

A Review Study on Technology-Supported Teachers' Epistemological Beliefs

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Abstract: Epistemological beliefs refer to an individual's beliefs about the nature of knowledge and the process of knowledge acquisition. The epistemological beliefs held by teachers not only influence their own learning and professional development but also have a significant impact on their teaching objects, namely the learners. Meanwhile, since the widespread adoption of internet technology in the field of education, various advanced technologies have emerged continuously, and contemporary teachers have naturally or inevitably entered the arena of applying information technology to instruction. This situation necessitates researchers' further understanding of teachers' domain-specific epistemological beliefs and their influencing factors. Based on this context, this paper attempts to review relevant domestic and international literature, sort out the research progress and influencing factors concerning technology-supported teachers' epistemological beliefs, and further summarize the developmental trends in this area.

Keywords: Epistemological Beliefs; Teachers' Epistemological Beliefs; Information Technology

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1. Introduction

Beliefs concerning the nature of knowledge and the process of knowledge acquisition are commonly referred to as epistemological beliefs (Hofer & Pintrich, 1997; Schommer, 1994; Schommer-Aikins, 2004). In early research, scholars associated epistemological beliefs with various activities or elements that reflect learners' metacognitive development, including reading comprehension (Kardash & Scholes, 1996; Schommer, 1990), mathematical problem-solving (Schoenfeld, 2013), engagement with difficult tasks (Dweck & Leggett, 1988; Qian & Alvermann, 1995), and performance across different academic disciplines (Jehng et al., 1993; Schommer & Walker, 1995). Epistemological beliefs pertain to how learners or teachers conceptualize such issues. Since the emergence of this line of inquiry, the research subjects have gradually expanded from students to in-service teachers and pre-service teachers (Chan & Elliott, 2002). With the continuous advancement of emerging technologies, understanding how teachers perceive the nature of knowledge and the process of knowledge acquisition within diverse technological environments—such as the internet, virtual reality, and artificial intelligence—has increasingly become a focal point of research. Concurrently, many scholars have attended to the relationships between teachers' epistemological beliefs and various factors, including self-regulation, critical thinking, teaching conceptions, peer assessment, disciplinary categories, learning performance (Hofer & Pintrich, 1997), and learning strategies (Schommer, Crouse, & Rhodes, 1992; Tsai, 2000). Therefore, as human activities progressively enter a developmental phase centered on information and intelligence, examining how teachers perceive and acquire knowledge within this specific context and arena

has emerged as one of the most critical topics of the present era. Teachers' epistemological beliefs are not only pertinent to their own self-development and classroom performance in this age (Chan & Elliott, 2004; Lawrence, 1992) but also implicate how teachers will influence students' epistemological beliefs, conceptions of learning, metacognition, and related issues of belief and practice (Kang & Wallace, 2005).

Within existing research, various developmental models of epistemological beliefs converge on a trajectory that moves from absolutist epistemological beliefs toward constructivist epistemological beliefs. Stated differently, it is generally posited that learners who hold constructivist epistemological beliefs are capable of engaging in higher-order thinking when approaching knowledge and problems. The structural dimensions of epistemological beliefs reflect the distinction between lower-order and higher-order thinking. Schommer (1994) conceptualized epistemological beliefs as a systematic belief system comprising five dimensions, primarily concerning the certainty of knowledge, the simplicity of knowledge, the absolute authority of knowledge sources, the quick and effortless acquisition of knowledge, and the fixedness of ability. Similarly, Hofer and Pintrich (1997) delineated epistemological beliefs into the dimensions of certainty of knowledge, simplicity of knowledge, absolute authority of knowledge sources, and justification of knowledge. Furthermore, epistemological beliefs are not confined solely to general investigations; they also extend to specific disciplinary backgrounds, distinct cognitive contexts, and varied identities. These include studies on mathematical epistemological beliefs, English language epistemological beliefs, scientific epistemological beliefs, Internet-specific epistemological beliefs, as well as the epistemological beliefs of high school students, middle school students, university students, pre-service teachers, and in-service teachers.

2. Current State of Domestic and International Research

Although the study of epistemological beliefs began to emerge as early as the 1950s and 1960s, the clear delineation and categorization of epistemological beliefs did not truly occur until the 1990s. Research on epistemological beliefs within the context of information technology in education, however, approached the turn of the 21st century. For instance, Hartley and Bendixen (2001) emphasized the importance of epistemological beliefs in technology-enhanced learning environments. This was followed by investigations into personal epistemological beliefs within hypermedia and web-supported learning contexts (Bendixen & Hartley, 2003). Subsequently, Hofer (2004) further demonstrated that during web searching activities, learners' think-aloud protocols continued to reveal that personal epistemological beliefs correspond to the four dimensions of certainty of knowledge, simplicity of knowledge, source of knowledge, and justification of knowledge.

Thereafter, based on the foundation of the internet and the integration of various technologies into the educational field, research gradually expanded to encompass technology-supported teacher learning and instruction across diverse technological environments. Consequently, research on teachers' epistemological beliefs can be categorized according to multiple dimensions, including different technologies, different academic disciplines, and relationships with various other constructs.

First, research on teachers' epistemological beliefs has gradually migrated from traditional general investigations toward studies situated in technology-supported classrooms and internet-based environments. Peng et al. (2006) examined the relationship between pre-service teachers' epistemological beliefs and learning outcomes within a case-based hypermedia learning environment, finding a significant but low-level correlation between the two. Concurrently, many scholars have pointed out that teachers' epistemological beliefs in internet environments warrant careful consideration, as the information resources provided by the internet differ fundamentally from those in traditional settings, necessitating an examination of internet-specific epistemological beliefs (Yılmaz & Çakmak, 2016). Internet-specific epistemological beliefs encompass individuals' beliefs regarding the source, accuracy, and structure of information on the internet, as well as the evaluation of such information and its sources (Kılıç Çakmak, Karaođlan Yılmaz, & Yılmaz, 2015). The most prevalent framework for delineating domain-specific epistemological beliefs in the information age is the Internet-Specific Epistemological Questionnaire (ISEQ) developed by Bråten et al. (2005). This instrument primarily addresses dimensions such as "certainty and source of knowledge," "justification of knowledge," and "structure of knowledge." Its theoretical underpinning is the general model of personal epistemology proposed by Hofer and Pintrich (1997), and it addresses a critical shortcoming of traditional scales by accounting for the specific domain of the internet. Subsequently, many researchers have adapted or revised epistemological belief scales for various technological environments based on this model, or developed instruments such as the Constructivist

Internet-Based Learning Environment Survey (CILES) to understand teachers' epistemological beliefs specific to the internet domain (Chuang & Tsai, 2005; Wen et al., 2004). Mason, Boldrin, and Ariasi (2010) explored epistemological beliefs in web-based environments, developing a scale that conceptualizes beliefs about knowledge (comprising the dimensions of certainty of knowledge and simplicity of knowledge) and beliefs about knowing (comprising the dimensions of source of knowledge and justification of knowledge). Following this, research on epistemological beliefs in internet environments has progressively shifted from scale development toward investigations situated in specific contexts or examinations of relationships with other constructs. For example, Ren et al. (2009), based on the five-dimensional model of epistemological beliefs proposed by Schommer (1990), compared the performance of pre-service teachers in a traditional course versus a course involving the creation of their own textbook on a wiki platform. They found differences between the two groups regarding beliefs about the certainty of knowledge, while no differences were observed in the dimensions of simple knowledge, innate ability, omniscient authority, and quick learning.

Second, the majority of research concerning teachers' epistemological beliefs has concentrated on the domain of science. A substantial body of work has investigated the relationships between science teachers' epistemological beliefs and constructs such as teaching beliefs (Bahçivan, 2014), academic achievement (Stathopoulou & Vosniadou, 2007), achievement goals (Lin & Tsai, 2017), and self-regulation (Muis & Franco, 2009). With the increasing penetration of technologies like the internet, recent studies have also begun to address the relationship between science teachers' epistemological beliefs and digital literacy (Greene et al., 2014; Güneş & Bahçivan, 2018). Furthermore, considerable research exists on the epistemological beliefs of teachers in mathematics and English. For instance, Koponen et al. (2014) examined the epistemological beliefs of Finnish pre-service mathematics teachers, finding that they often view mathematics as a static system and that their beliefs about the goals of mathematics instruction encompass four characteristics: those related to formalism, scheme, process, and application. Ketabi et al. (2014), utilizing the scale developed by Chan and Elliott (2004), surveyed 92 Iranian pre-service English teachers and discovered a tendency toward beliefs in fixed ability and certain knowledge, reflecting support for traditional conceptions in language teaching and learning, with a significant positive relationship observed between these two beliefs.

Third, research has explored the relationships between teachers' epistemological beliefs and constructs pertinent to technological environments such as the internet, including information searching, self-efficacy, and digital literacy. Tsai et al. (2011) investigated the correlation between teachers' online search strategy use and search outcomes with their epistemological beliefs in internet environments. The results indicated that teachers holding more advanced epistemological beliefs about the internet environment were able to employ more sophisticated web search strategies to filter and organize information, and the sophistication of their epistemological beliefs was positively correlated with search outcomes for open-ended questions. Gizem and Ebru (2016) explored whether pre-service teachers' internet-specific epistemological beliefs were influenced by gender differences, finding no such effect but noting an influence based on the teachers' academic department; however, epistemological beliefs did not appear to impact their information search strategies. In another study, Chan (2004) also noted that factors such as age and gender did not affect pre-service teachers' epistemological beliefs. Pre-service teachers in Hong Kong tended to believe that "knowledge is acquired through effort and learning processes rather than being transmitted by authorities or experts, ability is not innate and fixed, and knowledge is not certain and immutable." The cultural context appeared to account for differences between these findings and those reported by Schommer (1990) among North American populations. Furthermore, a significant relationship was found between pre-service teachers' epistemological beliefs and their conceptions of teaching. This finding is echoed in numerous studies examining epistemological beliefs from the learner's perspective, which consistently indicate that learners with constructivist thinking tend to exhibit higher-order thinking compared to those engaged in traditional learning approaches. Although both of the aforementioned studies addressed the relationship between teachers' epistemological beliefs and online information searching, some discrepancies exist. These may stem from underlying differences—such as regional variations, cultural disparities, and disciplinary distinctions—that were not fully controlled for. Consequently, this supports the notion that the relationship between teachers' epistemological beliefs and other constructs is inevitably influenced by factors such as region, culture, and disciplinary nature (Chan, 2010), underscoring the

necessity of providing appropriate support for teachers.

3. Potential Future Directions

Although research on technology-supported teachers' epistemological beliefs has yielded a certain number of findings, there remains a relative paucity of studies situated within teaching and learning scenarios involving newer technologies. In particular, when confronting advanced technologies such as virtual reality and artificial intelligence, whether teachers' epistemological beliefs undergo transformation due to the intensity of the technology, or whether they exhibit differences across disciplines and in relation to various constructs compared to traditional or internet-based environments, represents both a significant gap in the literature and a considerable challenge.

First, teachers' epistemological beliefs appear to exhibit characteristics that shift in accordance with the migration across different technological contexts. It is precisely for this reason that specialized instruments, such as the Internet-Specific Epistemological Questionnaire, have been developed. The development or adaptation of epistemological belief scales tailored to diverse technological scenarios, along with the investigation of teachers' and students' epistemological beliefs, students' conceptions of learning, and self-regulation within various technology-supported instructional contexts, constitutes a pressing issue that requires resolution.

Second, current research on teachers' epistemological beliefs predominantly concentrates on disciplines such as science, mathematics, and English. Studies focusing on humanities disciplines with localized or indigenous characteristics, such as Chinese language/literature and history, remain relatively scarce. However, the epistemological beliefs held by teachers in these humanities disciplines inherently appear to differ significantly from those of teachers in science and engineering fields. Within technology-supported teaching environments, these differences may further exacerbate issues related to beliefs about utilizing technology for instruction, thereby influencing teachers' epistemological beliefs.

Finally, given that research on epistemological beliefs has largely centered on how learners perceive and conceive of knowledge, many studies concerning teachers still focus on the specific demographic of pre-service teachers. Consequently, future research should direct attention toward the epistemological beliefs of in-service teachers within humanities disciplines possessing local characteristics and those engaging with advanced technologies. Such research can effectively assist teachers in integrating into technology-mediated teaching environments and can also support teachers in employing technology appropriately and judiciously, rather than misusing or eschewing it.

4. Conclusion

By synthesizing the domestic and international scholarship on technology-supported teachers' epistemological beliefs, it is evident that the research subjects within this domain have transitioned from students to pre-service teachers and subsequently to in-service teachers. Furthermore, research themes have progressively moved from general inquiries toward investigations focused on specific domains, such as internet-based technologies or particular academic disciplines. Nonetheless, this body of research is still subject to certain limitations, which are primarily manifested in three aspects.

First, there is a notable lack of research examining teachers' epistemological beliefs in relation to cutting-edge technologies. Although existing studies have thoroughly investigated teachers' epistemological beliefs within internet-based environments, the rapid pace of technological advancement in recent years means that research concerning how virtual reality, artificial intelligence, 5G technology, and similar innovations influence teachers' epistemological beliefs and associated constructs remains underdeveloped.

Second, existing research predominantly centers on the epistemological beliefs of pre-service teachers, with comparatively fewer studies addressing the beliefs of in-service teachers. While both pre-service and in-service teachers belong to the broader category of adult learners, their identity characteristics are demonstrably distinct; pre-service teachers embody a dual identity as both university students and nascent educators. Therefore, further investigation into technology-supported teachers' epistemological beliefs and the mechanisms by which these beliefs influence students' epistemological beliefs remains a key focus and a significant challenge for the field. Multilevel linear modeling may constitute an appropriate methodological approach for such inquiries.

Third, there remains considerable scope for further exploration concerning the relationship between technology-supported teachers' epistemological beliefs and studies of personal epistemology, conceptions of teaching, and conceptions of learning. For instance, the distinctions between epistemological beliefs and personal epistemology, as well as the interconnections between teachers' epistemological beliefs and their conceptions of teaching and learning—or their relationship with students' conceptions of learning—warrant additional investigation.

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Conflict of Interests

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