

Teachers' epistemic beliefs and reported practices in two cultural contexts

Heidi Lammassaari, Lauri Hietajärvi, Kirsti Lonka, Sufen Chen & Chin-Chung Tsai

To cite this article: Heidi Lammassaari, Lauri Hietajärvi, Kirsti Lonka, Sufen Chen & Chin-Chung Tsai (2024) Teachers' epistemic beliefs and reported practices in two cultural contexts, *Educational Studies*, 50:5, 781-805, DOI: [10.1080/03055698.2021.2000369](https://doi.org/10.1080/03055698.2021.2000369)

To link to this article: <https://doi.org/10.1080/03055698.2021.2000369>



© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 11 Nov 2021.



[Submit your article to this journal](#)



Article views: 5901



[View related articles](#)



[View Crossmark data](#)



Citing articles: 10 [View citing articles](#)

Teachers' epistemic beliefs and reported practices in two cultural contexts

Heidi Lammassaari ^a, Lauri Hietajärvi ^a, Kirsti Lonka ^{a,b}, Sufen Chen ^{b,c} and Chin-Chung Tsai ^d

^aFaculty of Educational Sciences, University of Helsinki, Helsinki, Finland; ^bOptentia Research Focus Area, North-West University, Vanderbijlpark, South Africa; ^cGraduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taipei, Taiwan; ^dProgram of Learning Sciences & Institute for Research Excellence in Learning Sciences, Taipei, Taiwan

ABSTRACT

Teachers' epistemic beliefs may have consequences for their pedagogical work. We used previously developed scales to assess epistemic beliefs that teachers hold about learning, knowledge and knowing, and how they report putting such ideas into practice. The scales consisted of self-reported Likert-type statements considering collaborative knowledge building, valuing metacognition, certainty of knowledge, and a surface approach to learning. The participants were 127 subject-matter teachers from Finland and 97 teachers from Taiwan. Based on previous research, we constructed a confirmatory factor analysis (CFA) model for the Finnish sample and replicated this with the Taiwanese sample. We confirmed two factors: 1) reflective-collaborative theory (consisting of collaborative knowledge building and valuing metacognition scales) and 2) knowledge transmission theory (consisting of certainty of knowledge and simple learning scales) in both samples. In conclusion, essential and corresponding aspects of teachers' epistemic beliefs and their reported practices were found. However, the results showed some cross-cultural variance.

It is important to look at teachers' epistemic beliefs because they may have consequences for teachers' pedagogical work. These beliefs are a part of epistemic cognition which in this context consists of epistemic beliefs (beliefs about knowledge and learning) and how teachers report to put them into practice (e.g.). The aim of this study is to identify and assess teachers' core epistemic beliefs and how such beliefs are associated with their practical ideas on pedagogy in two diverse cultural contexts. We used previously developed scales to assess beliefs that teachers hold about learning, knowledge and knowing, and how they report putting such ideas into practice. The scales consisted of self-reported Likert-type statements considering collaborative knowledge building, valuing metacognition, emphasising certainty of knowledge, and a surface approach to learning. The participants were 127 subject-matter teachers from Finland and 97 teachers from Taiwan. Based on previous research, we constructed a confirmatory factor analysis

ARTICLE HISTORY

Received 14 April 2021

Accepted 26 October 2021

KEYWORDS

Epistemic beliefs; teachers; teaching practices; cultural contexts; confirmatory factor analysis

CONTACT Heidi Lammassaari  heidi.lammassaari@helsinki.fi  Faculty of Educational Sciences, University of Helsinki, Helsinki 00014, Finland

© 2021 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

(CFA) model for the Finnish sample and replicated this with the Taiwanese sample. We confirmed two factors: 1) reflective-collaborative theory (consisting of collaborative knowledge building and valuing metacognition scales) and 2) knowledge transmission theory (consisting of certainty of knowledge and simple learning scales) in both samples. In conclusion, essential and corresponding aspects of teachers' epistemic beliefs and their reported practices were found. However, the results showed some cross-cultural variance.

Educational reforms are challenging teachers worldwide. Introducing new pedagogical innovations and practices in education requires openness and flexibility from the teachers. Teachers' willingness to question and renew their current understanding and knowledge about learning, teaching and related practices are central issues in school reforms, because it is difficult to implement reforms without engaging the teachers in the change process (Lonka 2018). However, to be able to change how people talk about learning and schooling, there is a need to find a way of bringing practical and epistemic matters into line with each other, and further, to examine both teachers' ideas of knowledge and the meta-level processes involved in the acquisition and application of knowledge, that is, epistemic cognition (Buehl and Fives 2016).

In general, epistemic cognition refers to the beliefs that we hold about knowledge and knowing, and how these play a role in how we search for meaning and how we define and justify knowledge, as well as how we see the processes related to knowing, teaching and learning (Buehl and Fives 2016; Hofer 2016; Bråten, Muis, and Reznitskaya 2017). These beliefs may manifest themselves as more or less coherent epistemic theories (see e.g. Lonka, Ketonen, and Vermunt 2021; Muis et al. 2016). There is accumulating evidence about teachers' epistemic cognition mediating their practices and preferences (e.g. Buehl and Fives 2009; Feucht 2011).

The research literature on epistemic cognition is broad and extensive, and psychological research on it encompasses a range of theoretical and methodological approaches (Lunn Brownlee et al., 2017). Further, the terminology regarding epistemic cognition has varied over years of research. Current literature suggests that epistemic cognition is an "umbrella term for epistemic beliefs, epistemic development, epistemological beliefs and personal epistemologies" (Lunn Brownlee et al., 2017 p. 243; see also Greene, Azevedo, and Torney-Purta 2008). In this study, we focus on the dimensional perspectives of epistemic cognition (Hofer & Pintrich, 1997; Schommer 1990) and especially epistemic beliefs, giving less emphasis to the alternative perspectives such as developmental models (e.g. Perry 1970; Kuhn 2000), or "philosophically informed" models (e.g. Chinn, Buckland, and Samarapungavan 2011; Greene, Azevedo, and Torney-Purta 2008). Multidimensionality in epistemic beliefs refers to ideas suggesting that epistemic beliefs constitute belief systems that may or may not develop in synchrony (Schommer 1990, 1993) or how separate beliefs constitute intuitive epistemic theories (see e.g. Hofer & Pintrich, 1997). Empirically, multidimensional models have not previously been able to capture very complex or "sophisticated" epistemic beliefs (Richardson 2013). However, Lonka, Ketonen, and Vermunt (2021) recently confirmed five dimensions of epistemic

beliefs that constituted more or less simple and complex epistemic theories that were closely related to conceptions of learning: fact-oriented or pragmatist and collaborative-reflective epistemic theories, the latter being typical of student teachers.

However, epistemic beliefs, described earlier as “personal epistemologies” (Hofer & Pintrich 1997, Hofer and Pintrich 2002) or “conceptions of learning and knowledge” (Lonka, Joram, and Bryson 1996) are considered to be an important part of epistemic cognition, as well as how those beliefs occur in practice (Markauskaite and Goodyear 2014). Currently, epistemic beliefs are also considered to include conceptions of learning (Lonka, Ketonen, and Vermunt 2021). This is because when people are asked about how they come to know something, a window is implicitly opened to studying their conceptions of learning as well as how one should approach the practices related to learning, and moreover, teaching (Lonka, Joram, and Bryson 1996).

Overall, research in educational psychology has documented that epistemic beliefs are related to various facets of learning, such as how conceptual change takes place (Mason, Gava, and Boldrin 2008; Qian and Alvermann 1995; Sinatra et al. 2003) and how students provide grounds for their argumentation (Mason and Scirica 2006; Weinstock, Neuman, and Tabak 2004). They are also an important part of teacher beliefs because teacher beliefs in general, and teachers’ ideas of knowledge and knowing in particular, are expected to have consequences on teachers’ practice (Ajzen and Madden 1986; Kim et al. 2013; Pajares 1992). Therefore, in the fields of education and instruction, it has been argued that epistemic beliefs are related to how people learn, how they apply their knowledge, and how they put their knowledge into practice (Lonka, Joram, and Bryson 1996; Schommer 1990, 1993; Vedenpää and Lonka 2014). Consequently, many educators agree that teachers’ epistemic beliefs may have consequences for their instructional practices (Deng et al. 2014; Nespor 1987; Pajares 1992; Stoddard 2010).

We suggest that to deepen our understanding of teachers’ epistemic cognition, it is important to measure teachers’ core epistemic beliefs (beliefs about knowledge, knowing and learning), which may play a role in how they see current educational reforms and how they report to put ideas in practice (Deng et al. 2014). For instance, in Finland the 2016 national curriculum reflects a complex epistemic stance, strongly promoting students’ thinking skills, self-regulation, collaboration, and learning how to learn as well as other important 21st century skills (Finnish National Agency of Education 2016; Lonka 2018). There is a risk that a mismatch between teachers’ epistemic beliefs and their prevalent pedagogical practices will make it difficult to implement such reforms.

We studied teachers’ epistemic beliefs in two countries: Finland and Taiwan. These two countries performed similarly in TIMSS 2015 and PISA 2018, but they are quite different in terms of culture. According to Hofstede’s cultural values (Hofstede 2001), as compared to Finland, Taiwan was high in uncertainty avoidance (i.e. prefer certainty), power distance, and long-term orientation (i.e. encouraging efforts in modern education as a way to prepare for the future). According to Hofstede (2001), Finnish culture was more individualistic, whereas Taiwanese culture was more collectivist.

Teachers' epistemic beliefs

Epistemic beliefs and teachers' teaching practice

Epistemic beliefs are conceived as a set of independent beliefs about the nature and acquisition of knowledge (see e.g. Schommer 1990; Hofer 2000, 2004). The present article looks at some systematic dimensions of teachers' epistemic beliefs that constitute their core epistemic theories. For Hofer (2000, 2004) and Mason, Boldrin, and Ariasi (2010) identified four dimensions of epistemic beliefs. Regarding the nature of knowledge (what knowledge is), there are beliefs of knowledge about certainty and simplicity; and regarding the process of knowing (how one comes to know, including learning), there are beliefs about source of knowledge and justification for knowing. For example, there is an epistemic theory that would see knowledge as certain and simple, the process of knowing as mere acquisition of facts, and the justification of knowledge as referring to certain facts received from the teacher. A contrasting epistemic theory would see knowledge as complex and relative or integrated, the process of knowing something as creative and collaborative, and the source of knowledge to be scholarly references and methods that can be critically reflected on by applying metacognitive processes. The former epistemic theory can be referred to as knowledge transmission, whereas the latter could be seen as socio-constructivist and reflective in nature (e.g. Deng et al. 2014; Lonka 1997), because it involves metacognitive activity and critical thinking, as well as readiness to judge the origin of reliable knowledge. From the perspective of teachers' epistemic beliefs, the former could end up in transmissive practices of teaching, whereas the latter might lead to favouring collaborative and reflective activities during instruction.

Teacher education plays a central role in developing teachers' ideas and beliefs about learning and teaching. For instance, Miguel-Revilla, Carril-Merino, and Sánchez-Agustí (2021) found that consistency in epistemic beliefs seemed to increase from second-year to third-year primary education student history teachers, and further to secondary education prospective history teachers, also indicating epistemic that beliefs evolve towards a more nuanced type. What is more, reflections on intended practice start to appear from early on. As Sosu and Gray (2012) found, student teachers' epistemic beliefs had already started to predict their self-reported instructional preferences. Epistemic beliefs that are shared in academia may especially be significant in shaping the epistemic beliefs of the future teachers. In a study by Van Rossum and Hamer (2010), almost 60% of higher education teachers expressed ideas of teaching, learning and knowledge that reflected the idea of transmission of knowledge from teachers to students. Disciplinary differences in epistemic thinking between faculties may also be reflected in teachers' thinking about the nature of knowledge (Lonka, Ketonen, and Vermunt 2021). For instance, in the context of the natural sciences, epistemic beliefs tend to be more dualistic and absolutist in nature (Jehng, Johnson, and Anderson 1993; Nieminen, Lindblom-Ylänne, and Lonka 2004), whereas in the social sciences, (such as history), a construction-based approach and multiplicity in sources of knowledge are emphasised (Mathis and Parkes 2020). Both history teachers and science teachers may bring elements of such domain-specific epistemic beliefs into their

epistemic theories of teaching. This happens even though modern science education often applies methods of working that are constructivist in nature, such as inquiry-based learning, collaborative problem solving and knowledge creation (Deng et al. 2014; Juuti et al. 2010).

Epistemic beliefs have been shown to be related to various learning and teaching processes, e.g. reasoning and judgment (Bråten and Strømss 2006; Hofer 2001, 2004). Although it is important to acknowledge that teaching practices are an outcome of the complex interplay between the various forms of beliefs and contexts (Buehl and Fives 2016; Deng et al. 2014), it seems to be clear that epistemic beliefs and theories are related to teachers' instructional practice which they apply in the classroom, and therefore, epistemic theories may serve as foundations for teaching (Nespor 1987; Pajares 1992; Tsai 2002; Vedenpää and Lonka 2014) and even assessment works (Barnes et al. 2020). According to Deng et al. (2014), teachers holding a relativistic epistemic belief may be more inclined to constructivist pedagogy and tend to support students' personal construction of knowledge, whereas teachers who view knowledge and knowing more as certain, unchanging and something that can be achieved through knowledge transmission are more likely to practice traditional teacher-centred teaching. In the PISA survey, two approaches to teaching were measured that resembled these orientations: inquiry-based versus teacher-led (Bonneville-Roussy et al. 2019).

Approaches to learning and teaching

In higher education, the aim of the surface approach to learning is at memorisation and passing the examinations, whereas the deep approach aims at understanding (e.g. Marton and Säljö 1976). Research on teacher education shows that there is variation in student teachers' approaches to learning (Oosterheert and Vermunt 2001; Vedenpää and Lonka 2014). Some students appear to study for meaning, when others mainly focus on reproduction of knowledge and practical suggestions. Correspondingly, if teachers' epistemic theories of learning emphasise knowledge transmission, it may lead them to applying some ideas in their classroom practices mechanistically, whereas a more meaning-oriented approach often helps them to consider the underlying reasons why something worked or not in the classroom (Vermunt and Endedijk 2011).

When looking at university teachers' variation in their own descriptions of teaching, Postareff and Lindblom-Ylänne (2008) found two major approaches: learning-focused and content-focused. In the former, the purpose of teaching, according to the teachers, was to improve students' learning and the teacher's own teaching continually. In the latter, the purpose and emphasis of teaching was placed on transmission of knowledge and repeating traditional and familiar teaching practices.

According to Trigwell, Prosser, and Waterhouse (1999), students' approaches to learning mirrored their teachers' approaches to teaching: in the classes in which university teachers described their approach to teaching as transmissive, students were more likely to report having a surface approach to the learning of the subject in question. Consistently, in the classes in which students reported significantly deeper approaches to learning, their teachers reported approaches to teaching that were more student-centred and in which the emphasis was on changing the students' conceptions (Trigwell, Prosser, and Waterhouse 1999). The findings by Trigwell, Prosser, and

Waterhouse (1999) are highlighted further when taking a closer look at undergraduate students' epistemic beliefs: Wan, Lee, and Hu (2021) found that students' emphasis on certainty of knowledge was negatively related to students' intellectual risk-taking and creativity whereas emphasis on complexity of knowledge had an opposite effect. Therefore, the pedagogical approaches used during teacher education should be considered as first, they could play a central role how teacher students socialise in adopting traditional or progressive pedagogy and have consequences on teachers' practices both before and after graduation, and second, they may also direct their students' thinking. Identifying these approaches has its meaning because in science education, research on epistemic beliefs has been linked to the use of constructivist practice and inquiry-based learning in the classroom, often related to various national reforms (Luft and Roehrig 2007; Tsai 2002).

How conceptions of knowledge, learning and teaching intertwine

When the researchers study conceptions of knowledge and learning empirically, they appear to be closely linked and often interrelated (Hofer 2004; Lonka, Joram, and Bryson 1996; Lonka, Ketonen, and Vermunt 2021; Lonka and Lindblom-Ylänne 1996; Richardson 2013; Schommer 1990, 1993). For instance, a surface approach to learning tended to correlate with dualistic ideas of knowledge (e.g. Lonka and Lindblom-Ylänne 1996; Nieminen, Lindblom-Ylänne, and Lonka 2004), whereas a deep approach to learning was part of a collaborative-constructivist epistemic view (Lonka et al. 2008).

Consequently, a conception of learning can be defined as a coherent system of knowledge and beliefs about learning and related phenomena (Vermunt and Vermetten 2004). More precisely, such a pattern of knowledge and beliefs can cover knowledge and beliefs about oneself as a learner, learning objectives, learning activities and strategies, learning tasks, learning and studying in general, and about the task division between students, teachers, and fellow students in learning processes (Vermunt and Vermetten 2004). The emphasis among these can also vary over time: Lonka, Joram, and Bryson (1996) defined constructivity and active epistemology as the two core conceptions that link epistemologies and conceptions of learning. At the lower end of the continuum of constructivity, learning is seen as the accumulation of new information in memory, and at the higher end as a constructive process that involves the qualitative restructuring and modification of mental models. Learners at the higher end of the continuum of active epistemology are seen as active and intentional actors who are responsible for their own learning, whereas at the lower end, the learners are seen as objects who passively receive what is taught by the teacher. However, even these approaches are not necessarily mutually exclusive. According to Tsai's research (Tsai 2002), teachers may simultaneously hold belief systems that combine traditional, process-oriented and constructivist beliefs about teaching, learning and the nature of science.

Cultural variation in epistemic beliefs

Many aspects of epistemic beliefs appear to be universal, but there are also contextual and cultural variations. The predominant Chinese philosophies (e.g. Confucianism and Taoism) have roots in an epistemology that differs from Western traditions (de Bary 1988;

Yang and Sternberg (1997a). Watkins and Biggs (2001) pointed out that in terms of conceptions of learning, Western and Chinese contexts are culturally different. In the Western perspective, Chinese learners appear to apply a surface approach, even though their responses to learning strategy questionnaires point out deep approaches. According to Watkins and Biggs (2001), the explanation for this “Chinese paradox” lies in the cultural differences: the relation between memorising and understanding appears to be somehow different in the Chinese and Western contexts. In the Chinese context, both strategies are considered necessary for high-quality learning (see e.g. Dahlin and Watkins 2000; Lin, Liang, and Tsai 2015). Whereas Chinese learners typically appear to Western teachers to be rote learners, Western learners are assumed to be more committed to deep and reflective learning to understand the learning content. Yang and Sternberg (1997a) pointed out that such stereotypes appear not to be fully accurate. The potential explanation might lie in how the relationship between memorising and understanding is perceived: in the Chinese context, rote memorising and understanding are not seen as opposite as in the Western context, but rather as complementary processes that together lead to high quality learning outcomes and integrated thought: memorising *with* understanding (Lee 1996; Rao and Chan 2010; Watkins and Biggs 2001). However, according to some researchers (see Marton, Dall’Alba, and Tse 1996), the Chinese context may still posit “an order” for the learning process that emphasises memorising first, then understanding.

Measuring teachers’ epistemic beliefs and related practices

Some researchers conclude that beliefs must change before practices can change, while some others consider that beliefs and practices are interactive (Luft and Roehrig 2007). We wanted to understand how teachers’ epistemic beliefs would inform their practices, and whether there were differences in these cultural contexts in the way described above. Constructivist-collaborative beliefs may be desirable when innovative curricula are introduced. However, epistemic change from traditional views to new ways of thinking may still be difficult. The problem may not lie in the individuals, but in collective knowledge practices at the school level, institutional routines and widely shared cultural beliefs (Hakkarainen 2009). Therefore, it often happens that shared traditional views of teaching may appear in teachers’ practice regardless of their epistemic beliefs (see Tsai 2002). Thus, the correspondence between teachers’ beliefs and practices is a complicated matter (see Tsai 2007) regardless of the cultural background.

While earlier studies revealed a consistency between teachers’ beliefs about the nature of science and instructional practice (Brickhouse 1989), later on Mellado (1998) and Lederman (1999) showed that there was no general connection between science teachers’ pedagogical views on teaching science and their classroom behaviour. Despite the controversial previous findings concerning the relationship between teachers’ beliefs and practices, understanding teachers’ epistemic beliefs requires inspection at both the idea and instructional levels in different cultural contexts.

In our previous studies (e.g. Vedenpää and Lonka 2014) some epistemic beliefs appeared more distinctive than the others: valuing metacognition and collaboration were the most reliable measures of complex epistemic beliefs among Finnish teachers, whereas beliefs of certain knowledge and surface learning appeared to measure simpler epistemic beliefs reliably. Since asking about epistemic matters only at the belief level

may shed light only on one side of the belief system, we used a two-step method adopted from Nieminen (2011) and Vedenpää and Lonka (2014): first, asking about epistemic beliefs (A questions), and second, how teachers would put such beliefs in action (B questions nested in the A questions). In previous studies, constructivist beliefs emphasising reflection, collaboration and metacognition always received higher scores at the belief level than those measuring how to put these ideas into practice. In contrast, simple epistemic beliefs and transmissive ideas of learning and teaching always scored lower at the belief level and higher in practice.

Aims of the present study

The aims of this study were to identify and assess teachers' core epistemic beliefs and how such beliefs are associated with their practical ideas on pedagogy. For this purpose, we used a short instrument, based on previously validated instruments (Lonka et al. 2008; Lonka, Ketonen, and Vermunt 2021; Vedenpää and Lonka 2014) that had been used for assessing beliefs that teachers hold about knowledge, knowing, and learning as well as how they report to put such ideas into practice. There was a need for an instrument that measured complex epistemic beliefs that have mainly been assessed using qualitative methods (Hofer 2016; Richardson 2013). Moreover, research on the relationship between teachers' epistemic beliefs and pedagogical practices have also tended to use a qualitative approach (Maggioni and Parkinson 2008), and little is known about whether such conceptions could be reliably measured in different contexts (Richardson 2013).

To explore these matters in greater detail, the following research questions were formulated:

Research question 1: *Can we confirm the same factor structure in two diverse cultures that reflect teachers' knowledge transmission theory and collaborative-reflective theory?*

Based on the previous research presented above, we expected that two latent variables would emerge that could combine the simplistic epistemic beliefs (emphasising certain knowledge and surface learning) reflecting an understanding of teaching as a knowledge transmission process, whereas the more complex beliefs (valuing metacognition and collaborative knowledge building) would reflect a theory which highlights teaching as promoting a collaborative knowledge creation (socio-constructivist) process.

Research question 2: *Are beliefs concerning knowledge transmission more closely related to the corresponding practices than collaborative-reflective beliefs? Is there some cultural variation?*

Based on previous research presented above, it was expected that teachers represented in this study would find it more difficult to put into practice such epistemic beliefs that call for reflection or collaboration. Therefore, stronger alignment was expected between beliefs and reported practices concerning the knowledge transmission theory than the reflective-collaborative theory.

We expected divergence between knowledge transmission theory and reflective-collaborative theory in the Western learner context (see. Watkins and Biggs 2001). In the Taiwanese sample, we did not expect negative correlations between the two theories due to the "Chinese paradox" which suggests that in terms of learning both memorising and understanding are necessary for high-quality outcome (Dahlin and Watkins 2000; Lin, Liang, and Tsai 2015; Watkins and Biggs 2001). In terms of means, we expected the Finnish

teachers to score higher on reflective-collaborative beliefs than on transmissive beliefs. Taiwanese teachers were expected to score about the same on all variables, seeing memorising and comprehension as complementary, not necessarily as being opposed to each other.

Material and Methods

Context of the study

In this study, we shed light on teachers' epistemic beliefs in Finland and Taiwan. They are both small countries which have performed well in international comparisons, e.g. TIMSS and PISA, and they are also ambitious in terms of intentions about technology-use in education (Hsieh and Tsai 2017; Lonka 2018). Economic-wise, GDP per capita in Finland and Taiwan is relatively high and also close to each other as they are both listed in top 20–30 in international comparisons (see e.g. IMF – International Monetary Fund 2021). However, both countries have their own special qualities in terms of culture and education.

The Finnish education system is based on a free 9-year comprehensive school system (see Lonka 2018). Finnish schools rely strongly on highly educated teachers as all teachers are required to have a combined bachelor's and master's degree. Although all Finnish schools follow the National Core Curricula all in primary, secondary and upper secondary levels, teachers' autonomy is still very high as there are no school inspections and few standardised tests (Lonka 2018). The teacher education programme, which aims to educate teachers who are reflective, research-oriented and who base their pedagogy on the latest evidence in the field, has traditionally been very popular. Approximately 10% of the applicants could ultimately enrol in the program (see Mikkola 2016). This has enabled universities to choose the best applicants aligned with the current goals of the teacher education program.

As in Finland, the education system in Taiwan relies on highly educated teachers. All the teachers have a bachelor's degree and most of the teachers have a master's degree. Schools in Taiwan follow the National Curriculum Guidelines of 12-year basic education from primary schools to high schools. Like in Finland, there is a certain degree of flexibility or autonomy for teachers and course activities. However, there are still some important national standard examinations for junior high school and high school students, most teachers, especially those at the high school level, follow more traditional and mainly one-way lecturing in some core subjects, such as mathematics, language and science (Hsieh and Tsai 2018). Also, under the tradition of Confucianism, teachers are well respected by society in Taiwan. The teacher is typically a symbol of authority in the classroom (Lin and Tsai 2017). Many universities offer teacher education programmes for undergraduate and graduate students. The quality of teachers is ensured by national certification examinations for teachers.

Participants

The participants were subject-matter teachers from Finland and Taiwan ($n = 224$). Participants in the Finnish Sample ($n = 127$) were comprehensive school and high school subject-matter teachers from Finnish teacher data (Academy of Finland, grants 265,528, 308,352). The participants represented a range of subject-matter areas and career stages.

Participants in the Taiwanese Sample ($n = 97$) were middle school (Grades 7–9) teachers from the metropolitan Taipei area. They were subject-matter teachers in the domains of English, mathematics, and science. They were recruited from public or private sector schools of varied sizes, located in districts with a range of household incomes.

Procedure

The data for the Finnish sample were collected by an electronic teacher questionnaire in 2016 as a part of Mind the Gap study (Academy of Finland, 265,528). This convenience sample represented the schools which participated in this research project (2013–2016). The aim of the project overall was to examine prevailing gaps between the personal and social practices of students and those of their schools and educational institutions.

The Taiwanese sample was collected from seven schools located in the Taipei metropolitan area in 2017. The data collection was not a part of a particular research project, but was aimed at studying teachers' ideas about expertise, collaborative practices as well as work engagement. The scales included were mostly the same as those in the Finnish teacher questionnaire. The questionnaire was in paper form.

In acquiring both samples, the participating schools were contacted by the principal investigators of the project, and the teachers at these schools were requested to answer the questionnaire. Data collection in both countries was carried out following the ethical guidelines for research, i.e. ensuring participants' anonymity, basing the participation on volition as well as storing and handling the data according to the ethical requirements of the University of Helsinki (Academy of Finland, project 265,528).

Instruments

The questionnaire used in this study consisted of 12 two-part Likert-type self-reported items based on the MED NORD questionnaire (Lonka et al. 2008; Vedenpää and Lonka 2014). The MED NORD questionnaire was originally developed in the context of medical education in order to assess issues concerning medical students' conceptions and orientations to knowledge and learning (in MED NORD still named *epistemologies*) and wellbeing. In total, the original full version of MED NORD consisted of 93 items.

Selection of the 24 items used for the present study was based on pilot analyses that aimed at measuring teachers' epistemic beliefs (Lammasaari et al. 2016; Lonka et al. 2016). A set of six items was designated to assess epistemic beliefs indicated by collaborative knowledge building (three items) and valuing metacognition (three items). Another set of six items was designed to tap into an understanding of knowledge more as factual transmission, indicated by an emphasis on certain

Table 1. Examples of the questionnaire items.

Dimension (variable number)	General belief (item A)	Pedagogical practice (item B)
Emphasising certain facts in teaching (Q11)	The main aim of teaching is to offer certain facts about the subject of study	This is essential in my teaching
Surface approach to learning (Q5)	It is important that pupils repeat central facts until they know them by heart	I encourage my students to memorise central facts in my classroom
Collaborative knowledge building (Q2)	In my opinion, it is important that students generate new ideas together	I reserve a lot of time for this in my work as a teacher
Valuing metacognitive thinking (Q7)	By learning to know their own ways of thinking, students achieve much better learning results	I use many different methods to enhance this particular skill

knowledge (three items) and promoting a surface approach to learning (three items). All questions were asked twice: The first statements (A questions) were designed to reflect the epistemic beliefs whereas the second statements (B questions, nested in the corresponding A questions) were designed to reflect the associated pedagogical practice (see Table 1). The statements were rated on six-point Likert-type scales. Scale 1 to 6 (1 = totally disagree, 2 = disagree, 3 = partially disagree, 4 = partially agree, 5 = agree, 6 = totally agree). The scales were previously validated (McLaughlan and Lodge 2019; Lonka et al. 2008; Lonka, Ketonen, and Vermunt 2021). The A and B questions were reported by Vedenpää and Lonka (2014).

Data analysis

To answer the first research question concerning the factor structure in both cultural contexts, we constructed a Confirmatory Factor Analysis (CFA) for the Finnish sample and replicated this with the Taiwanese sample. We included both A and B items in the same model but specified an own factor influencing A and B items separately. We allowed for residual covariance between the A and B options of the same item. The model was estimated with Maximum Likelihood with standard errors robust for deviations from a normal distribution (MLR) and the missing values were considered using Full Information Maximum Likelihood (FIML). The goodness-of-fit for the CFA solution was examined using multiple fit indices such as the Chi-Square test supplemented with Root Mean Square Error of Approximation (RMSEA) with cut-offs of <.08 and <.05, Comparative Fit Index (CFI) with cut-offs of >.9 and >.95, and SRMR with a cut-off of <.08, indicating, respectively, an acceptable and good model fit to the data (Hu & Bentler, 1999; Schreiber et al. 2006).

To answer the second research question concerning correspondences and divergences between epistemic beliefs and practices in these two cultural contexts, latent variable correlations among reflective-collaborative and knowledge transmission theories were examined in both countries. In addition, we examined the raw means, standard deviations and Cronbach’s Alphas for each scale in both countries. The mean difference between beliefs and reported practices were explored by carrying out paired samples t-tests.

Results

To answer the first research question, the expected factor structure was confirmed separately with the Finnish sample and the Taiwanese sample. The model fit for the Finnish sample was acceptable ($\chi^2(234) = 360.75$, $p < .001$, RMSEA = .067, CFI = .942, SRMR = .071). The factor model is presented in Table 2. It shows that items 3, 7 and 15 representing metacognitive thinking and items 1, 2 and 10, representing collaborative knowledge building, loaded in the same factor, *Reflective-collaborative theory (rc)*, whereas items 4, 8, 11, representing emphasis on certain knowledge, and items 5, 16, 23, representing surface approach, loaded in the other factor, *Knowledge transmission theory (kt)*.

Then the structure of the CFA was replicated using the data from another cultural context (Taiwan). It appeared that the same factor structure could be obtained. The model fit for the Taiwanese sample was acceptable ($\chi^2(234) = 374.75$, $p < .001$, RMSEA = .078, CFI = .902, SRMR = .094). The factor model is presented in Table 3. It shows that items 3, 7 and 15 representing metacognitive thinking, and 1, 2 and 10, representing collaborative knowledge building loaded in the same factor, *Reflective-collaborative theory (rc)*, whereas items 4, 8, 11, representing emphasis on certain knowledge, and items 5, 16, 23, representing surface approach for learning loaded, in the other factor, *Knowledge transmission theory (kt)*.

To sum up, the expected factor structure fit the data acceptably in both samples. However, there was a difference: unlike in the Finnish sample, the reflective-collaborative and knowledge transmission theories did not correlate negatively with each other in the Taiwanese sample.

To answer the second research question, correlations were examined separately for the two countries. Tables 4 and 5 show the correlations for the Finnish and Taiwanese samples, respectively. Correlation matrices in both tables show that there were strong correlations between teachers' epistemic beliefs and the corresponding reported practices. In both samples, the correlation between beliefs and reported practices was stronger in the case of knowledge transmission theory than in reflective-collaborative theory.

To take a closer look at the Finnish sample, Table 4 shows that there was a strong positive correlation between knowledge transmissive beliefs and the corresponding practices (.97). As well, there was a positive correlation between reflective-collaborative beliefs and the corresponding practices (.74). Nevertheless, a significant negative correlation was found between knowledge transmission theory (incl. beliefs and reported practices) and reflective-collaborative theory (from $-.39$ to $-.23$).

In the Finnish sample, a paired samples t-test showed that the mean of reflective-collaborative beliefs (5.1) was considerably higher than the mean of the corresponding practices (4.4) ($t(202) = 18.462$, $p < .001$, 2-tailed). In the case of knowledge transmission theory, there were no significant difference between means of beliefs and practices. Cronbach's Alphas in the Finnish sample varied from .79 (knowledge transmission practices) to .84 (reflective-collaborative beliefs).

Table 5 shows the correlations for the Taiwanese sample. As in the Finnish sample, reflective-collaborative beliefs and corresponding reported practices correlated positively with each other, and so did knowledge transmission beliefs and practices. The correlation was the strongest between knowledge transmissive beliefs and

Table 2. Confirmatory factor analysis of the two-factor model in the finnish sample.

Item	Reflective-collaborative theory A	Reflective-collaborative practice B	Knowledge transmission theory A	Knowledge transmission practice B	λ	r^2
MET 3A	0.64	0	0	0	0	0.41
MET 7A	0.65	0	0	0	0	0.42
MET 15A	0.68	0	0	0	0	0.46
COL 1A	0.71	0	0	0	0	0.50
COL 2A	0.79	0	0	0	0	0.62
COL 10A	0.71	0	0	0	0	0.50
MET 3B	0	0.74	0	0	0	0.55
MET 7B	0	0.66	0	0	0	0.43
MET 15B	0	0.58	0	0	0	0.34
COL 1B	0	0.71	0	0	0	0.51
COL 2B	0	0.82	0	0	0	0.67
COL 10B	0	0.58	0	0	0	0.34
CER 4A	0	0	0.56	0	0	0.31
CER 8A	0	0	0.71	0	0	0.51
CER 11A	0	0	0.79	0	0	0.62
SUR 5A	0	0	0.67	0	0	0.44
SUR 16A	0	0	0.56	0	0	0.31
SUR 23A	0	0	0.42	0	0	0.18
CER 4B	0	0	0	0.57	0.57	0.32
CER 8B	0	0	0	0.77	0.77	0.59
CER 11B	0	0	0	0.82	0.82	0.67
SUR 5B	0	0	0	0.65	0.65	0.43
SUR 16B	0	0	0	0.57	0.57	0.32
SUR 23B	0	0	0	0.42	0.42	0.18

Note: In the “Item” column, the abbreviation MET refers to an item measuring valuing metacognition and COL to collaborative knowledge building whereas abbreviation CER refers to an item measuring the emphasis on certain knowledge and SUR to surface approach. Numbers refer to the item number. Letter A refers to an idea-level item and letter B refers to the application-level item.

Table 3. Confirmatory factor analysis of the two-factor model in the Taiwanese sample.

Item	Reflective-collaborative theory A	Reflective-collaborative practice B	Knowledge transmission theory A	Knowledge transmission practice B	λ	r^2
MET 3A	0.70	0	0	0	0	0.49
MET 7A	0.68	0	0	0	0	0.46
MET 15A	0.44	0	0	0	0	0.20
COL 1A	0.54	0	0	0	0	0.29
COL 2A	0.72	0	0	0	0	0.51
COL 10A	0.72	0	0	0	0	0.52
MET 3B	0	0.67	0	0	0	0.45
MET 7B	0	0.75	0	0	0	0.57
MET 15B	0	0.48	0	0	0	0.23
COL 1B	0	0.47	0	0	0	0.22
COL 2B	0	0.59	0	0	0	0.35
COL 10B	0	0.75	0	0	0	0.56
CER 4A	0	0	0.65	0	0	0.43
CER 8A	0	0	0.85	0	0	0.72
CER 11A	0	0	0.44	0.40	0	0.19
SUR 5A	0	0	0.63	0	0	0.39
SUR 16A	0	0	0.45	0	0	0.20
SUR 23A	0	0	0.59	0	0	0.35
CER 4B	0	0	0	0.65	0	0.42
CER 8B	0	0	0	0.84	0	0.71
CER 11B	0	0	0	0.40	0	0.16
SUR 5B	0	0	0	0.59	0	0.35
SUR 16B	0	0	0	0.40	0	0.16
SUR 23B	0	0	0	0.56	0	0.32

Note: In the “Item” column, the abbreviation MET refers to an item measuring valuing metacognition and COL to collaborative knowledge building whereas abbreviation CER refers to an item measuring the emphasis on certain knowledge and SUR to surface approach. Numbers refer to the item number. Letter A refers to an idea-level item and letter B refers to the application-level item.

Table 4. Latent factor correlations and descriptive results (Finland).

	Factor 1 A	Factor 1 B	Factor 2 A	Factor 2 B	Raw M (SD)	Alpha
Factor 1 A Reflective-collaborative beliefs					5.1 (.631)	.84
Factor 1 B Reflective-collaborative practices	.74**				4.4 (.706)	.81
Factor 2 A Knowledge transmission beliefs	-.26*	-.39**			3.2 (.913)	.80
Factor 2 B Knowledge transmission practices	-.23*	-.35**	.97**		3.3 (.909)	.79

Note: Numbers 1 and 2 in the table refers to the different factors, 1 representing Reflective-collaborative theory, and 2 representing Knowledge transmission theory. Letter A in the table refer to the idea or belief level and B to the application level.

Table 5. Latent factor correlations and descriptive results (Taiwan).

	Factor 1 A	Factor 1 B	Factor 2 A	Factor 2 B	Raw M (SD)	Alpha
Factor 1 A Reflective-collaborative beliefs					5.0 (.534)	.80
Factor 1 B Reflective-collaborative practices	.66**				4.2 (.636)	.79
Factor 2 A Knowledge transmission beliefs	.08	.28			4.5 (.697)	.78
Factor 2 B Knowledge transmission practices	.05	.29	.97**		4.4 (.684)	.75

Note: Numbers 1 and 2 in the table refers to the different factors, 1 representing Reflective-collaborative theory, and 2 representing Knowledge transmission theory. Letter A in the table refer to the idea or belief level and B to the application level.

corresponding practices. There was also significant correlation between reflective-collaborative beliefs and practices. Unlike in the Finnish sample, there were no significant correlations between reflective-collaborative theory (incl. beliefs and reported practices) and knowledge transmission theory. However, there was a weak positive correlation between knowledge transmission beliefs and practices reflective-collaborative practices.

In the Taiwanese sample, a paired samples t-test showed that the mean of reflective-collaborative beliefs (5.0) was considerably higher than the mean of the corresponding practices (4.2) ($t(95) = 15.56$, $p < .001$, 2-tailed). In the case of knowledge transmission theory, there were no significant difference between means of beliefs and practices. Cronbach's Alphas in the Taiwanese sample varied from .75 (knowledge transmission practices) to .80 (reflective-collaborative beliefs).

Discussion

According to the first research question, we expected a latent factor structure based on teachers' epistemic beliefs reflecting a knowledge transmission theory and a reflective-collaborative theory. Based on the previous research presented in the introduction, we expected the first latent variable to combine the simplistic epistemic beliefs seeing teaching as a knowledge transmission process, whereas the second would combine more constructivist beliefs and emphasising teaching as a process to promote metacognition and collaborative knowledge construction. Our results showed that the expected factor structure fit the data acceptably in both samples, and could be confirmed in two cultural contexts. However, there was a difference between the two cultural contexts. In the Finnish sample, knowledge transmission theory and reflective-collaborative theory appeared to be opposed, whereas in the Taiwanese sample the reflective-collaborative and knowledge transmission theories did not correlate negatively with each other

meaning that in Taiwanese context these two theories appeared to be more orthogonal, not opposed. This finding was in line with previous research conducted on the Chinese learner's context, in which transmissive and constructivist ideas are not contradictory but may exist side by side (see Dahlin and Watkins 2000; Rao and Chan 2010; Tsai 2002). However, the two epistemic theories were necessarily not intertwined, unlike what some researchers have indicated (see e.g. Marton, Dall'Alba, and Tse 1996; Watkins and Biggs 2001).

The aim of the second research question was to find out whether knowledge transmissive beliefs would be more closely related to corresponding reported practices than reflective-collaborative beliefs. We expected that it would be more challenging for the teachers to put into practice socio-constructivist epistemic beliefs that also call for supporting reflection, collaboration and metacognitive thinking. Moreover, we wanted to find out whether there is any variation between Finnish and Taiwanese samples considering correlations among epistemic theories. Our results showed that there were strong correlations between beliefs and corresponding practices in both countries. However, when looking at means, it appeared that in the case of reflective-collaborative theory, there was a considerable difference between teachers' beliefs and how much they reported to put these beliefs into practice. This applied in both cultural contexts. It seems that reflection and collaboration were highly valued by teachers, but they may have challenges in acting in line with these ideals. It is notable that teachers are often very aware of experts' recommendations and recognise the answers in the questionnaires that are in line with the requirements of national reforms. Therefore, teachers may have a strong *theory-in-use* which directs their action, but alongside also an *espoused theory* which is a theory that they talk about or write down if asked to explain their actions (see Argyris and Schon 1974). Interestingly, Vedenpää and Lonka (2014) found out that when teachers answered open-ended questions about the nature of learning, the responses were much less constructivist than when they reacted to structured items. This may indicate that the theory-in-use comes out more easily when it is not possible to recognise the "correct" answer from the questions.

In terms of means, the results showed that Finnish teachers scored higher on reflective-collaborative theory compared to knowledge transmission theory. Taiwanese teachers, in turn, scored about the same in all variables. For its part, this was in line with the Chinese Learner phenomenon (Rao and Chan 2010; Watkins and Biggs 2001) in which memorising and comprehension are considered to complement each other naturally. In this study, Taiwanese teachers represented a traditionally Confucian culture (see e.g. Vogel 1991). Respectively, the Finnish teachers were likely to manifest Western thinking, especially in terms of the school system reflecting higher individualism and lower power distance (Hofstede 2001; Lonka 2018). However, we are not suggesting that our samples are representative or generalisable across Western or Chinese contexts.

Methodological Reflections

There is a need for an instrument that measures complex epistemic beliefs, because such beliefs have mainly been assessed using qualitative measures (Hofer 2016; Richardson 2013). Furthermore, instruments need to be validated in each cultural context when they are implemented (Richardson 2013). The instrument should not only capture some universal tendencies, but also be able to detect potential cultural variance.

However, capturing complex epistemic constructions with a questionnaire of limited length has its challenges. This because teachers very often recognise how they should approach knowledge and learning and what practice they should apply in their classroom. Therefore, an issue of social desirability might appear in teachers' answers. Many educators know that an approach based on reflective and collaborative thinking and practices is more advisable in their work, and this might affect their answers. For instance, ceiling effects appeared when measuring complex epistemic beliefs, whereas more moderate answers tended to be given when reacting to simple beliefs. Constructivist beliefs become less popular at the practical level, when inquiring how teachers would act with their pupils (Vedenpää and Lonka 2014) or how students would study for examinations (Nieminen 2011).

There are future needs for the development of our questionnaire, e.g. in terms of item wordings to get rid of artefactual residual covariance, developing items' difficulty and precision and overall cultural sensitivity. Despite this, the same two-factor structure was retained in both exploratory and confirmatory factor analysis in three independent samples. The internal consistencies also supported the use of the two-factor structure in both samples. Still, a two-factor model should not be considered as self-evident: e.g. Stoel et al. (2017) based their questionnaire measuring epistemic beliefs in a history education context on a basic division of "naïve" and "nuanced" epistemic beliefs, however, in their study they found that such distinction oversimplified the underlying belief structure. Thus, new items could be added to the questionnaire presented in this study since we only used three items in each subscale. Adding a fourth question for each subscale would allow us to test for the unidimensionality of each subscale and possibly use four separate subscales, resulting possibly in a four-factor model.

Replication issues across contexts should be considered and investigated more thoroughly. The questions were carefully back translated, but nevertheless, we may have missed some cultural features. Still, it is notable that the factor structures of the two countries were remarkably similar, regardless of cultural variation. The instrument also needs to be tested in larger samples and in new contexts. Small sample size is part of a wider phenomenon considering teacher studies, and in spite of a well-organised data collection, there have been challenges to motivate teachers to answer the questionnaires in addition to their daily work. Especially in the case of Finland, teachers may be requested to answer numerous questionnaires during the term which might decrease their drive to respond. However, using a convenience sample was an opening for confirming the findings in more rigorous studies. In our ongoing study, we have measured the same beliefs and practices in five European countries.

Yet, there is good evidence that some essential aspects of teachers' epistemic beliefs in two different cultural contexts can be reliably caught using the present brief questionnaire. However, in the future, epistemic beliefs should be assessed not only by self-

reported questionnaires (Buehl et al., 2002; Hofer 2000; Schommer 1990), but also in more context-sensitive and naturalistic ways to gain a more accurate understanding of them (Mason, Boldrin, and Ariasi 2010).

Conclusion

It is important to continue research on teachers' epistemic beliefs. Teachers' epistemic theories may have consequences for their students' learning in various ways, because teachers' ideas about knowledge and knowing may have an impact on their practice and either foster or hinder their students' deep understanding and argumentation (Bråten, Muis, and Reznitskaya 2017). For example, Murtonen, Gruber, and Lehtinen (2017) showed that seeing knowledge as pieces of stored information, manipulated in a mental space, may lead to less effective teaching and learning activities in a classroom. A contrasting epistemic theory would see knowledge as collaboratively constructed, the process of knowing involving reflection and metacognition, and the source of knowledge to be critically evaluated (Magolda 1992; Lonka et al. 2008; Perry 1970). Being able to distinguish these two contrasting theories from teachers' reported beliefs and practices in a reliable way in several cultural contexts provides a stable ground to deepen this understanding.

Simultaneously, it is important to acknowledge that epistemic beliefs do not automatically have a direct effect on teachers' practice. Conceptions of knowledge may appear constructivist in nature, but only high-level experts may exhibit coherence between their theories and practices: only during long-term training do epistemic beliefs become part of how people act (Bråten, Muis, and Reznitskaya 2017; Lonka, Joram, and Bryson 1996). Allusions for that appeared in this study also; teachers' reports of integrating their complex epistemic beliefs in actual practice were more modest comparing it to reported pedagogical application of more transmissive beliefs. It might be that, at times, only the language about teaching changes instead of solving the epistemic problem of how to foster students' understanding and meaningful learning (Lonka 2018; Rainio and Hofmann 2015). Also, prevailing institutional routines and practices in schools may either hinder or promote how epistemic beliefs can appear in teachers' practice (Hakkarainen 2009).

It has been shown that when teachers were investigated to scan their *own learning*, they mainly reported changes in knowledge, beliefs and emotions but hardly any changes in actual teaching practices (Bakkenes, Vermunt, and Wubbels 2010). Teachers' epistemic beliefs may even direct teachers' willingness to learn new ways of thinking and acting or even implementing contemporary reforms at school. That is, in other words, to show *epistemic fluency* (Markauskaite and Goodyear 2017; McLaughlan and Lodge 2019), a capacity to recognise and participate in different ways of knowing, combine different kinds of specialised and context-dependent knowledge and reconfiguring their work environment, when facing new challenges and requirements set for education. However, according to Bakkenes, Vermunt, and Wubbels (2010), intentions to develop the practice were often reported, and that might be a precursor for transforming instruction and indicated the readiness to change.

Teachers' work in the present rapidly changing society is demanding. Many educational reforms reflect ambitious epistemic stances and aims. In many countries, municipalities collaborate with experts who are very enlightened on epistemological questions. One of the main goals of teacher education and continuing education should therefore be to foster actual epistemic change (Lunn Brownlee et al., 2017). Our study provided some justification for this assumption that teachers may need support for applying complex epistemic beliefs, reflected in the curricular reforms, in practice. Our ongoing studies explore the relations between work engagement and epistemic beliefs. We have already found that reflective and transformational epistemic beliefs were positively related to university students' well-being (Heiskanen and Lonka 2012) as well as doctoral candidates' well-being and written productivity (Lonka 2018).

In the future, it will be important to study a possible mismatch between the ambitious epistemic aims of educational reforms and how these line up with teachers' beliefs and practices. Potential mismatches may lead to problems in implementing reforms regardless of the cultural context, and therefore monitoring teachers' epistemic beliefs and practices and comparing their development in different countries and cultural backgrounds could play a salient role in understanding teachers' praxis and evolving requirements that are directed to it. Our instrument is ready to be used in teacher education in various countries, and as Richardson (2004) suggests, the reliability of such an instrument should be researched from scratch in any new cultural context. Our instrument has already been translated into eight European languages in addition to Mandarin Chinese in order to see whether the results presented in this article can be replicated in other cultures and contexts.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This study was funded by Finnish Strategic Research Council [327242], Academy of Finland [308352] and Academy of Finland Mobility Funds [318353, 318380]

Notes on contributors

Heidi Lammassaari is a PhD Candidate in The Research Group for Educational Psychology at the University of Helsinki.

Lauri Hietajärvi has PhD in educational psychology. He is a researcher and lecturer in Educational Psychology at the the Faculty of Educational Sciences, University of Helsinki, Finland.

Kirsti Lonka has PhD in psychology. She is Professor of Educational Psychology and Director of Research Group for Educational Psychology at the Faculty of Educational Sciences, University of Helsinki, Finland. She is also Extraordinary Professor in Optentia Research Unit, North-West University, South Africa. Her research interests are psychology of learning, motivation, and emotion, mainly in educational settings.

Sufen Chen is chair professor at National Taiwan University of Science and Technology, Taiwan and extraordinary professor at North-West University, South Africa. She has research interests in the area of science education, technology-enhanced learning, metacognition, achievement emotions, and social media. She is currently the Stanford-Taiwan Social Science Fellow at the Center for Advanced Study in the Behavioral Sciences, Stanford University.

Chin-Chung Tsai is currently a Chair Professor and Dean for School of Learning Informatics, National Taiwan Normal University, Taipei, Taiwan. He is also the Director of the Institute for Research Excellence in Learning Sciences, National Taiwan Normal University. His research interests deal largely with constructivism, epistemic beliefs, and educational technology.

ORCID

Heidi Lammasaari  <http://orcid.org/0000-0002-2752-0191>

Lauri Hietajärvi  <http://orcid.org/0000-0003-2149-9237>

Kirsti Lonka  <http://orcid.org/0000-0001-5487-3964>

Sufen Chen  <http://orcid.org/0000-0001-8453-0225>

Chin-Chung Tsai  <http://orcid.org/0000-0001-7744-9971>

References

- Ajzen, I., and T. J. Madden. 1986. "Prediction of Goal-directed Behavior: Attitudes, Intentions, and Perceived Behavioral Control." *Journal of Experimental Social Psychology* 22 (5): 453–474. doi:10.1016/0022-1031(86)90045-4.
- Argyris, C., and D. A. Schon. 1974. *Theory in Practice: Increasing Professional Effectiveness*. San Francisco: Jossey-bass.
- Bakkenes, I., J. D. Vermunt, and T. Wubbels. 2010. "Teacher Learning in the Context of Educational Innovation: Learning Activities and Learning Outcomes of Experienced Teachers." *Learning and Instruction* 20 (6): 533–548. doi:10.1016/j.learninstruc.2009.09.001.
- Barnes, N., H. Fives, S. Mabrouk-Hattab, and K. SaizdeLaMora. 2020. "Teachers' Epistemic Cognition in Situ: Evidence from Classroom Assessment." *Contemporary Educational Psychology* 60: 101837. doi:10.1016/j.cedpsych.2020.101837.
- Bonneville-Roussy, A., T. Bouffard, O. Palikara, and C. Vezeau. 2019. "The Role of Cultural Values in Teacher and Student Self-efficacy: Evidence from 16 Nations." *Contemporary Educational Psychology* 59: 101798. doi:10.1016/j.cedpsych.2019.101798.
- Bråten, I., and H. I. Strømss. 2006. "Epistemological Beliefs, Interest, and Gender as Predictors of Internet-based Learning Activities." *Computers in Human Behavior* 22 (6): 1027–1042. doi:10.1016/j.chb.2004.03.026.
- Bråten, I., K. R. Muis, and A. Reznitskaya. 2017. "Teachers' Epistemic Cognition in the Context of Dialogic Practice: A Question of Calibration?" *Educational Psychologist* 52 (4): 253–269. doi:10.1080/00461520.2017.1341319.
- Brickhouse, N. W. 1989. "The Teaching of the Philosophy of Science in Secondary Classrooms: Case Studies of Teachers' Personal Theories." *International Journal of Science Education* 11 (4): 437–449. doi:10.1080/0950069890110408.
- Buehl, M. M., and H. Fives. 2016. "The Role of Epistemic Cognition in Teacher Learning and Praxis." In *Handbook of Epistemic Cognition*, edited by J. A. Greene, W. A. Sandoval, and I. Bråten, 247–264, New York, NY: Routledge.
- 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.
- Buehl, M. M., and H. Fives. 2009. "Exploring Teachers' Beliefs About Teaching Knowledge: Where Does It Come From? Does It Change?" *The Journal of Experimental Education* 77 (4): 367–408. doi:10.3200/JEXE.77.4.367-408.

- Chinn, C., L. Buckland, and A. Samarapungavan. 2011. "Expanding the Dimensions of Epistemic Cognition: Arguments from Philosophy and Psychology." *Educational Psychologist* 46 (3): 141–167. doi:[10.1080/00461520.2011.587722](https://doi.org/10.1080/00461520.2011.587722).
- Dahlin, B., and D. Watkins. 2000. "The Role of Repetition in the Processes of Memorising and Understanding: A Comparison of the Views of German and Chinese Secondary School Students in Hong Kong." *British Journal of Educational Psychology* 70 (1): 65–84. doi:[10.1348/000709900157976](https://doi.org/10.1348/000709900157976).
- de Bary, W. T. 1988. *East Asian Civilizations*. Cambridge, MA: Harvard University Press.
- Deng, F., C. S. Chai, -C.-C. Tsai, and M.-H. Lee. 2014. "The Relationships among Chinese Practicing Teachers' Epistemic Beliefs, Pedagogical Beliefs and Their Beliefs about the Use of ICT." *Journal of Educational Technology & Society* 17 (2): 245.
- Feucht, F. C. 2011. "The Epistemic Underpinnings of Mrs. M's Reading Lesson on Drawing Conclusions: A Classroom-based Research Study." In *Personal Epistemology and Teacher Education*, edited by J. Lunn Brownlee, G. Schraw, and D. Berthelsen, 3–21. New York, NY: Routledge.
- Finnish National Agency of Education. 2016. *The National Core Curriculum for Basic Education*. Helsinki: Next Print.
- Greene, J. A., R. Azevedo, and J. Torney-Purta. 2008. "Modeling Epistemic and Ontological Cognition: Philosophical Perspectives and Methodological Directions." *Educational Psychologist* 43 (3): 142–160. doi:[10.1080/00461520802178458](https://doi.org/10.1080/00461520802178458).
- Hakkarainen, K. 2009. "A Knowledge-practice Perspective on Technology-mediated Learning." *International Journal of Computer-Supported Collaborative Learning* 4 (2): 213–231. doi:[10.1007/s11412-009-9064-x](https://doi.org/10.1007/s11412-009-9064-x).
- Heiskanen, H., and K. Lonka. 2012. "Are Epistemological Beliefs and Motivational Strategies Related to Study Engagement in Higher Education?" *Procedia-Social and Behavioral Sciences* 69: 306–313. doi:[10.1016/j.sbspro.2012.11.414](https://doi.org/10.1016/j.sbspro.2012.11.414).
- Hofer, B. K. 2000. "Dimensionality and Disciplinary Differences in Personal Epistemology." *Contemporary Educational Psychology* 25 (4): 378–405. doi:[10.1006/ceps.1999.1026](https://doi.org/10.1006/ceps.1999.1026).
- Hofer, B. K. 2001. "Personal Epistemology Research: Implications for Learning and Teaching." *Educational Psychology Review* 13 (4): 353–383. doi:[10.1023/A:1011965830686](https://doi.org/10.1023/A:1011965830686).
- 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. doi:[10.1016/j.cedpsych.2004.01.002](https://doi.org/10.1016/j.cedpsych.2004.01.002).
- Hofer, B. K. 2016. "Epistemic Cognition as a Psychological Construct: Advancements and Challenges." In *Handbook of Epistemic Cognition*, edited by J. A. Greene, W. A. Sandoval, and I. Bråten, 31–50. New York, NY: Routledge.
- Hofer, B. K., and P. R. Pintrich, Eds. 2002. *Personal Epistemology: The Psychology of Beliefs about Knowledge and Knowing*. Mahwah: Lawrence Erlbaum Associates.
- 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.
- Hofstede, G. 2001. *Culture's Consequences: Comparing Values, Behaviors, Institutions, and Organizations across Nations*. Thousand Oaks, CA: Sage.
- Hsieh, W.-M., and -C.-C. Tsai. 2017. "Taiwanese High School Teachers' Conceptions of Mobile Learning." *Computers & Education* 115: 82–95. doi:[10.1016/j.compedu.2017.07.013](https://doi.org/10.1016/j.compedu.2017.07.013).
- Hsieh, W.-M., and -C.-C. Tsai. 2018. "Learning Illustrated: An Exploratory Cross-sectional Drawing Analysis of Students' Conceptions of Learning." *The Journal of Educational Research* 111 (2): 139–150. doi:[10.1080/00220671.2016.1220357](https://doi.org/10.1080/00220671.2016.1220357).
- Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, 6(1), 1–55.
- IMF – International Monetary Fund. 2021, October 15. "GDP per Capita, Current Prices." <https://www.imf.org/external/datamapper/NGDPDPC@WEO/COD>

- Jehng, J. C. J., S. D. Johnson, and R. C. Anderson. 1993. "Schooling and Students' Epistemological Beliefs about Learning." *Contemporary Educational Psychology* 18 (1): 23–35. doi:[10.1006/ceps.1993.1004](https://doi.org/10.1006/ceps.1993.1004).
- Juuti, K., J. Lavonen, A. Uitto, R. Byman, and V. Meisalo. 2010. "Science Teaching Methods Preferred by Grade 9 Students in Finland." *International Journal of Science and Mathematics Education* 8 (4): 611–632. doi:[10.1007/s10763-009-9177-8](https://doi.org/10.1007/s10763-009-9177-8).
- Kim, C., M. K. Kim, C. Lee, J. M. Spector, and K. DeMeester. 2013. "Teacher Beliefs and Technology Integration." *Teaching and Teacher Education* 29: 76–85. doi:[10.1016/j.tate.2012.08.005](https://doi.org/10.1016/j.tate.2012.08.005).
- Kuhn, D. (2000). Theory of mind, metacognition, and reasoning: A life-span perspective. In P. Mitchell & K. J. Riggs (Eds.), *Children's reasoning and the mind* (pp. 301–326). Psychology Press/Taylor & Francis (UK).
- Lammassaari, H., N. Sandström, J. Järvinen, and K. Lonka 2016, December. "How Ready are Teachers for Change in Finnish Schools - Their Epistemic Beliefs, Work Engagement, Burnout and Perceptions of Physical School Environment." *The Second International Conference for "Personal Epistemology and Learning (PEL)"*. National Taiwan University of Science and Technology, Taipei, Taiwan.
- Lederman, N. G. 1999. "Teachers' Understanding of the Nature of Science and Classroom Practice: Factors that Facilitate or Impede the Relationship." *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching* 36 (8): 916–929. doi:[10.1002/\(SICI\)1098-2736\(199910\)36:8<916::AID-TEA2>3.0.CO;2-A](https://doi.org/10.1002/(SICI)1098-2736(199910)36:8<916::AID-TEA2>3.0.CO;2-A).
- Lee, W. O. 1996. "The Cultural Context for Chinese Learners: Conceptions of Learning in the Confucian Tradition." *The Chinese Learner: Cultural, Psychological and Contextual Influences* 34: 63–67.
- Lin, T.-C., J.-C. Liang, and -C.-C. Tsai. 2015. "Conceptions of Memorizing and Understanding in Learning, and Self-efficacy Held by University Biology Majors." *International Journal of Science Education* 37 (3): 446–468. doi:[10.1080/09500693.2014.992057](https://doi.org/10.1080/09500693.2014.992057).
- Lin, T.-J., and -C.-C. Tsai. 2017. "Developing Instruments Concerning Scientific Epistemic Beliefs and Goal Orientations in Learning Science: A Validation Study." *International Journal of Science Education* 39 (17): 2382–2401. doi:[10.1080/09500693.2017.1384593](https://doi.org/10.1080/09500693.2017.1384593).
- Lonka, K. 1997. *Explorations of Constructive Processes in Student Learning*. [Doctoral dissertation, University of Helsinki]. Helsinki University Press.
- Lonka, K. 2018. *Phenomenal Learning from Finland*. Helsinki: Edita.
- Lonka, K., E. Joram, and M. Bryson. 1996. "Conceptions of Learning and Knowledge: Does Training Make a Difference?" *Contemporary Educational Psychology* 21 (3): 240–260. doi:[10.1006/ceps.1996.0021](https://doi.org/10.1006/ceps.1996.0021).
- Lonka, K., E. Ketonen, and J. D. Vermunt. 2021. "University Students' Epistemic Profiles, Conceptions of Learning, and Academic Performance." *Higher Education* 81 (4): 775–793. doi:[10.1007/s10734-020-00575-6](https://doi.org/10.1007/s10734-020-00575-6).
- Lonka, K., J. Järvinen, J. Makkonen, and L. Hietajärvi 2016, December. "Teachers' Epistemological Theories: Are They Related to Their Ideas of Assessment?" *The Second International Conference for "Personal Epistemology and Learning (PEL)"*. National Taiwan University of Science and Technology, Taipei, Taiwan.
- Lonka, K., P. Sharafi, K. Karlgren, I. Masiello, J. Nieminen, G. Birgegård, and A. Josephson. 2008. "MED NORD—A Tool for Measuring Medical Students' Well-being and Study Orientations." *Medical Teacher* 30 (1): 72–79. doi:[10.1080/01421590701769555](https://doi.org/10.1080/01421590701769555).
- Lonka, K., and S. Lindblom-Ylänne. 1996. "Epistemologies, Conceptions of Learning, and Study Practices in Medicine and Psychology." *Higher Education* 31 (1): 5–24. doi:[10.1007/BF00129105](https://doi.org/10.1007/BF00129105).
- Luft, Luft, J. A., & Roehrig, G. H. (2007). Capturing science teachers' epistemological beliefs: The development of the Teacher Beliefs Interview. *Electronic Journal of Science Education*, 11(2), 38–63.
- Lunn Brownlee, J., Ferguson, L. E., & Ryan, M. 2017. Changing teachers' epistemic cognition: A new conceptual framework for epistemic reflexivity. *Educational Psychologist*, 52(4), 242–252.

- Maggioni, L., and M. M. Parkinson. 2008. "The Role of Teacher Epistemic Cognition, Epistemic Beliefs, and Calibration in Instruction." *Educational Psychology Review* 20 (4): 445–461. doi:[10.1007/s10648-008-9081-8](https://doi.org/10.1007/s10648-008-9081-8).
- Magolda, M. B. B. 1992. "Students' Epistemologies and Academic Experiences: Implications for Pedagogy." *The Review of Higher Education* 15 (3): 265–287. doi:[10.1353/rhe.1992.0013](https://doi.org/10.1353/rhe.1992.0013).
- Markauskaite, L., and P. Goodyear. 2014. "Tapping into the Mental Resources of Teachers' Working Knowledge: Insights into the Generative Power of Intuitive Pedagogy." *Learning, Culture and Social Interaction* 3 (4): 237–251. doi:[10.1016/j.lcsi.2014.01.001](https://doi.org/10.1016/j.lcsi.2014.01.001).
- Markauskaite, L., and P. Goodyear. 2017. *Epistemic Fluency and Professional Education*. Dordrecht: Springer.
- Marton, F., G. Dall'Alba, and L. K. Tse. 1996. "Memorizing and Understanding: The Keys to the Paradox?" In *The Chinese Learner: Cultural, Psychological and Contextual Influences*, edited by D. A. Watkins and J. B. Biggs, 69–84. Hong Kong, Melbourne: CERC, ACER.
- Marton, F., and R. Säljö. 1976. "On Qualitative Differences in Learning: I-outcome and Process." *British Journal of Educational Psychology* 46 (1): 4–11. doi:[10.1111/j.2044-8279.1976.tb02980.x](https://doi.org/10.1111/j.2044-8279.1976.tb02980.x).
- Mason, L., A. Boldrin, and N. Ariasi. 2010. "Epistemic Metacognition in Context: Evaluating and Learning Online Information." *Metacognition and Learning* 5 (1): 67–90. doi:[10.1007/s11409-009-9048-2](https://doi.org/10.1007/s11409-009-9048-2).
- Mason, L., and F. Scirica. 2006. "Prediction of Students' Argumentation Skills about Controversial Topics by Epistemological Understanding." *Learning and Instruction* 16 (5): 492–509. doi:[10.1016/j.learninstruc.2006.09.007](https://doi.org/10.1016/j.learninstruc.2006.09.007).
- Mason, L., M. Gava, and A. Boldrin. 2008. "On Warm Conceptual Change: The Interplay of Text, Epistemological Beliefs, and Topic Interest." *Journal of Educational Psychology* 100 (2): 291. doi:[10.1037/0022-0663.100.2.291](https://doi.org/10.1037/0022-0663.100.2.291).
- Mathis, C., and R. Parkes. 2020. "Historical Thinking, Epistemic Cognition, and History Teacher Education." In *The Palgrave Handbook of History and Social Studies Education*, edited by C. W. Berg and T. M. Christou, 189–212. Cham, Switzerland: Springer International Publishing.
- McLaughlan, R., and J. M. Lodge. 2019. "Facilitating Epistemic Fluency through Design Thinking: A Strategy for the Broader Application of Studio Pedagogy within Higher Education." *Teaching in Higher Education* 24 (1): 81–97. doi:[10.1080/13562517.2018.1461621](https://doi.org/10.1080/13562517.2018.1461621).
- Mellado, V. 1998. "The Classroom Practice of Preservice Teachers and Their Conceptions of Teaching and Learning Science." *Science Education* 82 (2): 197–214. doi:[10.1002/\(SICI\)1098-237X\(199804\)82:2<197::AID-SCE5>3.0.CO;2-9](https://doi.org/10.1002/(SICI)1098-237X(199804)82:2<197::AID-SCE5>3.0.CO;2-9).
- Miguel-Revilla, D., T. Carril-Merino, and M. Sánchez-Agustí. 2021. "An Examination of Epistemic Beliefs about History in Initial Teacher Training: A Comparative Analysis between Primary and Secondary Education Prospective Teachers." *The Journal of Experimental Education* 89 (1): 54–73. doi:[10.1080/00220973.2020.1718059](https://doi.org/10.1080/00220973.2020.1718059).
- Mikkola, A. 2016. "Foreword." In *Miracle of Education: The Principles and Practices of Teaching and Learning in Finnish Schools*, edited by H. Niemi, A. Toom, and A. Kallioniemi, vii–ix. Rotterdam, The Netherlands: Springer.
- Muis, K. R., G. Trevors, M. Chevrier, J. A. Greene, W. Sandoval, and I. Bråten. 2016. "Epistemic Climate for Epistemic Change." In *Handbook of Epistemic Cognition*, edited by J. A. Greene, W. A. Sandoval, and I. Bråten, 331–359. New York, NY: Routledge.
- Murtonen, M., H. Gruber, and E. Lehtinen. 2017. "The Return of Behaviourist Epistemology: A Review of Learning Outcomes Studies." *Educational Research Review* 22: 114–128. doi:[10.1016/j.edurev.2017.08.001](https://doi.org/10.1016/j.edurev.2017.08.001).
- Nespor, J. 1987. "The Role of Beliefs in the Practice of Teaching." *Journal of Curriculum Studies* 19 (4): 317–328. doi:[10.1080/0022027870190403](https://doi.org/10.1080/0022027870190403).
- Nieminen, J. 2011. "Dimensions of University Student Learning in Medicine and Pharmacy." [Doctoral dissertation, University of Helsinki]. Helsinki University Press.
- Nieminen, J., S. Lindblom-Ylänne, and K. Lonka. 2004. "The Development of Study Orientations and Study Success in Students of Pharmacy." *Instructional Science* 32 (5): 387–417. doi:[10.1023/B:TRUC.0000044642.35553.e5](https://doi.org/10.1023/B:TRUC.0000044642.35553.e5).

- Oosterheert, I. E., and J. D. Vermunt. 2001. "Individual Differences in Learning to Teach: Relating Cognition, Regulation and Affect." *Learning and Instruction* 11 (2): 133–156. doi:10.1016/S0959-4752(00)00019-0.
- Pajares, M. F. 1992. "Teachers' Beliefs and Educational Research: Cleaning up a Messy Construct." *Review of Educational Research* 62 (3): 307–332. doi:10.3102/00346543062003307.
- Perry, W. G. 1970. *Forms of Intellectual and Ethical Development in the College Years: A Scheme*. Holt: Rinehart & Winston.
- Postareff, L., and S. Lindblom-Ylänne. 2008. "Variation in Teachers' Descriptions of Teaching: Broadening the Understanding of Teaching in Higher Education." *Learning and Instruction* 18 (2): 109–120. doi:10.1016/j.learninstruc.2007.01.008.
- Qian, G., and D. Alvermann. 1995. "Role of Epistemological Beliefs and Learned Helplessness in Secondary School Students' Learning Science Concepts from Text." *Journal of Educational Psychology* 87 (2): 282. doi:10.1037/0022-0663.87.2.282.
- Rainio, A. P., and R. Hofmann. 2015. "Transformations in Teachers' Discourse about Their Students during a School-Led Pedagogic Intervention." *The European Journal of Social & Behavioural Sciences* 13 (2): 1815. doi:10.15405/ejsbs.163.
- Rao, N., and C. K. Chan. 2010. "Moving beyond Paradoxes: Understanding Chinese Learners and Their Teachers." In *Revisiting the Chinese Learner*, 3–32. Dordrecht: Springer.
- Richardson, J. T. 2004. "Methodological Issues in Questionnaire-based Research on Student Learning in Higher Education." *Educational Psychology Review* 16 (4): 347–358. doi:10.1007/s10648-004-0004-z.
- Richardson, J. T. 2013. "Epistemological Development in Higher Education." *Educational Research Review* 9: 191–206. doi:10.1016/j.edurev.2012.10.001.
- Schommer, M. 1990. "Effects of Beliefs about the Nature of Knowledge on Comprehension." *Journal of Educational Psychology* 82 (3): 498–504. doi:10.1037/0022-0663.82.3.498.
- Schommer, M. 1993. "Epistemological Development and Academic Performance among Secondary Students." *Journal of Educational Psychology* 85 (3): 406. doi:10.1037/0022-0663.85.3.406.
- Schreiber, J. B., A. Nora, F. K. Stage, E. A. Barlow, and J. King. 2006. "Reporting Structural Equation Modeling and Confirmatory Factor Analysis Results: A Review." *The Journal of Educational Research* 99 (6): 323–338. doi:10.3200/JOER.99.6.323-338.
- Sinatra, G. M., S. A. Southerland, F. McConaughy, and J. Demastes. 2003. "Intentions and Beliefs in Students' Understanding and Acceptance of Biological Evolution." *Journal of Research in Science Teaching* 40 (5): 510–528. doi:10.1002/tea.10087.
- Sosu, E. M., and D. S. Gray. 2012. "Investigating Change in Epistemic Beliefs: An Evaluation of the Impact of Student Teachers' Beliefs on Instructional Preferences and Teaching Competence." *International Journal of Educational Research* 53: 80–92. doi:10.1016/j.ijer.2012.02.002.
- Stoddard, J. D. 2010. "The Roles of Epistemology and Ideology in Teachers' Pedagogy with Historical 'Media'." *Teachers and Teaching: Theory and Practice* 16 (1): 153–171. doi:10.1080/13540600903475694.
- Stoel, G., A. Logtenberg, B. Wansink, T. Huijgen, C. van Boxtel, and J. van Drie. 2017. "Measuring Epistemological Beliefs in History Education: An Exploration of Naïve and Nuanced Beliefs." *International Journal of Educational Research* 83: 120–134. doi:10.1016/j.ijer.2017.03.003.
- Trigwell, K., M. Prosser, and F. Waterhouse. 1999. "Relations between Teachers' Approaches to Teaching and Students' Approaches to Learning." *Higher Education* 37 (1): 57–70. doi:10.1023/A:1003548313194.
- Tsai, C. C. 2007. "Teachers' Scientific Epistemological Views: The Coherence with Instruction and Students' Views." *Science Education* 91 (2): 222–243. doi:10.1002/sce.20175.
- Tsai, -C.-C. 2002. "Nested Epistemologies: Science Teachers' Beliefs of Teaching, Learning and Science." *International Journal of Science Education* 24 (8): 771–783. doi:10.1080/09500690110049132.
- Van Rossum, E. J., and R. N. Hamer. 2010. *The Meaning of Learning and Knowing*. Rotterdam : Sense Publishers.
- Vedenpää, I., and K. Lonka. 2014. "Teachers' and Teacher Students' Conceptions of Learning and Creativity." *Creative Education* 5 (20): 1821–1833. doi:10.4236/ce.2014.520203.

- Vermunt, J. D., and M. D. Endedijk. 2011. "Patterns in Teacher Learning in Different Phases of the Professional Career." *Learning and Individual Differences* 21 (3): 294–302. doi:[10.1016/j.lindif.2010.11.019](https://doi.org/10.1016/j.lindif.2010.11.019).
- Vermunt, J. D., and Y. J. Vermetten. 2004. "Patterns in Student Learning: Relationships between Learning Strategies, Conceptions of Learning, and Learning Orientations." *Educational Psychology Review* 16 (4): 359–384. doi:[10.1007/s10648-004-0005-y](https://doi.org/10.1007/s10648-004-0005-y).
- Vogel, E. F. 1991. *The Four Little Dragons: The Spread of Industrialization in East Asia*. Vol. 3. London, England: Harvard University Press.
- Wan, Z. H., J. C. K. Lee, and W. Hu. 2021. "How Should Undergraduate Students Perceive Knowledge as a Product of Human Creation? Insights from a Study on Epistemic Beliefs, Intellectual Risk-taking, and Creativity." *Thinking Skills and Creativity* 39: 100786. doi:[10.1016/j.tsc.2021.100786](https://doi.org/10.1016/j.tsc.2021.100786).
- Watkins, D. A., and J. B. Biggs. 2001. *Teaching the Chinese Learner: Psychological and Pedagogical Perspectives*. Hong Kong/Melbourne: Comparative Education Research Centre, The University of Hong Kong/Australian Council for Educational Research.
- Weinstock, M., Y. Neuman, and I. Tabak. 2004. "Missing the Point or Missing the Norms? Epistemological Norms as Predictors of Students' Ability to Identify Fallacious Arguments." *Contemporary Educational Psychology* 29 (1): 77–94. doi:[10.1016/S0361-476X\(03\)00024-9](https://doi.org/10.1016/S0361-476X(03)00024-9).
- Yang, S. Y., and R. J. Sternberg. 1997a. "Conceptions of Intelligence in Ancient Chinese Philosophy." *Journal of Theoretical and Philosophical Psychology* 17 (2): 101. doi:[10.1037/h0091164](https://doi.org/10.1037/h0091164).