AJET | ASCILITE

Internet-based epistemic beliefs, engagement in online activities, and intention for constructivist ICT integration among pre-service teachers

Yuan-Hsuan Lee
National Tsing Hua University, Taiwan

This study investigated pre-service teachers' epistemic beliefs about the Internet using the Inventory of Internet-Based Epistemic Beliefs (IBEB). Also examined were their belief profiles to delineate the effect of IBEB on pre-service teachers' engagement in online reading activities and intention for ICT integration for constructivist learning activities. Participants were 474 teacher education students in Taiwan. Results revealed the four hypothesised constructs – structure, uncertainty, source, and justification for Internet knowledge – with good validity and reliability. Four epistemic belief groups were derived based on these constructs; and they exhibited differential effects on the validating variables. Cluster 1 was characterised by four positive epistemic beliefs (the *positive beliefs*), Cluster 2 by four negative epistemic beliefs (the *negative beliefs*), Cluster 3 by modest scores of the epistemic beliefs (the *modest beliefs*), and Cluster 4 by positive uncertainty and justification scores as well as negative structure and source scores (the *high justification* and *uncertainty*). Findings suggest that intervention targeting pre-service teachers in the *negative beliefs* and the *modest beliefs* may be necessary to foster positive epistemic beliefs for better constructivist learning in the online environment.

Introduction

The rapid development of information and communication technologies (ICT) has provided great affordances for students to satisfy their social and educational needs (Chou & Lee, 2017; Lee, Ko, & Chou, 2015; Wu, 2015, 2017). Using ICT for constructive learning activities in classrooms, however, is not yet as widespread as might be expected (Deng, Chai, Tsai, & Lee, 2014; Lee & Wu, 2012). Instructors' perceptions of the use of technology may be related to their classroom teaching practices. In fact, a wealth of literature has documented a positive correlation between instructors' epistemic beliefs and their conceptions of teaching and learning (Chan, 2004; Chan & Elliott, 2004; M. M. Cheng, Chan, Tang, & Cheng, 2009; Deng et al., 2014; Wong, Chan, & Lai, 2009). Epistemic beliefs are a system of beliefs about the nature of knowledge and process of knowing (Hofer, 2004). Learners with more sophisticated epistemic beliefs may think that most knowledge is complex and evolving, and needs active construction and justification from multiple sources, while learners with more naïve beliefs may hold that most information is simple and certain, and relies on passive transmission from the authority (Buehl, Alexander, & Murphy, 2002; Hofer, 2004; Schommer, Crouse, & Rhodes, 1992). More sophisticated epistemic beliefs have been found to be associated with a constructivist view of learning, whereas more naïve epistemic beliefs are associated with a behaviourist view of learning in pre-service teachers (Cheng et al., 2009).

Within the context of teacher education and professional development, epistemic beliefs are central to teachers' instructional practices and habitual behaviours. Researchers have found that teachers' epistemic beliefs are indirectly associated with constructivist use of ICT through pedagogical beliefs (Deng et al., 2014); in addition, more sophisticated epistemic beliefs are related with a more student-centred learning process, which is associated with higher level of technology integration (C. Kim, Kim, Lee, Spector, & DeMeester, 2013). However, it is not known how epistemic beliefs specific to Internet-based information would be related with pre-service teachers' intention for constructivist ICT integration.

Moreover, pre-service teachers' characteristics such as their engagement in online activities are also associated with their epistemic beliefs (Bråten & Strømsø, 2006; Strømsø & Bråten, 2010). Pre-service teachers who hold a naïve epistemic belief that knowledge is passively transmitted and is unchanging are less likely to participate in online discussion for subject content (Bråten & Strømsø, 2006). Furthermore, students

who view that Internet-based information is a good source of detailed and stable information for course-related work have more frequent online activities, while those who thought that Internet-based knowledge claims should be critically evaluated against other sources have less frequent online activities (Strømsø & Bråten, 2010). Studies showed that engagement in online activities is related with students' metacognitive strategies and cognitive performance; specifically, engagement in online information-reading behaviour is positively associated with better metacognitive knowledge and better navigation skills, while engagement in online social entertaining activities is negatively associated with metacognitive knowledge and navigation skills (Lee & Wu, 2013; Wu, 2014; Wu & Peng, 2017). Nevertheless, in Strømsø and Bråten's (2010) study, the ICT use construct included items for various purposes, such as for studying, for gaming and word processing, and for emailing, online chatting, and online shopping. Different online activities may have distinct patterns of correlations with epistemic beliefs. Therefore, I categorised online activities into information-reading activities and social entertaining activities (Lee & Wu, 2013; Wu, 2014) to investigate the relationship between Internet-based epistemic beliefs and engagement in different online activities.

Study purposes and research questions

The purposes of the present study were threefold. First, I investigated pre-service teachers' epistemic beliefs using the Inventory of Internet-Based Epistemic Beliefs (IBEB). Second, I examined the profile dynamics of the IBEB dimensions among pre-service teachers using a person-centred approach. Third, I tested the effect of epistemic belief profiles on preservice teachers with regard to their engagement in information-reading activities, online social entertaining activities, and their intention for constructivist ICT integration. Past research has examined the epistemic beliefs about Internet-based information among high school students or college students (e.g., Cheng, Liang, & Tsai, 2013; Chiu, Tsai, & Liang, 2015; Kammerer, Bråten, Gerjets, & Strømsø, 2013); however, no study to date has examined pre-service teachers' epistemic beliefs about Internet-based information. Understanding pre-service teachers' IBEB may have important implications for teacher education, because pre-service teachers' beliefs are associated with their judgement and decision making, which in turn affect their preferred instructional practices (Pajares, 1992). I posited that the IBEB would reveal a four-factor structure in line with Hofer (2004); however, I made no hypothesis on the scores of the IBEB dimensions.

I began by examining the relationship among the IBEB variables using a variable-centred approach, then the relationship between them and the pre-service teachers' online activities, and the intention for constructivist ICT integration. Besides the use of a variable-centred approach to explore how variables are related, I also employed a person-centred approach to help me understand individuals who might show distinct patterns on the measured variables and how the variables might interact encompassing possible linear and non-linear relationships (Bauer & Shanahan, 2007). Then I described the pre-service teachers' group differences on engagement of online information-reading activities, social entertaining activities, and intention for constructivist ICT integration, using K-means cluster analysis, which classified individuals into meaningfully homogeneous groups.

Investigating pre-service teachers' IBEB and the configuration dynamics reflected by their belief profiles may provide both researchers and practitioners an understanding of the state of pre-service teachers' IBEB, which in turn could help provide effective suggestions for enhancing pre-service teachers' IBEB to a specific profile group. However, no study to date has examined pre-service teachers' IBEB in relation to their engagement in online activities and intention for constructivist ICT integration, as well as the profile dynamics of IBEB on these variables. This study was designed to fill this void by using rigorous statistical techniques, including both variable-centred and person-centred approaches.

Literature review

The theories of epistemic beliefs

The field of personal epistemology studies what one thinks of knowledge and how one gets to know (Barzilai & Zohar, 2014; Hofer, 2004). According to Perry (1970), personal epistemology evolves through the following stages: dualistic view, multiplicity view, relativistic world view, and commitment within relativism. The first stage is the dualistic view stage, where students possess a dualistic view of knowledge, viewing knowledge as either correct or false, absolute and unchanging, believing in authority and regarding authority as the source of knowledge. The second stage is the multiplicity view stage, where they believe that knowledge can differ based on changes in perspectives but still with an absolute answer. The third stage is the relativistic world view, which views knowledge as created by human beings, not absolute, and capable of being validated. The final stage is commitment within relativism. By then, people have learned that no knowledge is absolutely correct; instead, it changes with time and situation.

Hofer and Pintrich (1997) conducted a systematic review of epistemic theories and proposed two major areas of epistemic beliefs, the nature of knowledge and the process of knowing:

- The nature of knowledge focuses on what one thinks knowledge is and includes certainty of knowledge and simplicity of knowledge. The certainty dimension measures beliefs as to whether knowledge is fluid or fixed, while the simplicity dimension measures beliefs as to whether knowledge contains simple and detailed facts or complex and interrelated facts.
- The process of knowing investigates how one obtains knowledge and includes source of knowledge and justification for knowing. The source dimension measures whether knowledge is actively constructed or passively transmitted. Justification for knowing is the way one evaluates evidence and justifies one's beliefs by using evidence, referring to authority or expertise, and evaluating information provided by experts.

"As individuals learn to evaluate evidence and to substantiate and justify their beliefs, they move through a continuum of dualistic beliefs to the multiplistic acceptance of opinions to reasoned justification for beliefs" (Hofer & Pintrich, 1997, p. 120). Therefore, more sophisticated justification of knowing is evident as one uses a variety of ways to justify one's beliefs. In the present study, I took the stance of Hofer and Pintrich (1997), viewing epistemic beliefs in terms of the nature of knowledge and the process of knowing to develop four Internet-specific epistemic belief dimensions.

Internet-specific epistemic beliefs and online behaviours

Researchers have investigated Internet-specific epistemic beliefs as a way to understand the relationship between epistemic beliefs and Internet-related behaviour and performance (e.g., Bråten, Srømsø, & Samuelstuen, 2005; Chiu, Liang, & Tsai, 2013; Lee, Chiu, Liang, & Tsai, 2014). To begin with, Bråten et al. (2005) developed the Internet-Specific Epistemic Questionnaire (ISEQ) to assess university students' epistemic beliefs about the Internet. Their analysis revealed a two-factor structure in ISEQ: a factor for general Internet epistemology and one for justification for knowing. According to Bråten et al. (2005), students reporting that they viewed the Internet as an essential source of accurate information were more adept at Internet searches and participated in more Internet-based communication activities – a finding that greatly surprised the authors. Similar results were found by Strømsø and Bråten (2010), where they asked undergraduate students to reflect on their beliefs about the course-related Internet-based knowledge. They found a three-factor structure in ISEB, consisting of certainty and source of knowledge, structure (simplicity) of knowledge, and justification for knowing. Students who held that the Internet is a good source to find correct answers on course-related questions and issues (i.e., a naïve certainty and source belief) tended to possess the view that the Internet contains a vast amount of detailed facts concerning course-related issues (i.e., a naïve structure/simplicity belief). Nevertheless, neither the certainty and source belief nor the structure

belief was correlated with claims by multiple sources of undergraduate students' justification for knowing of Internet-based knowledge (Strømsø & Bråten, 2010).

Using Bråten et al.'s ISEQ (2005), Cheng et al. (2013) revealed a two-factor structure in ISEQ and found that more sophisticated justification for knowing was positively associated with advanced self-regulation, information search, and formal and informal queries, directly and indirectly. Nevertheless, a stronger belief that the Internet is an inadequate source for knowledge was related with less formal (seeking help from teachers or classmates) and informal queries (seeking help from unknown people online), suggesting that those who did not think that the Internet is a good source of reliable and detailed information were less likely to ask for help through online means. Additionally, general epistemic beliefs about the Internet predicted university students' certainty of their decisions in recommending a specific therapy about a conflicting and unfamiliar medical issue, while Internet-specific justification for knowing predicted their performance in forming balanced arguments on two competing medical therapies (Kammerer et al., 2013). These findings revealed that students' ISEB were associated with their online information-reading behaviours and decisions, which may have implications in pre-service teachers' intention for constructivist ICT integration, because beliefs about the nature of Internet information and the process of knowing Internet-based knowledge may indirectly affect pre-service teachers' decision to integrate ICT in their instruction (Deng et al., 2014; C. Kim et al., 2013).

Instead of two- or three-factor structures such as those above, recent studies have revealed a four-factor structure in ISEQ in accordance with Hofer and Pintrich's (1997) hypothesised dimensions of epistemic beliefs (Chiu et al., 2013; W.-C. Lee et al., 2014). The results of these studies showed that simplicity and source of Internet knowledge were negatively associated with the planning phase of self-regulation directly and with the implementation phase of self-regulation indirectly (Chiu et al., 2013); in addition, Internet-specific epistemic beliefs were predictive of information search and help-seeking (W.-C. Lee et al., 2014). The previous studies represent advances in understanding Internet-specific epistemic beliefs. However, they consistently obtained findings against their hypotheses for the simplicity or source dimension. For example, researchers found a positive relationship between information search and a simple view of structure and source (Bråten et al., 2005; Cheng et al., 2013; Lee et al., 2014). Besides, a more naïve belief in structure or source was related to better self-regulation in online learning (Cheng et al., 2013; Chiu et al., 2013). It is likely that what represent more sophisticated and adaptive Internet-specific epistemic beliefs is unique with regard to the structure of Internet-based knowledge. Moreover, no study to date has been conducted on the Internet-specific epistemic beliefs of pre-service teachers, considering the interplay of Internet-specific epistemic beliefs. Therefore, using a self-developed questionnaire, the current study examined the Internet-based epistemic beliefs of pre-service teachers and explored their belief profile patterns regarding their engagement in online activities, and intention for constructivist ICT integration using both the variable-centred approach and the person-centred approach.

A person-centred approach towards understanding epistemic beliefs

People's personal epistemology is a system of beliefs regarding what they think knowledge is and how they get to know (Hofer, 2004). Therefore, person-centred approaches are appropriate in studying people's personal epistemology. Studies using a person-centred approach help us understand how individuals differ quantitatively, qualitatively, or both, on the variables of interest (Marsh, Lüdtke, Trautwein, & Morin, 2009). Instead of investigating how each individual construct of epistemic beliefs is related with students' knowledge in controversial issues during online searches, Mason, Ariasi, and Boldrin (2011) employed a person-centred approach to understand the effect of belief configurations on online controversial issues searches with think-out-loud strategies. They found two online search patterns through think-out-loud techniques in a sample of 64 students in grade 13. The first pattern represented students' evaluation of information sources and justification of their knowing. About 40% of the students belonged to this category. That is, they evaluated the authority of sources and the speed of updates and recognised that a claim of knowledge needs support from scientific evidence. The second pattern represented students' evaluation of information sources only. About 60% of students fell in this category. That is, they evaluated the trustworthiness of websites. These students seldom provided a justification for knowing. Students in both categories seldom reflected on the

simplicity and certainty of knowledge. Students in the first category performed better in online reading than those in the second. Most epistemic reflections were on source of knowledge.

These results are reminiscent of the patterns identified in previous research. Mason et al.'s (2011) findings are also consistent with those of Hofer (2004) in some ways. For example, using retrospective think-aloud interviews, Hofer elicited the metacognitive process of epistemic understanding and verified the existence of the four epistemic beliefs during online search. Although she had assumed that certainty and simplicity were tacit beliefs and might be less disclosed, she detected these two intangible constructs. Inconsistent with Mason et al.'s (2011) findings, she found that students provided more disclosure on justification for knowing than source of knowledge. This difference might result from the development of students' information search skills, because the two studies were published 7 years apart. The importance of evaluating the trustworthiness and relevance of Internet information may be more pronounced in recent years.

Ferguson and Bråten (2013) focused specifically on justification for knowing in natural science in an effort to understand the composition of belief profiles with multiple-texts comprehension as an external criterion. They categorised justification for knowing into three areas: personal justification, justification by authority, and justification from multiple sources. Then, they used the three justification beliefs as the clustering variables along with students' actual content knowledge. The cluster analysis revealed three clusters based on data collected after students read conflicting texts. Cluster 3, characterised by high content knowledge, low personal justification, and high justification by multiple sources, outperformed the other two clusters. In addition, Cluster 2, characterised by high content knowledge and high justification by authority, performed better than Cluster 1, which was characterised by moderate content knowledge and moderate scores in all epistemic beliefs. The strength of Ferguson and Bråten's study (2013) lies in adopting different justification perspectives to inform the importance of justification by multiple sources; nevertheless, using content knowledge scores in place of beliefs about the nature of knowledge cannot reflect participants' certainty and simplicity beliefs. I agree with Hofer (2004) that the epistemic constructs were interactive and integrated. Therefore, I included all four self-reported epistemic constructs in our cluster analysis to understand the configuration of epistemic beliefs and examine the differences in the magnitude of epistemic constructs among the profiles in pre-service teachers.

Method

Participants

Participants were 474 teacher education students (female 73.7% and male 26.3%) from a major university for elementary teacher training in Taiwan. Data were collected in the compulsory courses for teacher education training, such as educational psychology, learning assessment, child psychology, and developmental psychology. Students provided informed consent to participate in the study in return for partial course credit. The data collection procedure was in accordance with the American Psychological Association guidelines.

Seventy-eight percent of the students were in the age group of 18–22, 12.4% in the age group of 23–27, and 8.2% above 27, with 1.5% of the students not reporting their age. The sample was comprised of 78.3% of undergraduate students and 20.9% of graduate students, with 0.8% of the students not reporting their grade level.

Materials

The initial IBEB contained 20 items developed by the researcher. Two experts in epistemic beliefs and Internet-based learning reviewed the items and provided suggestions for revision to ensure content validity. Pre-service teachers were asked to reflect on their attitudes towards and beliefs about the Internet-based knowledge when undertaking in-depth online reading on a specific topic or subject area based on their experiences over the preceding 3 months. Responses were measured on a 7-point Likert scale with 1 indicating *extreme disagreement* and 7 *extreme agreement*. Higher scores indicated more sophisticated views

of Internet-specific epistemic beliefs. I provide a detailed description of the study measures in Table 1. The operational definitions of the proposed constructs were described as follows.

Justification for knowing on the Internet (Justification) measured the degree of critical evaluation, whereby a person justifies his or her knowledge claims on the Internet by referring to multiple sources, personal experiences, or experts and authority. The rationale for constructing this factor is that learners are at the centre of Internet-based learning. If learners score high in all aspects of justification for knowing, they possess more flexible use of the justification methods.

Structure of Internet knowledge (Structure) is the same as the simplicity belief, which assessed participants' belief as to whether the structure of Internet knowledge is non-continuous, independent, and cumulative in nature or interconnected and coherent. Higher scores indicated a view that Internet knowledge is simple and piecemeal.

Table 1
Item description of IBEB and intention for constructivist ICT integration

Item description for the IBEB	
JUS1:	I justify the accuracy of Internet knowledge based on my background knowledge.
JUS2:	I justify the trustworthiness of the content on the web page based on its author or source.
JUS3:	I justify the trustworthiness of the content on the web page based on the types of websites (e.g., .gov, .org, .com, etc).
JUS4:	I justify the trustworthiness of the Internet-based information based on my reasoning.
JUS5:	I justify the accuracy of the Internet-based information by consulting multiple sources/websites.
JUS6:	I justify the accuracy of the Internet-based information based on the evidence provided in the article.
STR1:	I think that a lot of Internet-based information is rumour.
STR2:	I think that Internet-based information is piecemeal and independent.
STR3:	I think that Internet-based information is fragmental and lacking in a coherent view.
STR4:	I think that Internet-based information is mainly accumulation of messages and contents.
SOR1:	I think that knowledge claims on the Internet should be actively constructed by discussing with friends, classmates, and instructors.
SOR2:	I think that knowledge claims on the Internet should be actively constructed by consulting experts.
SOR3:	I think that knowledge claims on the Internet should be actively constructed by interacting with contents on the web pages.
UNC1:	I think Internet-based information is uncertain and is lacking in absolute answers.
UNC2:	I think Internet-based information is changing all the time and is not necessarily correct.
UNC3:	I think Internet-based information is malleable and requires efforts to synthesise and verify.
Item description for intention for constructivist ICT integration	
INT1:	I will ask my students to use the Internet to look up course-relevant information.
INT2:	I will ask my students to use the Internet for extended learning.
INT3:	I will assign research projects that require inquiry on the Internet.
INT4:	I will have my students collaborate with their classmates on the Internet.
INT5:	I will have my students collaborate with students from all over the world.
INT6:	I will have my students participate in online learning (e.g., Junyi, Khan academy … etc.)
INT7:	I will have my students complete the homework using the Internet.
INT8:	I will ask my students to collect information on the Internet for their own research project and present their findings based on the outlines I provide.
INT9:	I will ask my students to develop a research question, locate quality information, and organise information to support their conclusions.
INT10:	I will teach my students how to use the search engine and evaluate the quality of information.
INT11:	I will introduce advanced search techniques used in specific databases, including limiting results by date, availability, publication type, etc.

Source of Internet knowledge (*source*) evaluated participants' view as to whether Internet knowledge is actively constructed (by interacting with teachers, classmates, the authority, or the content of web pages), or passively transmitted by others, a view consistent with Schommer (1990) and Hofer (2004).

Uncertainty of Internet knowledge (*uncertainty*) measured participants' view that knowledge on the Internet is fluid, malleable, and changing with time rather than fixed and stable.

Intention for constructivist ICT integration (11 items) was operationalised as the likelihood that pre-service teachers would assign various learning activities and homework that require students to use the Internet to construct knowledge. Responses were rated on 7-point Likert scale with 1 indicating *never* and 7 *always*.

Engagement in online activities was categorised into information-reading activities (5 items) and social entertaining activities (5 items) to assess participants' frequency to perform the following activities on a daily basis (1 *never* to 7 *always*). Information-reading activities included reading e-books, using online dictionaries, using the library electronic resources, reading online news, and browsing professional websites such as museums and research centres. Social entertaining activities consisted of playing online games, watching online videos, online chatting, visiting social network sites, and online shopping.

Data analysis

I employed exploratory factor analysis (EFA) using principal-axis extraction with oblique rotation to explore the factor structure in IBEB, intention for constructivist ICT integration, and engagement in online activities, using half of the randomly selected sample. The sampling adequacy for EFA was determined using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test. The optimal factor solution was decided by the number of factors with eigenvalue greater than 1, the explained variance by the extracted factors, and the empirical evidence of the factors (Thompson, 2004).

A series of confirmatory factor analyses (CFA) were then conducted on the full sample to verify the factor structure in IBEB, intention for constructivist ICT integration, and engagement in online activities using Mplus version 7.2 (Muthén & Muthén, 2012). The appropriateness of the hypothesised model was determined by a chi-square test of model fit, comparative fit index (CFI) greater than .90, and a root mean square error approximation (RMSEA) and standardised root mean square residual (SRMR) equal to or less than .08 (Hu & Bentler, 1992).

Further, the k-means clustering procedure was used to investigate the epistemic belief profiles among teacher education students. In order to obviate the contamination of measurement errors and ensure an equal footing of clustering variables (Wu, 2015), I used the factor scores of the extracted IBEB constructs to conduct the k-means clustering analysis with three-, four-, and five-cluster solutions. The optimal cluster solution was determined by the cluster solution with the largest averaged between-group and the smallest averaged within-cluster distance. By so doing, I obtained heterogeneous between-group clusters and homogeneous within-group observations. All the cluster analyses reached convergence.

Results

Factor structure of the intention for constructivist ICT integration, engagement in online activities, and the IBEB

The EFA revealed a single factor for intention of constructivist ICT integration, KMO = .90, Bartlett's test of sphericity = 1322.963, *df* = 55, *p* < .001. The factor loadings ranged from .49 to .76 with 49% variance explained. The internal consistency of this factor was .90. For engagement in online activities, the EFA exhibited the two hypothesised factors: the information-reading activities and the social entertaining activities, KMO = .73, Bartlett's test of sphericity = 548.586, *df* = 45, *p* < .001. The factor loadings ranged from .38

to .86 with 39% variance explained. The internal consistency was .71 for information-reading and .72 for social entertaining activities.

The EFA for IBEB revealed the four proposed factors with eigenvalue greater than 1. Four items were excluded because they were either cross-loaded on multiple factors or were loaded on the unintended factor with trivial loadings. The KMO (.820) and significant Bartlett's test result (chi-square = 1424.257, *df* = 120, *p* < .01) demonstrated the adequacy of forming EFA with a total variance explained of 52%. The internal consistency of justification (6 items), structure (4 items), source (3 items), and certainty (3 items) were .80, .75, .71, and .72, respectively.

The results of CFAs for the intention of constructivist ICT integration, engagement in online activities, and IBEB using the full sample verified the EFA results. The CFAs showed an adequate fit of the model to the data (for intention of constructivist ICT integration, χ^2 = 158.12, *df* = 42, *p* < .01, CFI = .95, RMSEA = .08, SRMR = .04; for engagement in online activities, χ^2 = 82.44, *df* = 25, *p* < .01, CFI = .93, RMSEA = .08, SRMR = .08; for IBEB, χ^2 = 331.96, *df* = 97, *p* < .01, CFI = .91, RMSEA = .07; SRMR = .08).

Descriptive statistics and correlations among the observed variables

Table 2 shows the descriptive statistics of the observed IBEB items. As illustrated, most item scores in uncertainty and justification were above 5, indicating that on average pre-service teachers agreed that Internet-based information was uncertain and changing with time, and that knowledge claims should be justified through multiple sources. Besides, almost all item scores in structure and source were between 4 and 5, suggesting that pre-service teachers held a neutral to positive belief that Internet-based information was fragmented and accumulated in nature and needed actively constructing. The kurtosis and skewness of the observed items were within ±3, reflecting no non-normality problem (Kline, 2005).

Table 2
Standardised CFA factor loadings of the four hypothesised IBEB constructs

	Justification	Structure	Source	Uncertainty	*M*	*SD*	Min	Max	Kurtosis	Skewness
JUS1	0.82				5.45	0.89	3	7	-0.19	0.15
JUS2	0.79				5.39	0.94	3	7	-0.31	0.00
JUS3	0.51				4.85	1.21	1	7	0.28	-0.30
JUS4	0.44				4.83	1.03	1	7	0.60	-0.17
JUS5	0.61				5.41	0.94	2	7	-0.02	-0.15
JUS6	0.64				5.33	0.87	3	7	-0.27	0.09
STR1		0.50			3.76	1.06	1	7	0.88	0.17
STR2		0.81			4.44	1.05	1	7	0.42	-0.02
STR3		0.88			4.48	1.12	1	7	0.34	-0.01
STR4		0.46			4.93	0.89	1	7	0.96	0.19
SOR1			0.80		4.85	1.07	2	7	-0.21	0.03
SOR2			0.68		4.35	1.15	1	7	0.02	0.10
SOR3			0.53		4.83	0.94	1	7	0.77	0.07
UNC1				0.86	5.60	0.98	3	7	-0.44	-0.18
UNC2				0.86	5.79	0.98	1	7	0.23	-0.42
UNC3				0.41	5.05	1.10	1	7	0.19	-0.14
Alpha	.80	.75	.71	.72						

Note. JUS = Justification for knowing on the Internet, STR = Structure of Internet knowledge, SOR = Source of Internet knowledge, UNC = Uncertainty of Internet knowledge.

As shown in Table 3, scores of the four IBEB latent factors positively correlated with each other (*r* = .31~.68, *p* < .05). In addition, more positive views about source, uncertainty, and justification of Internet-based knowledge claims were positively correlated with higher engagement in online information-reading activities, online social entertaining activities, and potential use of the Internet in instruction (*r* = .13~.35, *p* < .05).

Table 3
Correlation among the study variables

	1	2	3	4	5	6
1. Justification						
2. Structure	0.33*					
3. Source	0.47*	0.47*				
4. Uncertainty	0.68*	0.42*	0.31*			
5. Information-reading activities	0.27*	0.08	0.16*	0.21*		
6. Social and entertaining activities	0.19*	0.01	0.14*	0.19*	0.08	
7. Intention for constructivist ICT integration	0.25*	<0.01	0.16*	0.16*	0.22*	0.16*

Note. p < .05

K-means cluster analysis

I used the four factor scores derived from the CFA to conduct k-means cluster analysis. I tested three-, four-, and five-cluster solutions on the epistemic belief profiles. The four-cluster solution yielded the largest between-group distance ($d_{between}$ = 3.58, 3.60, and 3.54 for the three-, four-, and five-cluster solution), compared with the three- and five-cluster solution. As for the average within-group distance, the five-cluster solution had the smallest average distance between observations and cluster centroid (d_{within} = 1.19, 1.11, and 1.09 for the three-, four-, and five-cluster solution), but the distances for the four-cluster solution and the five-cluster solution were not statistically different (p = .525). Therefore, I chose the more parsimonious solution, given that the four-cluster solution yielded homogeneous groups similar to the five-cluster solution. As shown in Table 4, the ANOVA test of the four-solution effect on the clustering variables indicated that the four groups had statistically significant mean differences in all the clustering variables, except that Cluster 2 and Cluster 4 had the same lowest scores in the constructs of structure and source of Internet knowledge.

Table 4
The effect of Internet-specific epistemic profiles on the clustering and validating variables

	Positive beliefs (n = 92)		Negative beliefs (n = 145)		Modest beliefs (n = 132)		High justification and uncertainty (n = 87)			
	M	SD	M	SD	M	SD	M	SD	F	p
Clustering variables										
Justification	1.13a	0.65	-0.83d	0.58	-0.22c	0.50	0.52b	0.60	250.27	< .001
Structure	1.08a	0.84	-0.59c	0.59	0.21b	0.57	-0.49c	0.78	121.38	< .001
Source	1.04a	0.72	-0.59c	0.54	0.34b	0.53	-0.62c	0.66	168.97	< .001
Uncertainty	1.00a	0.57	-0.88d	0.56	-0.16c	0.58	0.65b	0.60	246.82	< .001
Validating variables										
Information-reading activities	4.80a	0.93	4.16c	0.84	4.24c	0.87	4.51b	0.90	11.85	< .001
Social/entertaining activities	5.80a	0.76	5.48b	0.87	5.71ab	0.78	5.74ab	0.89	3.60	.014
Intention for constructivist ICT integration	5.53a	0.69	5.14b	0.95	5.33ab	0.63	5.42a	0.70	5.47	.001

Note. Numbers sharing the same subscript in a row were not statistically different from each other. Numbers with a subscript of "a" had the highest value, followed by those with subscript "b" and then "c".

As illustrated in Figure 1, Cluster 1 (C1) had congruent positive scores in all belief constructs (n = 92). Cluster 2 (C2) had congruent negative scores in all belief constructs (n = 145). Therefore, C1 was named the *positive beliefs* and C2 the *negative beliefs*. The epistemic belief scores for Cluster 3 (C3) centred around the factor score of zero, with slightly positive scores on structure and source and slightly negative scores on justification and uncertainty (n = 132). Compared with C3, the profile of Cluster 4 (C4) was reversed, with

more positive scores on justification and uncertainty and more negative scores on structure and source (n = 87). Therefore, C3 was named *modest beliefs* and C4 *high justification* and *uncertainty*.

Demographic differences in the epistemic profiles

By comparing the observed frequencies in each cell with the expected frequencies, I could examine the demographic differences in the profile groups. Nevertheless, none of the chi-square tests was statistically significant. There was no association between epistemic profiles and pre-service teachers' gender ($\chi^2 = 5.32, df = 3, p = .150$), age groups ($\chi^2 = 15.10, df = 12, p = .236$), and grade levels ($\chi^2 = 5.63, df = 3, p = .131$).
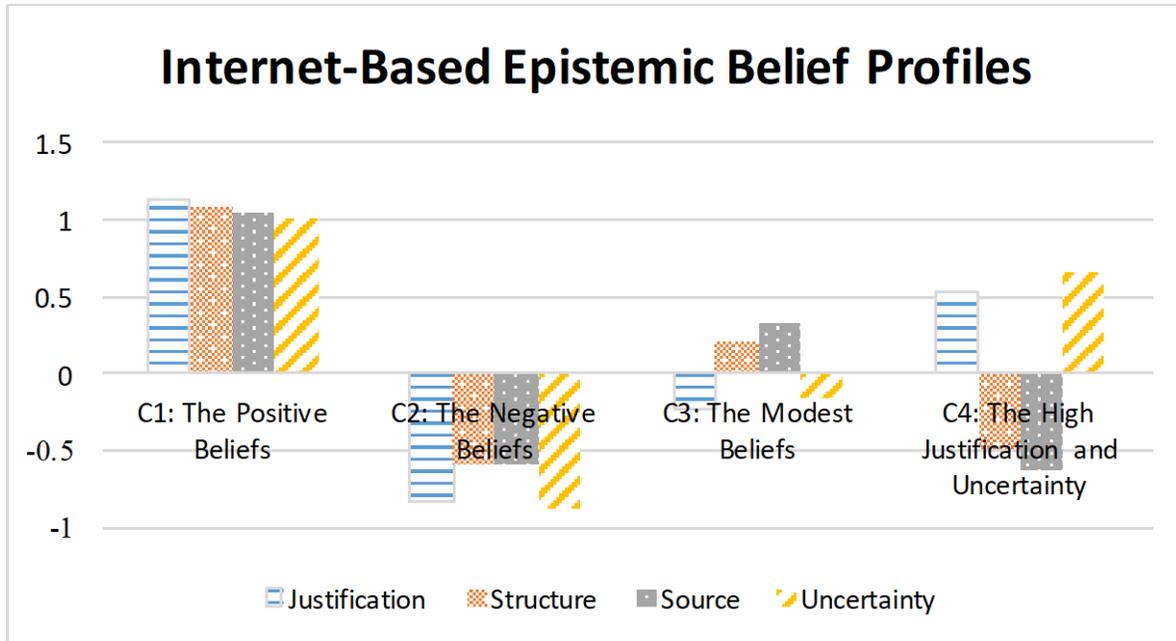
Figure 1. Internet-based epistemic belief profiles among preservice teachers

Analysis of variance of the epistemic profile effects on the validating variables

The epistemic profile groups exhibited differential mean differences in all four validating variables, as shown in Table 4. The *positive beliefs* scored highest in the frequency of engagement in information-reading activities, followed by the *high justification* and *uncertainty*, and the *negative beliefs* and the *modest beliefs*. The mean scores of the last two groups were not statistically different from each other. The *positive beliefs* scored significantly higher on social and entertaining online activities than the *negative beliefs*, but the scores were not statistically different among any other pairs of comparison. The *positive beliefs* and the *high justification and uncertainty* had the same highest intention for using the Internet for constructivist learning activities, which was higher than the scores of the *negative beliefs*, but was not statistically different from the scores of the *modest beliefs*.

Discussion

This study advances the theories of personal epistemology (Hofer, 2004) by verifying the hypothesised factor structure in IBEB and revealing the IBEB profiles among pre-service teachers at the elementary school level. Specifically, investigating the factor structure and the interplay of IBEB among pre-service teachers contributes to our understanding of the different epistemic compositions in pre-service teachers and the

potential impact of the belief configurations, and provides implications for improving teacher education. Below I discuss the theoretical and practical implications pertaining to the study findings.

The dimensions and interpretation of IBEB

As expected, four epistemic beliefs about Internet-based knowledge were derived from the IBEB with adequate model fit based on Hofer and Pintrich's (1997) theoretical framework. The four constructs were positively correlated with each other, suggesting that higher scores in one dimension were related with higher scores in other dimensions. Specifically, pre-service teachers who believed that Internet-based information is uncertain, should be actively constructed, and needs justification from multiple sources were more likely to think that Internet-based information is simple, piecemeal, and independent of one another. This finding may initially seem contradictory as we try to interpret it. However, after a detailed examination of the structure construct and its relationships to the other beliefs, I am involved in a discussion regarding the definition of sophistication (Bråten et al., 2005; Chiu et al., 2013).

Bråten et al. (2005) found that participants who regarded the Internet as an essential source of simple and detailed facts were more confident and skilled in searching relevant information and using the information they found, suggesting a positive relationship between a naïve view of Internet-based knowledge and Internet search skills. This finding is contradictory to what they hypothesised. They explained that it was the naïve belief about Internet knowledge that caused the participants to be unaware of the difficulties in dealing with the vast amount of Internet information, thereby resulting in higher self-reported Internet search scores. Moreover, studies employing separate factors for the epistemic belief domains also found a positive relationship between a naïve structure or simplicity belief and self-regulation (Strømsø & Bråten, 2010) and between naïve structure or simplicity and source beliefs with self-regulation (Chiu et al., 2013). Strømsø and Bråten (2010) commented that it is a representative belief that the Internet is an enormous open environment that contains a plethora of detailed facts; such a naïve perception, they speculated, may be related to a greater possibility or more experiences to locate reliable and correct information.

The current study finding provides an alternative interpretation of structure or simplicity in terms of sophistication. Pre-service teachers who recognise that Internet-based information is indeed fragmented and incoherent tend to actively construct and justify their knowledge claims using multiple sources of information, instead of accepting it as it is. In contrast, those who think that Internet-based information is coherent and interrelated tended to accept it without multiple justifications. This result is consistent with the inter-construct correlations in Chiu et al. (2013). Furthermore, results from the person-centred approach provide additional evidence to support this view. Specifically, having all positive scores on the four epistemic constructs, the *positive beliefs* had the most frequent information-reading and social entertaining activities as well as the highest scores in intention for constructivist ICT integration. Therefore, instead of assuming interrelated and coherent knowledge structure as more advanced beliefs, more positive and adaptive IBEB in the structure belief is when one realises that Internet-based information is fragmented and isolated in nature, and thus it entails active construction via justification by multiple sources. Below I describe the characteristics of the four derived epistemic profiles with implications for teacher education.

The impact of pre-service teachers' epistemic belief profiles

The epistemic belief profiles showed distinct patterns in the outcome variables. Pre-service teachers in the *positive beliefs* held that the Internet contains simple and tentative facts and that Internet-based knowledge should be actively constructed (instead of passively transmitted) via justification by multiple sources. The *Positive beliefs* reported the most frequent engagement in information-reading and social entertaining online activities and the greatest possibility for constructivist ICT integration. In contrast, the *negative beliefs* (congruent negative scores in the epistemic beliefs) scored the lowest in these three studied outcomes.

The *modest beliefs* (C3) and the *high justification* and *uncertainty* (C4) were reversed in profile patterns. The *modest beliefs* had a similar score to the *negative beliefs* in the frequency of information-reading activities, though their scores in social entertaining activities, and intention for constructivist ICT integration were not

statistically different from the other three groups. Compared to the *modest beliefs*, the *high justification* and *uncertainty* had lower scores in the structure and source beliefs, which were not statistically different from those for the *negative beliefs*. Nevertheless, the *high justification* and *uncertainty* scored higher in terms of engagement in information-reading activities and intention for constructivist ICT integration than the *negative beliefs* and the *modest beliefs*.

These results have implications for the relative importance of pre-service teachers' IBEB. Despite low scores in the structure and source beliefs, as long as pre-service teachers hold that Internet-based knowledge is constructed actively by justifying the knowledge claim using multiple sources, they are more likely to integrate constructivist ICT use in instruction. Unlike content presented in a book, information on the Internet is relatively unbounded and requires justification against evaluative standards. Barzilai and Zohar (2014) noted, "Evaluation is cognitive when its object is the correctness or truth of specific knowledge claims and is metacognitive when its object is the thinking processes and standards used in cognitive evaluation of knowledge claims" (p. 20). In line with this view, people engage in both evaluating the nature of Internet-based information (a cognitive process) and, at the same time, monitor the processes and standards in a cognitive evaluation of the Internet-based knowledge claim (a metacognitive process). Thus, from the perspective of epistemic cognition, which represents what people do when prompted to reflect the nature of knowledge and their justification of knowing (Maggioni & Parkinson, 2008), it will not be surprising when one evaluates and understands that the nature of Internet-based information is indeed simple, disjointed, fragmented, and accumulated, so that people justify their knowledge claim by multiple sources to perform adaptive regulation in consuming Internet-based information, such as those in the *positive beliefs* as well as those in the *high justification* and *uncertainty*.

Researchers have demonstrated that teachers cannot teach their students what they are not capable of (Binks-Cantrell, Washburn, Joshi, & Hougen, 2012), a phenomenon referred to as the "Peter effect" by Applegate and Applegate (2004). The current study applied this notion to teacher preparation towards increased ICT use and intention for constructivist ICT integration in instruction. Findings of the study reveal that the *positive beliefs* and the *high justification* and *uncertainty* were among the highest in terms of ICT use (i.e., information-reading and social entertaining reading activities) and intention for constructivist ICT integration. It is likely that when these pre-service teachers become in-service teachers, they will have positive impacts on their future students' ICT-related capability across curricula (Markauskaite, 2007) by assigning and modelling the use of Internet for information reading, for communicating with friends, and for collaborating on Internet-based projects and learning activities, which are the core ICT competences for pre-service teachers in order to meet 21st century demands (Tondeur et al., 2017). Meanwhile, intervention or professional preparation targeting pre-service teachers in the *negative beliefs* and the *modest beliefs* may be necessary to advance their negative Internet-based epistemic beliefs, especially in the justification dimension. Tsai (2004) posited that frequent exposure to Internet-based learning may change and shape students' epistemic beliefs, making them more advanced. Therefore, I suggest that pre-service teachers engage in more Internet-based learning to deal with the challenges derived from the nature and process of Internet-based knowledge claims and knowing. Specifically, instructional and pedagogical strategies featuring information evaluation and computer-supported collaborative learning (e.g., Kim & Hannafin, 2016; Lee, 2015, 2017) may be employed in instruction to facilitate pre-service teachers' critical thinking and to shape their Internet-based epistemic beliefs through individual or collaborative reflection on the uncertainty and structure of Internet-based information and a critical evaluation of knowledge claims by multiple sources.

Limitations

Though the study finding is enlightening and has practical implications for teacher education, the result should be interpreted with limitations. First, the sample consists of female pre-service teachers primarily, which, however, represents the actual composition of male and female pre-service teachers at the elementary school level in Taiwan. Future studies can still be conducted on a gender-based sample to test potential gender differences in IBEB. Second, the current study focused on pre-service teachers at the elementary school level; thus, the result may not be generalisable to pre-service teachers at other grade levels. More studies can be

done to test if the same factor structure and profile groups can be found in pre-service teachers at other grade levels. Third, the current study used pre-service teachers' engagement in online activities and intention for constructivist ICT integration as validating variables, which may not reflect their actual practices. Future study can examine the effect of pre-service teachers' IBEB profiles on their performance data.

Acknowledgments

References

Applegate, A. J., & Applegate, M. D. (2004). The Peter Effect: Reading habits and attitudes of preservice teachers. *The Reading Teacher, 57*(6), 554–563. https://doi.org/10.1080/19388071.2014.898719

Barzilai, S., & Zohar, A. (2014). Reconsidering personal epistemology as metacognition: A multifaceted approach to the analysis of epistemic thinking. *Educational Psychologist*, *49*(1), 13–35. https://doi.org/10.1080/00461520.2013.863265

Bauer, D. J., & Shanahan, M. J. (2007). Modeling complex interactions: Person-centered and variable-centered approaches. In T. D. Little, J. A. Bovaird, & N. A. Card (Eds.), *Modeling contextual effects in longitudinal studies* (pp. 255–284). Mahwah, NJ: Erlbaum.

Binks-Cantrell, E., Washburn, E. K., Joshi, R. M., & Hougen, M. (2012). Peter effect in the preparation of reading teachers. *Scientific Studies of Reading, 16*(6), 526–536. https://doi.org/10.1080/10888438.2011.601434

Bråten, I., & Strømsø, H. I. (2006). Epistemological beliefs, interest, and gender as predictors of Internet-based learning activities. *Computers in Human Behavior*, *22*(6), 1027–1042. https://doi.org/10.1016/j.chb.2004.03.026

Bråten, I., Srømsø, H. I., & Samuelstuen, M. S. (2005). The relationship between Internet-specific epistemological beliefs and learning within Internet technologies. *Journal of Educational Computing Research, 33*(2), 141–171. https://doi.org/10.2190/E763-X0LN-6NMF-CB86

Buehl, M. M., Alexander, P. A., & Murphy, P. K. (2002). Beliefs about schooled knowledge: Domain specific or domain general? *Contemporary Educational Psychology, 27*(3), 415–449. https://doi.org/10.1006/ceps.2001.1103

Chan, K. (2004). Preservice teachers' epistemological beliefs and conceptions about teaching and learning: Cultural implications for research in teacher education. *Australian Journal of Teacher Education, 29*(1). https://doi.org/10.14221/ajte.2004v29n1.1

Chan, K.-W., & Elliott, R. G. (2004). Relational analysis of personal epistemology and conceptions about teaching and learning. *Teaching and Teacher Education, 20*(8), 817–831. https://doi.org/10.1016/j.tate.2004.09.002re

Cheng, K.-H., Liang, J.-C., & Tsai, C.-C. (2013). The role of Internet-specific epistemic beliefs and self-regulation in high school students' online academic help seeking: A structural equation modeling analysis. *Journal of Educational Computing Research*, *48*(4), 469–489. https://doi.org/10.2190/EC.48.4.d

Cheng, M. M., Chan, K.-W., Tang, S. Y., & Cheng, A. Y. (2009). Pre-service teacher education students' epistemological beliefs and their conceptions of teaching. *Teaching and Teacher Education, 25*(2), 319–327. https://doi.org/10.1016/j.tate.2008.09.018

Chiu, Y.-L., Liang, J.-C., & Tsai, C.-C. (2013). Internet-specific epistemic beliefs and self-regulated learning in online academic information searching. *Metacognition and Learning, 8*(3), 235–260. https://doi.org/10.1007/s11409-013-9103-x

Chiu, Y.-L., Tsai, C.-C., & Liang, J.-C. (2015). Testing measurement invariance and latent mean differences across gender groups in college students' Internet-specific epistemic beliefs. *Australasian Journal of Educational Technology, 31*(4), 486–499. https://doi.org/10.14742/ajet.1437

Chou, C., & Lee, Y.-H. (2017). The moderating effects of Internet parenting styles on the relationship between internet parenting behavior, Internet expectancy, and Internet addiction tendency. *The Asia-Pacific Education Researcher, 26*(3–4), 137–146. https://doi.org/10.1007/s40299-017-0334-5

Deng, F., Chai, C. S., Tsai, C.-C., & Lee, M.-H. (2014). The relationships among Chinese practicing teachers' epistemic beliefs, pedagogical beliefs and their beliefs about the use of ICT. *Educational Technology & Society, 17*(2), 245–256. Retrieved from http://www.ds.unipi.gr/et&s/journals/17_2/20.pdf

Ferguson, L. E., & Bråten, I. (2013). Student profiles of knowledge and epistemic beliefs: Changes and relations to multiple-text comprehension. *Learning and Instruction, 25*, 49–61. https://doi.org/10.1016/j.learninstruc.2012.11.003

Hofer, B. K. (2004). Exploring the dimensions of personal epistemology in differing classroom contexts: Student interpretations during the first year of college. *Contemporary Educational Psychology, 29*(2), 129–163. https://doi.org/10.1016/j.cedpsych.2004.01.002

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*(1), 88–140. https://doi.org/10.3102/00346543067001088

Hu, L., & Bentler, P. M. (1992). Can test statistics in covariance structure analysis be trusted? *Psychological Bulletin, 112*, 351–362. Retrieved from http://psycnet.apa.org/record/1993-04187-001

Kammerer, Y., Bråten, I., Gerjets, P., & Strømsø, H. I. (2013). The role of Internet-specific epistemic beliefs in laypersons' source evaluations and decisions during Web search on a medical issue. *Computers in Human Behavior, 29*(3), 1193–1203. https://doi.org/10.1016/j.chb.2012.10.012

Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education, 29*, 76–85. https://doi.org/10.1016/j.tate.2012.08.005

Kim, S. M., & Hannafin, M. J. (2016). Synergies: effects of source representation and goal instructions on evidence quality, reasoning, and conceptual integration during argumentation-driven inquiry. *Instructional Science, 44*(5), 441–476. https://doi.org/10.1007/s11251-016-9381-1

Kline, R. B. (2005). *Principles and practice of structural equation modeling*. New York, NY: The Guilford Press.

Lee, W.-C., Chiu, Y.-L., Liang, J.-C., & Tsai, C.-C. (2014). Exploring the structural relationships between high school students' Internet-specific epistemic beliefs and their utilization of online academic help seeking. *Computers in Human Behavior, 36*, 391–400. https://doi.org/10.1016/j.chb.2014.03.069

Lee, Y.-H. (2015). Facilitating critical thinking using the C-QRAC collaboration script: Enhancing science reading literacy in a computer-supported collaborative learning environment. *Computers & Education, 88*, 182–191. https://doi.org/10.1016/j.compedu.2015.05.004

Lee, Y.-H. (2017). Scripting to enhance university students' critical thinking in flipped learning: implications of the delayed effect on science reading literacy. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2017.1372483

Lee, Y.-H., Ko, C.-H., & Chou, C. (2015). Re-visiting Internet addiction among Taiwanese students: A cross-sectional comparison of students' expectations, online gaming, and online social interaction. *Journal of Abnormal Child Psychology, 43*(3), 589–599. https://doi.org/10.1007/s10802-014-9915-4

Lee, Y.-H., & Wu, J.-Y. (2012). The effect of individual differences in the inner and outer states of ICT on engagement in online reading activities and PISA 2009 reading literacy: Exploring the relationship between the old and new reading literacy. *Learning and Individual Differences*, *22*(3), 336–342. https://doi.org/10.1016/j.lindif.2012.01.007

Lee, Y.-H., & Wu, J.-Y. (2013). The indirect effects of online social entertainment and information seeking activities on reading literacy. *Computers & Education, 67*, 168–177. https://doi.org/10.1016/j.compedu.2013.03.001

Maggioni, L., & Parkinson, M. M. (2008). The role of teacher epistemic cognition, epistemic beliefs, and calibration in instruction. *Educational Psychology Review, 20*(4), 445–461. https://doi.org/10.1007/s10648-008-9081-8

Markauskaite, L. (2007). Exploring the structure of trainee teachers' ICT literacy: The main components of, and relationships between, general cognitive and technical capabilities. *Educational Technology Research and Development, 55*(6), 547–572. https://doi.org/10.1007/s11423-007-9043-8

Marsh, H. W., Lüdtke, O., Trautwein, U., & Morin, A. J. S. (2009). Classical latent profile analysis of academic self-concept dimensions: Synergy of person-and variable-centered approaches to theoretical models of self-concept. *Structural Equation Modeling, 16*(2), 191–225. https://doi.org/10.1080/10705510902751010

Mason, L., Ariasi, N., & Boldrin, A. (2011). Epistemic beliefs in action: Spontaneous reflections about knowledge and knowing during online information searching and their influence on learning. *Learning and Instruction, 21*(1), 137–151. https://doi.org/10.1016/j.learninstruc.2010.01.001

Muthén, L. K., & Muthén, B. O. (2012). *Mplus user's guide* (7th ed.). Los Angeles, CA: Authors.

Pajares, M. F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research, 62*(3), 307–332. https://doi.org/10.3102/00346543062003307

Perry, W. G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. Hoboken, NJ: Wiley.

Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology, 82*(3), 498. Retrieved from http://psycnet.apa.org/record/1991-05940-001

Schommer, M., Crouse, A., & Rhodes, N. (1992). Epistemological beliefs and mathematical text comprehension: Believing it is simple does not make it so. *Journal of Educational Psychology, 84*(4), 435–443. Retrieved from http://psycnet.apa.org/record/1993-15452-001

Strømsø, H. I., & Bråten, I. (2010). The role of personal epistemology in the self-regulation of internet-based learning. *Metacognition and Learning, 5*(1), 91–111. https://doi.org/10.1007/s11409-009-9043-7

Thompson, B. (2004). *Exploratory and confirmatory factor analysis: Understanding concepts and applications*. Washington, DC: American Psychological Association.

Tondeur, J., Aesaert, K., Pynoo, B., Braak, J., Fraeyman, N., & Erstad, O. (2017). Developing a validated instrument to measure preservice teachers' ICT competencies: Meeting the demands of the 21st century. *British Journal of Educational Technology, 48*(2), 462–472. https://doi.org/10.1111/bjet.12380

Tsai, C.-C. (2004). Beyond cognitive and metacognitive tools: the use of the Internet as an "epistemological" tool for instruction. *British Journal of Educational Technology, 35*(5), 525–536. https://doi.org/10.1111/j.0007-1013.2004.00411.x

Wong, K., Chan, K., & Lai, P. (2009). Revisiting the relationships of epistemological beliefs and conceptions about teaching and learning of pre-service teachers in Hong Kong. *Asia-Pacific Education Researcher (De La Salle University Manila), 18*(1), 1–19. Retrieved from https://ejournals.ph/article.php?id=3903

Wu, J. Y. (2014). Gender differences in online reading engagement, metacognitive strategies, navigation skills and reading literacy. *Journal of Computer Assisted Learning, 30*(3), 252–271. https://doi.org/10.1111/jcal.12054

Wu, J. Y. (2015). University students' motivated attention and use of regulation strategies on social media. *Computers & Education, 89*, 75–90. https://doi.org/10.1016/j.compedu.2015.08.016

Wu, J. Y. (2017). The indirect relationship of media multitasking self-efficacy on learning performance within the personal learning environment: Implications from the mechanism of perceived attention problems and self-regulation strategies. *Computers & Education, 106*, 56–72. https://doi.org/10.1016/j.compedu.2016.10.010

Wu, J. Y., & Peng, Y.-C. (2017). The modality effect on reading literacy: perspectives from students' online reading habits, cognitive and metacognitive strategies, and web navigation skills across regions. *Interactive Learning Environments, 25*(7), 859–876. https://doi.org/10.1080/10494820.2016.1224251

Corresponding author: Yuan-Hsuan Lee, yuanhsuanlee@mx.nthu.edu.tw