elements, discussions, collaboration, project work, etc. (Hogarty *et al.*, 2003). To study the relationship between both categories, it is interesting to build on the study of Wozney, Venkatesh and Abrami (2006). They found

that supportive use of ICT was the most significant predictor of classroom use of ICT.

### 2.3. An integrated model

As mentioned in the previous section, teachers' classroom use of ICT depends on a variety of internal teacher variables. Considering the available research evidence, we can develop an integrated model that interlinks these internal variables to explain and predict classroom use of ICT (Figure 1).

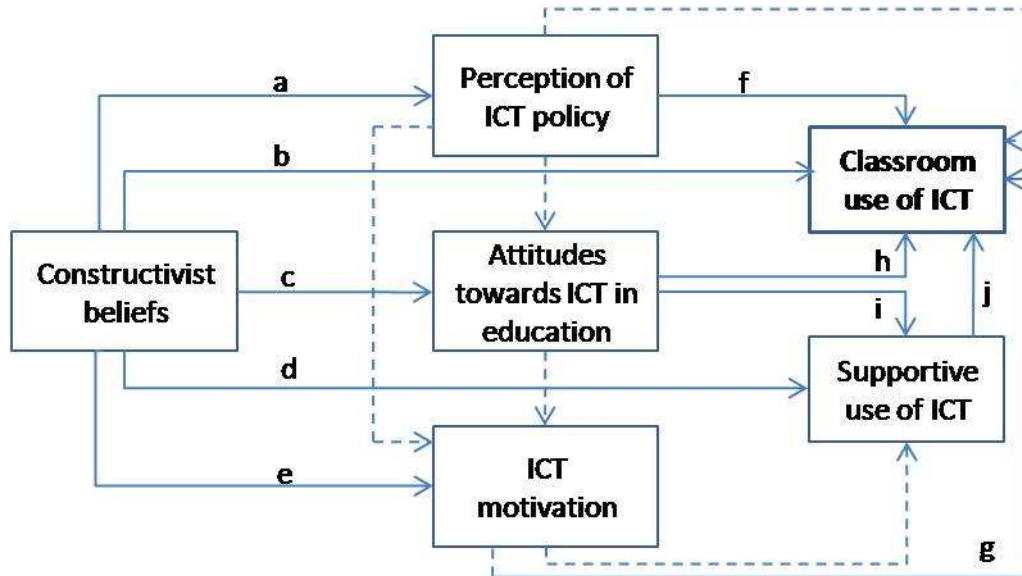


Figure 1: Integrated model of the impact of teacher variables on ICT use in the classroom

For ease of interpretation, linkages between variables are identified between brackets. The hypothetical relationships between the variables build on a variety of theoretical and empirical data:

- An interrelationship between teacher beliefs and perceptions has been documented by arguing that teacher beliefs influence their perceptions and judgments (Johnson, 1990; Munby, 1982; Pajares, 1992). Munby (1982) argued that teacher beliefs about learning and teaching are believed to make up an important part of the prior knowledge through which teachers perceive upon information in the classroom.
- As mentioned in section 2.1.1, teacher beliefs tend to be associated with their ICT integration the classroom teaching (Becker, 2001; Ertmer, 2005; Hermans, Tondeur, van Braak, Valcke, 2008; Windschitl & Sahl, 2002). For instance, Hermans et al. (2008) found a positive effect of constructivist beliefs on the classroom use of computers. Becker (2001) also states that constructivist teachers are more likely to use ICT in more challenging ways.
- On the base of the model of Fishbein and Ajzen (1975) we position beliefs as precursors of attitudes towards ICT in education. Hew and Brush (2007) state that although attitudes and beliefs are two separate constructs that are inextricably intertwined, beliefs mainly determine a person's attitude (see also Bodur, Brinberg, & Coupey, 2000). A series of studies did already examine and support the impact of teachers' educational beliefs on educational computer attitudes (e.g., Chai et al., 2009; Ertmer, 2005). Becker and Ravitz (1999) also state that teachers who hold constructivist beliefs are more likely to engage their students to use ICT.
- The direct impact of beliefs on the supportive ICT use has also been documented by

researchers (Becker, 2001; Scrimshaw, 2004; Tondeur *et al.*, 2007; Webb & Cox, 2004). For instance, Becker (2001) argues that constructivist beliefs foster ICT use in education.

- e. Davis, Bagozzi, and Warshaw (1989) focus on ICT motivation. They claimed that a primary motivation for computer adoption is the adopter's belief regarding the usage outcome or his perceptions of the usefulness of the technology.
- f. The influence of perceptions of school ICT policy on ICT integration has been confirmed in the research of Tondeur, van Keer, van Braak, and Valcke (2008b). They argue that it is the actual level of awareness about an ICT-policy determines the adoption and integration of educational ICT use.
- g. Researchers point at the impact of teacher motivation on the promotion of excellence in teaching with ICT (Abdullah, Abidin, Su Luan, & Atan, 2006; Hadley & Sheingold, 1993). Highly motivated teachers reflect higher levels of ICT use in their classroom (Karsenti, Villeneuve, & Goyer, 2006).
- h. The interrelationship between teacher attitudes toward computer and ICT classroom integration was discussed in section 2.1.3.
- i. An indirect interrelationship between teacher attitudes toward computer and supportive ICT use was reported by van Braak *et al.* (2004). Positive attitudes toward computers are also important since it leads to increased computer competency (Chai *et al.*, 2009; Ertmer, 2005).
- j. Supportive use of ICT can be considered as a significant predictor of classroom use of ICT (Cox, Preston, Cox, 1999; Wozney, Venkatesh, & Abrami, 2006). The former argues that teachers who are already regular users of ICT have confidence in using ICT in their teaching.

Although, clear theoretical and empirical grounding is available to develop the model, the existing research remains limited in two ways. First, what is missing is an overall study of the interplay between this set of internal teacher variables and how this affects the educational use of ICT. Secondly, a number of relationships have yet not been studied (dashed lines in the model): the interrelationship between the mediating variables perception of the ICT policy, attitudes towards ICT in education, and ICT motivation and the subsequent impact of types of computer use. From a theoretical point of view, these links can be drawn when we consider the interaction between cognitive processes (e.g., ICT policy perceptions) and motivational beliefs (ICT attitudes, ICT motivation) in e.g., the Expectancy-Value motivation model of Wigfield & Eccles (2000). Building on this model, perceptions and attitudes are considered to influence teacher motivation to use ICT. Both in a direct and indirect way these teacher variables are expected to affect both types of ICT use (supportive use and classroom use).

### **3. Method**

A survey was set up to gather data about the internal teacher variables discussed above, and information about the actual ICT use in education. Participation was organized after obtaining consent from the school principal. A sample of 27 primary school principals was contacted, resulting in a total of 1000 questionnaires being sent to the individual teachers. In total, 820 teachers returned the questionnaire, reflecting an 82% response rate.

#### *3.1. Characteristics of the Chinese participants*

The 820 respondents did teach in 11 different provinces throughout China. About 70% of the respondents were female. Average teacher age was 41.7 years (range 18-70 years),

average years of teaching experience was 14.6 (range 0-51 years). As to the school setting, 430 (52.4%) teachers worked in urban schools, and 390 (47.6%) teachers worked in rural schools.

To control for potential impact of background variables, respondents were grouped into 3 categories depending on their years of teaching experience: teachers with less than 5 years of teaching experience (12.4%); teachers with 6-15 years of teaching experience (46.2%); and teachers with more than 16 years of teaching experience (41.3%). Considering the varying classroom size of classrooms in Chinese primary schools, and the fact that this affects the adoption of specific teaching and learning approaches (see e.g., He, 2001), class size data was controlled for. Three class size categories were considered: small classes (< 30), medium classes (31-50), and large classes (51 >). 7% of the participants reported teaching small classes; 47% of them reported teaching medium classes; 40% of them reported teaching large classes. In addition, respondents were also categorized into groups depending on the subjects they teach. It is to be stressed, that in Chinese primary education and in clear contrast to many other countries, teaching responsibilities differ depending on the school subject: 63.3% of the teachers teach an academic (main) subject (i.e. Chinese, English, mathematics, science); 19.9% teach non-academic (subsidiary) subject (i.e. fine arts, music, physical education, information technology); 13.5% teach more than one subject; 27 teachers (3.3%) did not answer the subject-related question.

### *3.2. Research instruments*

Several existing scales were reused in this study to obtain measures in relation to the large set of internal teacher variables and the dependent variable. In view of adaptation and translation, the recommended translation procedure “back-translation” was applied to develop Chinese instrument versions (Hambleton, 1992).

#### *3.2.1. Teacher constructivist beliefs*

Teachers’ constructivist teaching beliefs were measured through the ‘Constructivist Teaching Beliefs’ (CTB, 8 items) scale adapted from 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). Item example: “*Learners must get the opportunity to build up their own knowledge in a collaborative way or together with the teacher*”. Exploratory factor analysis confirmed a one factor structure, accounting for 45.2% of the variance. Internal consistency was determined by calculating Cronbach’s alpha ( $\alpha = .82$ ). The single-factor solution is validated when carrying out a confirmatory factor analysis (CFA), resulting in a good model fit [ $\chi^2 = 44.931$  ( $df = 18$ ;  $p < .001$ ),  $CFI = .985$ ,  $GFI = .987$ ,  $AGFI = .973$ ,  $TLI = .977$ ,  $RMSEA = .043$ ].

#### *3.2.2. Perceptions of ICT-related school policy*

Considering the potential role of teacher perceptions about an ICT school policy, the ICT School Policy Survey (ICTP) was developed. Six items focusing on policies, strategies and plans at school level in relation to ICT infrastructure, ICT use, and ICT teacher training and evaluation are presented to the teachers. Respondents were asked to rate the extent to which a particular item was – in their perception – available in their school. Item example: “*I am aware that the school has a policy about ICT literacy for teacher evaluation*”. Exploratory factor analysis reflected a single factor solution, accounting for 55.7% of the variance. Cronbach’s  $\alpha$  coefficient of the ICTP was .89. The one-factor model was serified

on the base of a confirmatory factor analysis (CFA), reflecting a good model fit [ $\chi^2 = 20.897$  ( $df = 6$ ;  $p < .01$ ),  $CFI = .992$ ,  $GFI = .992$ ,  $AGFI = .971$ ,  $TLI = .981$ ,  $RMSEA = .055$ ].

### 3.2.3. Computer motivation

The Computer Motivation Scale (CMS) was newly developed and builds on eight items. An example item is “*I use computers to encourage students*”. Respondents were asked to rate each statement on a 5-point scale (from 1-strongly disagree to 5-strongly agree). Item example: “*I use ICT to prepare children for the information society*”. Exploratory factor analysis confirmed a one factor solution accounting for 50.3% of the variance. Cronbach’s  $\alpha$  coefficient of “CMS” was .89. A CFA test of the one-factor model, resulted in optimal goodness-of-fit indexes [ $\chi^2 = 35.999$  ( $df = 16$ ;  $p < .01$ ),  $CFI = .992$ ,  $GFI = .989$ ,  $AGFI = .975$ ,  $TLI = .986$ ,  $RMSEA = .039$ ].

### 3.2.4. Computer attitudes

The 10-item Attitudes towards Computers in Education Scale (ACE), designed by van Braak (2001), was used in the present study. The ACE measures teachers’ attitudes towards the effects of computer adoption in the classroom. The scale adopts a 5-point Likert scale (from 1-strongly disagree to 5-strongly agree). An example item is “*The efficiency of the learning process is increased through the use of ICT*”. Exploratory factor analysis confirmed a one factor accounting for 46.1% of the variance. The internal consistency of the scale was good ( $\alpha = .85$ ). A CFA test resulted in a one-factor model solution, reflecting good goodness-of-fit indexes [ $\chi^2 = 81.755$  ( $df = 30$ ;  $p < .001$ ),  $CFI = .982$ ,  $GFI = .980$ ,  $AGFI = .963$ ,  $TLI = .973$ ,  $RMSEA = .046$ ].

### 3.2.5. Supportive ICT use

The Supportive ICT Use Scale (SIUS) was adapted from van Braak *et al.* (2004). Scale items build on an eight 5-point Likert items (never, every term, monthly, weekly, daily). An example item is “*I use the computer for administration, e.g. reports, curriculum planning etc*”. Exploratory factor analysis confirmed a single factor accounting for 54.6% of the variance. Internal consistency of the scale was .92. The one-factor solution was corroborated by a confirmatory factor analysis (CFA), reflecting a good model fit [ $\chi^2 = 50.388$  ( $df = 18$ ;  $p < .001$ ),  $CFI = .988$ ,  $GFI = .985$ ,  $AGFI = .970$ ,  $TLI = .972$ ,  $RMSEA = .047$ ].

### 3.2.6. Classroom ICT use

The ICT Class Use Scale was developed by van Braak *et al.* (2004). It consists of six 5-point Likert items (never, every term, monthly, weekly, daily). An example item is “*I use ICT for independent work/ individual learning*”. Exploratory factor analysis confirmed a one factor accounting for 64.6% of the variance. Calculation of Cronbach’s alpha reflected a high level of internal consistency ( $\alpha = .92$ ). The one-factor model test resulted in optimal goodness-of-fit indexes [ $\chi^2 = 14.199$  ( $df = 6$ ;  $p < .05$ ),  $CFI = .997$ ,  $GFI = .994$ ,  $AGFI = .980$ ,  $TLI = .994$ ,  $RMSEA = .041$ ].

## 3.3. Data analysis

Next to descriptive data analysis, initially a correlation analysis procedure was adopted to study the nature of the associations between the different research variables. Subsequently, structural equation modelling (AMOS 7.0) was used to test the complex relationships between the internal teacher variables and teachers’ ICT class use variable (Arbuckle,

2006). Building on the recommendations of Hu and Bentler (1999), the following goodness-of-fit indices will be reported: the comparative fit index (CFI), the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), the Tucker-Lewis index (TLI), and the root mean square error of approximation (RMSEA).

## 4. Results

### 4.1. 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 1). For the purpose of this study, the correlations of all variables with with classroom use of ICT are of primary interest. The results suggest positive and significant interrelationships between classroom use of ICT and the other internal teacher variables. Also, significant correlations can be observed between the different internal teacher variables. None of the correlation values reflect problematic collinearity between the different constructs.

Table 1 Results of the bivariate correlation analysis (N= 820)

	{1}	{2}	{3}	{4}	{5}
{1} ICT class use					
{2} constructivist beliefs	.08*				
{3} perception on policies	.16**	.22**			
{4} ICT motivation	.31**	.34**	.19**		
{5} ICT attitudes in education	.19**	.40**	.14**	.54**	
{6} supportive ICT use	.51**	.13**	.19**	.19**	.16**

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

\* Correlation is significant at the 0.05 level (2-tailed).

The results suggest a strong interrelation between ICT classroom use and the internal teacher variables. ICT class use is strongly correlated with ICT motivation ( $r = .31$ ,  $p < .01$ ). Other important correlations are found between constructivist beliefs and ICT attitudes ( $r = .40$ ,  $p < .01$ ), between constructivist beliefs and ICT motivation ( $r = .34$ ,  $p < .01$ ), and between ICT motivation and ICT attitudes ( $r = .54$ ,  $p < .01$ ). In addition, ICT class use is strongly correlated with supportive ICT use ( $r = .51$ ,  $p < .01$ ).

### 4.2. Path modeling

In order to test the theoretical model - presented in Figure 1 - path analysis was applied to test the hypothetical links between internal teacher variables and the dependent variable. Of interest is the predictive power of these variables to explain the implementation of classroom use of ICT (adjusted  $R^2$  coefficient). Secondly, we are interested in the direct and indirect effects of the predictor variables on the dependent variable. Direct effects on endogenous variables were calculated as standardized beta-weight (path coefficients or  $\beta$ 's). All the goodness-of-fit indices are in line with recommended benchmarks for acceptable fit [ $\chi^2 = 11.670$  ( $df = 6$ ;  $p > .05$ ),  $CFI = .994$ ,  $GFI = .995$ ,  $AGFI = .983$ ,  $TLI = .984$ ,  $RMSEA = .034$ ]. The total proportion of explained variance in prospective computer use amounts to 35% ( $R^2 = .35$ ). Figure 2 shows the resulting path coefficients in the research model.

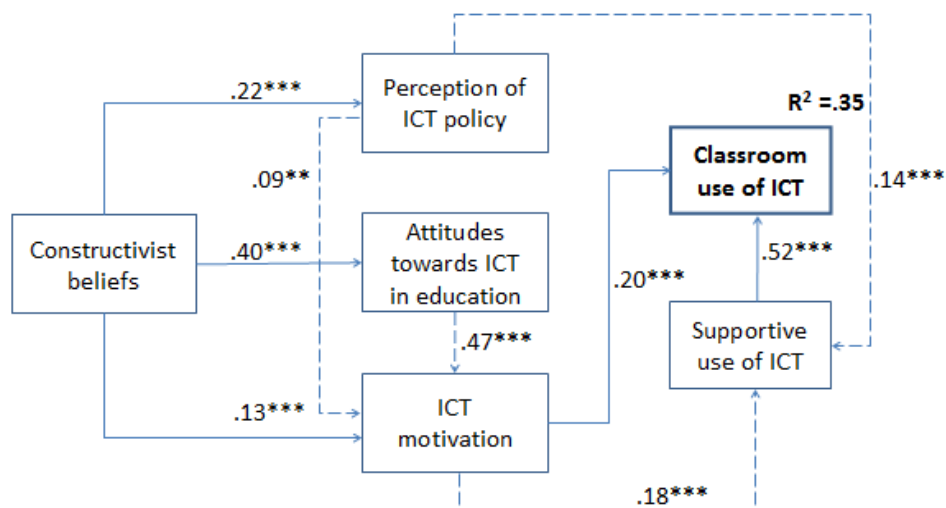


Figure 2: Results of the path analysis: estimates of direct and indirect effects on ‘Classroom use of ICT’.

The figure includes estimates of both direct and indirect effects on ICT use in the classroom. In view of parsimony, only significant effects have been retained in the model. ICT classroom use is directly predicted by the Supportive use of ICT ( $\beta = .52, p < .001$ ) and ICT motivation ( $\beta = .20, p < .001$ ). All other relationships in the model seem to be of an indirect nature, considering the role played by the mediating variables: Perception of ICT policy, Attitudes towards ICT in education, and ICT motivation.

The mediating role of the Attitudes towards ICT in education is clear when we consider the relationship between Constructivist beliefs and the Attitudes towards ICT in education ( $\beta = .40, p < .001$ ) and its consecutive impact on ICT motivation ( $\beta = .47, p < .001$ ). The Attitudes towards ICT in education play a comparable role in linking Constructivist beliefs and ICT motivation to the Supportive use of ICT ( $\beta = .18, p < .001$ ). The mediating role of ICT motivation is clear when we see the path from Constructivist beliefs via ICT motivation to Classroom use of ICT ( $\beta = .20, p < .001$ ). In a comparable, weaker, and somewhat complex way, does the Perception about ICT policy mediate in the relationship between Constructivist teaching beliefs and Supportive ICT use ( $\beta = .14, p < .001$ ). The Perception about ICT policy also has an indirect effect on ICT classroom use mediating by ICT motivation ( $\beta = .09, p < .01$ ).

## 5. Discussion

The key of the research problem dealt with in this article is that internal teacher variables far outweigh school factors to explain the adoption of particular teaching activities (Veen, 1993). Actual integration depends largely on teachers’ personal feelings, skills and attitudes to technology in general (Mumtaz, 2000). The results of this study confirm that at the teacher level, there are many factors influencing the integrated use of ICT in the classroom. Overall, the relationships between the teacher related variables and the use of ICT, as reflected in the structural equation model, are largely confirmed in the present study. Our findings underpin the direct and indirect relationship between internal teacher variables and ICT integration into classroom teaching. ICT integration in the class also seems to be strongly related to and depend on the use of ICT as a supportive tool.

The findings demonstrate that classroom use of ICT is clearly linked to the degree of ICT use as a supportive tool. Stated in a different way, when a teacher is a regular ICT user in view of preparing his/her teaching preparation and to develop a student management approach, he/she is more willing to integrate ICT in classroom activities. This finding is in accordance with the literature (Galanouli, Murphy, & Gardner, 2004; Tan, Hu, Wong, & Wettasinghe, 2003; van Braak *et al.*, 2004). We claim - in addition - that supportive ICT use can be enhanced by high ICT training, and as such enhance ICT integration into classroom teaching. This claim is supported by research of Cox *et al.* (1999) in which they found that the teachers who are already regular users of ICT have confidence in using ICT in classroom, perceiving it to be useful for their personal work and for their teaching and plan to extend ICT use further in the future. Because of the use for personal issues, ICT has become an evident part of the personal set of tools, instruments and solutions to deal with their work. From a theoretical point of view, we could even hypothesize that ICT has become part of their professional identity as theorized by Beijaard, Meijer and Verloop (2004).

Our finding that internal teacher variables affect - either directly or indirectly - the types of ICT use in education, is consistent with earlier research. A consistent body of research - in Western settings - has found a direct relationship between teachers' constructivist beliefs and ICT adoption (e.g., Becker & Ravitz, 1999; Becker, 2000; Higgins & Moseley, 2001; Mumtaz, 2004). For instance, Becker (2000) claims that teachers with a strong constructivist thinking are eager to adopt ICT in educational settings. However, in our results, only an indirect relationship was confirmed between teachers' constructivist beliefs and their ICT integration. This can partly be explained by the Chinese educational tradition, based on the Confucius philosophy emphasizing "a group-based, teacher-dominated, and centrally organized pedagogical culture" (Zhang, 2007, p. 302). The finding of Chai *et al.* (2009) in Singaporean and Taiwanese settings also supports our results. They claim that the pre-service teachers' attitude towards ICT use is not associated with their epistemological and pedagogical beliefs.

Attitudes towards ICT in education also indirectly influence ICT classroom integration through mediation of ICT motivation and ICT supportive use. The added value of this finding is that the mediating role of these teacher attitudes is confirmed within a larger complex of other variables and processes that influence ICT use. This implies that if primary teachers adopt favorable attitudes towards ICT in education, they are more eager to integrate ICT into their teaching. This finding is in accordance with the findings of previous studies (e.g., Wu & Morgan, 1989; van Braak *et al.*, 2004). For instance, van Braak *et al.* (2004) observed that a favorable attitude towards computers did positively and directly affect the degree of computer use in class. Moseley & Higgins (1999) also stated that teachers who efficiently use technology in classroom teaching adopt positive attitudes towards ICT.

According to Hadley & Sheingold (1993) and Karsenti *et al.* (2006), teachers who are motivated and have a strong commitment to foster learning processes integrate technology more easily in their teaching. This is consistent with our findings that between the internal teacher variables, ICT motivation seem to be the strongest predictor of ICT classroom use. In addition, teacher attitudes toward ICT use in education are strongly related to their ICT motivation being a predictor of ICT classroom use.

In our theoretical base, we also centered on the critical role of teacher perceptions about ICT school policies. Repeatedly, authors stress that an appropriate level of school planning is needed to enhance the successful integration of computers in the classroom (Baylor &

Ritchie, 2002; Tearle, 2003). Teachers are more willing to adopt new modes of ICT when the school aims underpin these modes of teaching and learning. Although a direct effect of these perceptions about the ICT school policy are not supported in our data model, evidence was found to consider teacher perceptions of an ICT school policy as a mediating variable in view of classroom use of ICT. This reiterates the findings of earlier studies set up in the Flemish (Belgium) educational context (Tondeur *et al.*, 2008b). It also is in line with the conclusions of Hughes & Zachariah (2001) that a successful ICT integration depends upon the development of a shared vision (Hughes & Zachariah, 2001). It appears that teachers engaged in school ICT planning and policy will be more likely to apply ICT in an innovative way (Kozma, 2003). The development of ICT school plan and policy aiming at setting clear goals and defining the means to realize these goals is a crucial step towards ICT integration (Bryderup & Kowalski, 2002). The proposed interrelation between perceptions about ICT school policies and attitudes toward ICT use in education is not supported by the analysis results.

As could be derived from Figure 2, classroom use of ICT is strongly influenced by the interrelated impact of internal teacher variables thoughts. First of all, constructivist beliefs are linked to the perception of ICT policy, attitudes towards ICT in education, and ICT motivation. These findings confirm the theoretical statements of Bodur *et al.* (2000) and Davis *et al.* (1989). Although their position is not explicitly related to technology adoption, it is easy to understand that teacher beliefs are central to the complex of internal teacher variables (Ertmer, 2005; Pajares, 1992). Teachers' perception of the ICT policy is correlated to ICT motivation. This is in line with the finding of Hughes and Zachariah (2001) claiming that efficient ICT integration relies on the development of a shared vision. Furthermore, the research confirms a strong interrelation between attitudes towards ICT in education and ICT motivation, which is partly supported by studies of Abdullah *et al.* (2006).

## 6. Conclusions

The present study did focus on the interrelated nature of internal teacher variables and ICT use in education. It is important to stress that the study was set up in the Chinese context. Our findings suggest that successful ICT integration is related to the direct and indirect effects of a number of internal teacher variables. The results underpin the importance to consider complex models to explain and predict educational ICT adoption and implementation.

A number of limitations have to be stressed. First, though a large sample from 11 different Chinese provinces was involved in the study, the sample was still too small to reflect the Chinese teacher population in a representative way. This affects the generalizability of the current findings. Secondly, the data in this study were obtained via survey instruments gathering self-report measures. Future studies could build on classroom observations and/or interviews with teachers. A next limitation of the study is the assumed independence of individuals as units of analysis (van Braak *et al.*, 2004). School level factors (leadership, school culture, infrastructure etc.), social background factors (economic status, social culture etc.) and national level factors (national policy, curriculum innovation etc.) may also influence teachers' ICT integration. A multilevel analysis would be helpful to integrate the above levels, since it is a powerful technique to analyze different statistical levels. The latter would require the adoption of a specific sampling procedure to

reflect the different levels in an adequate way. We can also criticize the way certain internal teacher variables have been operationalized. A number of scales were newly developed and should be externally validated in future studies (e.g., teacher perceptions about the school ICT policy). Lastly, the adoption of a longitudinal approach could be recommended to track changes in thinking processes and related teaching practices about educational ICT integration.

Despite the limitations, the current study contributes to the literature about ICT integration and teacher education in a number of ways. Firstly, from a theoretical perspective, more insight has been obtained in the complex interplay of teacher variables affecting their adoption and implementation of educational ICT use. Second, ICT policy-makers need to realize that teachers shouldn't be excluded from school policy planning when considering future educational ICT use. Thus, teachers should be involved and be familiar with school level policies. Lastly, considering the influence of the internal teacher variables on classroom use of ICT, teacher professional development should be aware of the direct and mediating impact of these variables. Especially, the essential role of teacher ICT motivation should be recognized.

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