

Technology and the Education of Chinese-language Teachers: Where Are We Now? (科技与中文教师教育之现况与发展)

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Abstract: Technology is exerting a profound influence on the development of Chinese-language skills and on the education of teachers of that language around the world. This qualitative synthesis of quantitative and qualitative research addressed trends and gaps in the literature related to technology and Chinese-language teacher education. The three main strands of research covered were 1) technology standards in Chinese-language teacher education, 2) the actual application of technology in such education, and 3) factors predicting Chinese-language teachers' technology adoption. Three major findings emerged. First, technology standards need to recognize an urgent need to agree upon and teach specific sets of skills, as theorized in frameworks such as Technological Pedagogical and Content Knowledge (TPACK). Second, while consistent improvements in Chinese-language teachers' technology knowledge and technological-pedagogical knowledge have been reported, three other key components – i.e., training, practice and reflection – need to be better integrated into their teacher-training models. Third, two external factors (resources and support) and three internal factors (pedagogical beliefs, technology knowledge and demographics) emerged as crucial to technology integration among these teachers. Based on these results, this review offers a series of recommendations to practitioners, policy-makers and teacher educators.

摘要: 教育技术对于对外汉语能力的发展与对外汉语教师教育, 有著重要的影响。此篇质性论文综述, 针对已发表的质化、量化研究, 指出科技与教师教育研究的发展与研究缺口。本文总结出三个研究方向: 1) 科技与对外汉语教师教育标准; 2) 科技与对外汉语教师教育; 3) 影响对外汉语教师使用科技的因素。三个主要发现为: 第一, 依据科技学科教学知识, 科技标准必须认识到科技知能是完全不同的能力。第二, 虽然教师的科技知识与科技学科在培训之后增长, 在训练过程, 三个重要环节: 培训、练习与反思, 必须更紧密地融入科技与对外汉语教师培训之中。第三, 两个外在因素(资源与支持) 和三个内在因素(教师信念、教师知识、教师个人背景) 会影响到对外汉语教师是否使

用教育科技于教学之中。依据这些发现，本文为对外汉语教师、教师教育与政策制定者提供了建议。

Keywords: technology standards, TPACK, teacher education, technology integration

关键词: 科技标准, 科技学科教学知识, 教师教育, 科技整合

1. Introduction

The use of information and communication technology (ICT) in language learning has been found to have a range of benefits (Chiu, 2013; Lin, 2015a, 2015b). ICT features such as time- and space-independent exchange, synchronous and asynchronous communication, text-based interaction, and many-to-many communication enable language learners to communicate with peers, instructors, and native speakers far beyond the limits of the classroom (Warschauer, 1997). Meta-analyses have shown that ICT demonstrates a moderate positive effect across many language skills (for a review, see Lin, 2015a).

A recent review by Wu (2016) of the literature on technology in Chinese-language education confirmed the benefits of ICT in the development of Chinese-language skills. Early forms of ICT such as online dictionaries and digital flashcards allowed Chinese students to improve the accuracy of their vocabulary knowledge, listening comprehension and pronunciation through computer-assisted repetitive practice. Subsequent advancements in ICT, such as virtual reality and social media, have provided learners with further agency to communicate and collaborate, and have facilitated project-and/or task-based language learning. Such advancements have thus motivated them to synthesize multiple language skills (i.e., reading, speaking, listening, writing) to reach their communicative goals in more authentic situations. The latest ICT developments such as mobile optical character recognition and automatic speech recognition are further directing the acquisition of various language skills into more discovery-oriented modes. In other words, ICT has shown considerable promise of “convenience, interactivity, consistency and effectiveness” in Chinese-language learning (Wu, 2016, p. 97).

Though the literature has highlighted many benefits of the use of ICT in language learning, little attention has been given to the role of ICT in language-teacher education, let alone in the context of teaching Chinese as a second language (L2). As Lin, Zhang, and Zheng (2017) recently noted, language teachers are pivotal players in the use of technology in language teaching. It is essential to understand how pre-service teachers are trained to use various technologies, and their attitudes toward using them in their classrooms. Without such knowledge, it is unrealistic to expect that L2 teachers can fulfil ICT’s potential to engage students in meaningful and interactive learning.

Accordingly, the purpose of this paper is to review three strands of research on Chinese-language-teacher education, namely: 1) its technology standards, 2) its actual use of technology, and 3) factors predicting Chinese-language teachers' technology adoption.

2. Technology Standards in Chinese-language-teacher Education

2.1 Teacher Preparation

With the aim of capitalizing on the benefits of technology in language education, U.S. education standards now frequently require pre-service teachers to be able to integrate technology into their teaching. Oxford and Jung (2007) reviewed five U.S. national guidelines for the integration of technology into the teaching English to speakers of other languages (TESOL), and found that all of them highlighted the importance of technology integration in teacher-education programs. Recently, the American Council on the Teaching of Foreign Languages (ACTFL) revised its program standards for preparing foreign-language teachers, to require teacher-education programs to offer pre-service teachers learning experiences in technology-enhanced learning environments, in the hope that this will increase their use of technology in their future teaching (ACTFL, 2013). In a recent review of technology standards for teacher-education programs in the U.S., Wang and Feng (2017) concluded that all such standards considered technology knowledge (TK) a necessary and integral component of pre-service teachers' knowledge. However, other types of teachers' knowledge including technological-pedagogical knowledge (TPK) and technological-pedagogical-content knowledge (TPACK; for definitions, see Mishra & Koehler, 2006) were not explicitly discussed. Wang and Feng also noted that these U.S. national standards were generic, i.e., that there was not yet any national standard tailored to a particular language.

Unlike the U.S., China has specific standards for Chinese-language teachers. The Office of Chinese Language Council, or *Hanban*, released *Standards for Teachers to Speakers of Other Languages* (国际汉语教师标准) in 2007 (see Zhang, 2009). These standards were then updated in 2012 and 2015, and published by the Foreign Language Teaching and Research Press (外语教学与研究出版社). As Wang and Feng (2017) noted, each successive iteration of these standards was frequently used in training and assessing pre-service teachers. Among the 10 standards enumerated by *Hanban*, the ninth concerns educational technology and its application in teaching. Specifically, it requires teachers to be familiar with the basic components and accessories of computers, to have basic levels of computer literacy, and to be able to use computers and online resources in teaching.

Nevertheless, such standards in China and in the U.S. remain brief (Wang & Feng, 2017). Based on a comparison of standards in these two nations, Wang and Feng (2017) suggested that, in China, TK was considered a part of teachers' pedagogical knowledge (PK) rather than as a stand-alone knowledge component.

2.2 In-service Teacher Development

The literature on technology standards for language teachers has focused overwhelmingly on teacher education, with little attention being paid to in-service teacher development. The Interstate New Teacher Assessment and Support Consortium (2013), a U.S. body “dedicated to the reform of the education, licensing, and on-going professional development of teachers” (National Research Council, 2001, p. 204), published *model core teaching standards* that did not include TK, though the term technology was used in many of their components (for a review, see Wang & Feng, 2017). This absence of TK ran counter to the recommendations of Mishra and Koehler (2006), whose theory of Technological Pedagogical Content Knowledge (TPACK) regarded technology as a tool to support instruction, assessment, reflective practice, and/or professional development. At the time of writing, technology standards for Chinese-language teachers in China also do not yet include standards for in-service teachers.

3. Technology in Chinese-language-teacher Education

This section focuses on training about and with technology for pre-service and in-service Chinese-language teachers. The first subsection will review research on training *with* technology, focusing on how ICT can be used to improve the effectiveness of Chinese-language teacher education. The second subsection then reviews studies related to teacher training *about* technology, with an emphasis on approaches that can facilitate Chinese-language teachers’ development of TK. The third subsection will summarize each of the five studied teacher- education models.

3.1 Training with Technology

Technology integration into teacher training has been a common form of pre-service training among Chinese-language teachers. Acknowledging the challenges that come with rapid technological advancement as well as the complex and context-bound nature of technology integration, a limited number of studies have sought to understand Chinese-language teachers’ development of technology-enhanced professional knowledge, and examined various training models (Cheng 2014). In such studies, the TPACK framework developed by Mishra and Koehler (2006), which emphasizes the connections and interplay among TK, PK, and content knowledge (CK), has played a central role.

To date, the few studies that have documented Chinese-language-teacher training with technology have covered video-conferencing tools (Cheng, 2014; Tseng, Lien, & Chen, 2016; Wang, Chen, & Levy, 2010a) and virtual reality (Cheng, Zhan, & Tsai, 2010).

3.1.1 Video-conferencing Tools

Several studies have examined the use of video conferencing in Chinese-language-teacher education. Wang, Chen, and Levy (2010b), for example, used the online synchronous video-conferencing tool Joinnet to train eight in-service Chinese-language teachers for 12 weeks in Australia. This was divided into four-weeks of online training, followed by an eight-week online teaching practicum. Wang et al. primarily focused on the stages that these teachers had gone through in developing their professional competence in teaching with technology. Through a survey, and collection of the participants' reflections and posts in online discussion forums, Wang et al. found that these teachers went through four stages: the "wow" stage, the "oh-oh" stage, the anxious stage, and the internalizing stage. Their first module was a face-to-face pre-training session, identified as the "wow" stage in which the teachers felt the training was both useful and easy. They were enthusiastic about online teaching, and exhibited little anxiety about the unknown, perhaps because they did not yet need to engage in any teaching preparation. This contrasted with the results reported by Cheng et al. (2010), whose pre-service participants were anxious from the beginning about using Second Life (see the next section for further details). The second stage that Wang et al. (2010b) identified, the "oh-oh" stage, arose when the training was offered online. Several technology issues arose, but the participating in-service Chinese teachers were not deterred by these challenges. Instead, they rapidly grasped the key differences between online and offline teaching, and soon adapted to the new online environment. The third or anxious stage started when they were asked to teach online for 15 minutes. Several participants reported feeling "inexperienced and incompetent" in online settings (p. 287), despite receiving very positive feedback from their peers. Wang et al. reported that through reflection, these teachers' apprehension and fear gradually faded. After spending at least three weeks actually teaching online, the participants entered the fourth or internalizing stage, in which what they had learned from the online training had been fully absorbed. All the participants showed improvements in their online-teaching skills and confidence, and ended the experiment with increased abilities to use technological tools in such teaching.

Similarly, Tseng, Lien, and Chen (2016) conducted a study that used web conferencing to develop in-service Chinese-language teachers' TPACK components. Based on the idea of group collaboration, Tseng et al. recruited four in-service teachers who were teaching online courses to American learners of Chinese. Each teacher had between two and four students in his or her online course. While the participants were teaching, they received the following four-stage training: 1) understanding TPACK, 2) observing and reflecting on peers' online instruction, 3) improving their own teaching by addressing problems identified in stage 2 by the other three teachers, and 4) reflecting on the revisions to their own teaching that were recommended in stage 3. This process was facilitated primarily by a teacher support group in which they sought to inspire each other and jointly examined various pedagogical approaches aimed at increasing student engagement. Based on data from online meetings, reflective reports, and individual interviews, Tseng et al. found that their teacher participants improved their TK and TPK, as evidenced by their use of multimodalities to present vocabulary concepts. Also, to

engage students and enhance linguistic production, it was found that the teachers began using multimedia as prompts.

Unlike Tseng et al. (2016) and Wang et al. (2010b), who used fully online training techniques, Cheng (2014) designed a 12-week blended training course to develop pre-service Chinese-language teachers' online teaching skills. Drawing on TPACK, Cheng employed content analysis of nine pre-service teachers' reflection journals to gain an understanding of the development of different types of knowledge. The results indicated that, among all components of teacher knowledge, PK increased the most; this was reflected in the pre-service teachers' increasing awareness of students' speaking opportunities, understandings of the significance of sufficient processing time, and adoption of more constructive strategies for asking questions. Ranked by degree of increase, PK was followed by TPK, i.e., teachers' adoption of multimedia, online resources and video-conferencing tools in their teaching; PCK, i.e., increasing importance attached to teacher feedback, student errors, and intercultural-communication activity design; TK, i.e., teachers' familiarity with available online tools and awareness of technology testing before class; and CK, i.e., teachers' awareness of regional linguistic differences, students' errors and intercultural-communication knowledge. However, the TPACK component technological content knowledge (TCK) was absent from the participants' reflection journals; Cheng attributed its absence to the curriculum and data source of the particular training program that she studied, and thus proposed that other research methods such as focus groups and surveys be used in future research.

3.1.2 Virtual Worlds

In addition to video conferencing, research on technology and Chinese-language teacher education has used virtual worlds to provide pre-service teachers with field experience. To enhance such teachers' learning experience, Cheng, Zhan, and Tsai (2010) designed a culture-enhanced Chinese region on Second Life: a massively multiplayer role-playing software launched by Linden Lab in 2003. Specifically, Cheng et al. designed a five-stage training model, including preparation, training, lesson planning, testing, and teaching. Their respondents, 65 pre-service teachers in Taiwan, were grouped into 13 groups, each of which was then paired with one Chinese-language learner in the United States. After two sessions, Cheng et al.'s survey revealed that the pre-service teachers had learned how to use Second Life effectively in their teaching. Though they encountered challenges relating to both pedagogy and technology, they gradually learned how to overcome them; and the authors concluded that after training, the pre-service teachers had favorable attitudes towards and increased confidence in using the virtual world in their Chinese-language teaching.

3.2 Training about Technology

As evidence mounts that pre-service teachers with higher levels of technology skills are more likely to use technology into their teaching (Koubek & Moeller, 2003), language educators have called for systematic and effective technology training to be

given to both pre-service teachers during their education and in-service teachers during their professional development (Fuchs & Akbar, 2013).

In an effort to understand the development of teacher trainees' technology-enhanced professional knowledge, Cheng (2017) further proposed and tested a Teaching-Learning version of TPACK known as TL-TPACK. Highlighting the importance of authentic instructional field practice in the pre-service training of Chinese-language teachers, TL-TPACK integrates five training strategies (practicum, course design, advisors, peer cooperation, and reflections) to ensure appropriate training and learning outcomes. Cheng's mixed-methods empirical study of pre-service Chinese-language teacher training using the TL-TPACK model used interviews with pre-service teachers and learners, content analysis of the trainees' reflections, and quantitative analysis of the trainees' and students' survey responses to review training outcomes and the pre-service teachers' TPACK competencies. Data analysis revealed that the pre-service teachers' technology-related knowledge, specifically TK, TCK and TPK, were enhanced by the TL-TPACK intervention. As such, this result answered Cheng's (2014) criticism that TCK tended to be ignored in such training. In addition, the pre-service teachers in Cheng's (2017) sample reported a belief that CK was gained through online field practice and enhanced through peer cooperation. The same study found that field practice, the use of intern advisors, and peer cooperation were all effective training strategies for the development of TK, PK and CK.

3.3 Training Models

Regardless of the medium (e.g., video-conferencing tools or Second Life), each teacher-education program developed by prior studies yielded some improvement in skills and knowledge among pre-service and/or in-service Chinese-language teachers. It should not be assumed, however, that such improvements are attributable to the mere use of technology in such settings. Rather, each component of such training programs – technological or otherwise – should be carefully examined as a possible contributor of their overall effectiveness.

Table 1, below, summarizes the training models developed by prior researchers on Chinese-language teacher education. Most include training, practice, and reflection among their major components. The first stage of such models normally comprises training, i.e., helping teachers to understand the whole process of the teacher-training program and providing them with the skills necessary to use the relevant technology – though there are wide variations in the terminology used, even by the same scholar. For example, Cheng (2014) used the term *teaching strategies* for this stage, while Cheng (2017) used *preparation stage*, with the former concept focusing on the development of pre-service PK, CK and TK, and the latter on acquiring skills for online teaching. Tseng et al. (2016) also called their first stage the *preparation stage*, even though it focused on TPACK and instructional strategies for using video-conferencing tools.

After an initial training stage, the second stage of such models is usually named the practice stage, and requires each trainee teacher to incorporate newly learned

knowledge and skills into their teaching. Cheng's (2010) second stage involved the writing of lesson plans, creation of testing materials, and actual teaching. Similarly, Wang et al. (2010a) designed a practice stage for in-service teachers in which they practiced teaching in a real online-teaching context (though in focusing on skill- and knowledge development alongside the practice of online teaching, Wang et al.'s model could be seen as a combination of the usual first and second stages). In the designs of their practice stages, several training models involved a collaboration component whereby in-service and pre-service teachers received feedback from their peers. As Wang, Chen, and Levy (2010a) noted, having such collaboration may facilitate the "personal and professional growth of the trainee teachers" (p. 779). Likewise, Cheng (2014) asked pre-service teachers to work collaboratively after completing their first-draft lesson plans, and to improve them based on peer feedback, and Tseng et al. (2016) asked in-service teachers to observe peer instruction and provide feedback on it.

Table 1 Summary of Training Models in Technology and Chinese Language Teaching

Study	Training model
Cheng (2010)	Preparation; training; lesson plan; testing; teaching
Cheng (2014)	Pedagogy training; teaching demonstration by master teachers; developing lesson plans; collaboration; feedback; reflection
Cheng (2017)	Preparation; practicum; reflection; evaluation
Tseng et al. (2016)	Comprehending TPACK; observing peer instruction; adjusting instruction; reflecting on enhanced teaching
Wang et al. (2010a)	Practice; reflection; collaboration

The third stage of such models usually involves asking in-service or pre-service Chinese-language teachers to reflect on the problems identified in previous stages and to adjust their teaching accordingly. Tseng et al. (2016) underscored the importance of reflection, a process that helps to link pedagogy to teaching with technology, and Cheng (2014) asked her participants to reflect based on TPACK. In addition to individual reflection, Wang et al. (2010a) asked their participants to share their reflections in an online discussion forum, and found that this activity helped to drive the participants' attention to a more theoretical level, and to consolidate the knowledge they had learned in prior stages of the model.

4. Factors Predicting Technology Adoption

Egbert, Paulus and Nakamichi's (2002) research on technological skills among pre-service language teachers found that they were not well-prepared to use technology in their future teaching. As compared to teachers of other subjects, language teachers have exhibited the least favorable attitudes toward using technology (Ravitz, Becker, & Wong, 2000), and their technology adoption has been documented as ineffective (Burston, 2014).

While many prior studies have explored facilitating factors for and barriers to technology use, only a few have focused on Chinese-language teachers. This section reviews the relevant studies in light of current scholarship on the factors influencing technology adoption among such teachers, which can usefully be divided into internal and external factors (for a review, see Liu, Lin, Zhang, & Zheng, 2017a; 2017b).

4.1 External Factors

External factors including time, access, administrative attitude, and resources have been discussed in the literature on barriers to teachers' use of technology (e.g., BECTA, 2004; Hew & Brush, 2007). Among such studies that focused on Chinese-language teachers, the two major external factors reported were resources and support.

4.1.1 Resources

Lack of resources has been called a major external barrier, not only to ICT-related practice but to achievement in general (BECTA, 2004). A recent study of 47 Chinese-language teachers in U.S. (Liu et al., 2017a) found that resource-related barriers still existed, with the participants highlighting the insufficient quantity online language-learning resources, difficulties in accessing the available technology, and devices not being set up properly for easy use.

4.1.2 Support

A lack of support has frequently been reported as an external barrier to technology integration, and may comprise deficiencies in funding, technical support and/or administrative support. Three studies of Chinese-language teachers identified problems related to support. Using a mixed methodology consisting of surveys and interviews, Lin, Huang and Chen (2014) found that external factors – including lack of support – were more significant barriers to such teachers' technology adoption than internal barriers were. Liu (2010) examined teachers' actual use of a specific technology – Second Life – instead of their general perceptions of technological adoption, and concluded that a lack of technical support was an external factor that prevented them from adopting it. Lastly, Liu et al. (2017a) reported that some of their participants found it troublesome to obtain help from the technicians in their schools, or that too few technicians were employed there.

Apart from these two major external factors, others such as insufficient time (Lin et al., 2014), pressure to meet high standards within a limited time (Liu et al., 2017a), or a lack of rubrics for evaluating learning outcomes (Liu et al., 2017a) have also been reported. Taken together, the results of the relevant prior literature indicate that external factors, considered as “first order barriers” (Ertmer, 1999, p. 48), still exist in Chinese-language classrooms.

4.2 Internal Factors

The importance of several internal barriers have also emerged from research on technology adoption among Chinese-language teachers. These include pedagogical beliefs, technology knowledge, and demographic factors.

4.2.1 Pedagogical Beliefs

Based on a comparison of expert and novice TESOL teachers' attitudes toward technology, Meskill, Mossop, DiAngelo, and Pasquale (2002) argued for the importance of aligning pedagogy with technology use. Research that focused specifically on Chinese-language teachers' technology adoption reported similar findings. Liu et al. (2017a), for example, reported that the set of negative attitudes originating from pre-service Chinese teachers' pedagogical beliefs was one of the two main internal barriers to such adoption in the United States (U.S.). Similarly, Li (2017) highlighted the importance of Chinese-language teachers' beliefs, and asserted that when they aligned their pedagogical beliefs with technology use, their instructional goals were more likely to be accomplished. Xie (2010) also contended that Chinese-language teachers needed to put more effort into choosing technological tools based on their pedagogical goals and teaching objectives.

In addition to the alignment of pedagogy with technology, the prior literature indicates that, if using a certain technology may cause problems, teachers' willingness to use it will decrease. Additionally, Liu (2010) reported that the possibility of inappropriate behaviors and comments in such open-ended learning environments as Second Life was also of major concern to teachers, especially at the K-12 levels.

Using technology effectively in teaching requires sufficient knowledge of the underlying psychological mechanisms of both learning and technology use. Wang (2006) examined the negotiation of meaning in a desktop video-conferencing environment, and found that – far more than in a face-to-face lecture – its one-to-one nature called for sustained concentration, careful planning, and awareness of and sensitivity to individual learners' needs.

4.2.2 Technology Knowledge

A lack of technology-related knowledge was one of the other main internal barriers identified in Liu et al. (2017a). Similarly, Lin (2010) indicated that a long learning curve may be the major obstacle to teachers adopting Second Life in their language classrooms. In their study of digital-technology use among nearly 200 K-16 Chinese-language teachers in the U.S., Ruan, Dai and Yeh (2014) noted the impacts of teachers' perceptions of technology use on their actual classroom use of it. Specifically, the authors noted a positive relationship between teachers' perceptions of digital technology and the number of technological tools they used in class, which in turn was correlated with their self-perceived abilities in technology integration and general computing.

4.2.3 Demographics

Several demographic factors have also been identified as potentially affecting Chinese-language teachers' use of technology. Lin et al. (2014), for example, reported that being under age 26, over age 30, and/or male could be a barrier to such teachers' technology use, with the age factor appearing to affect confidence in using ICT when preparing teaching material, and gender relating to whether teachers enjoyed spending time using ICT. Similarly, Ruan et al. (2014) found that Chinese-language teachers' ages and levels of teaching experience were negatively associated with their perceptions of technology use and their self-perceived abilities to use it effectively. This aligns with the findings of a study by Meskill et al. (2002), that compared expert and novice English teachers' attitudes toward the use of technology, and found that the more experienced teachers focused on learning processes and student empowerment, whereas the less experienced ones focused on learning products and student management.

5. Conclusion

This paper has reviewed the existing body of research on technology and Chinese language-teacher education, and identified its three main themes: 1) technology standards, 2) technology training for in-service and pre-service teachers, and 3) technology adoption. Regarding standards, the importance of technology in language-teacher education has been foregrounded in standards proposed in the U.S. and in China (Wang & Feng, 2017). Though these documents do not usually contain specific technology standards for pre-service language teachers' TK, it is clear that teachers are expected to use technology effectively for a variety of pedagogical purposes. Given the important role that these standards play in teacher education (Arnold & Ducate, 2015), it is important for them to reflect the fact that teaching languages with technology requires a specific set of skills, as theorized in TPACK and confirmed by multiple empirical studies (Comas-Quinn, 2011; Compton, 2009; Sun, 2014).

In terms of technology in Chinese-language teacher education, the literature can be further divided into three sub-themes: 1) training with technology, 2) training about technology, and 3) training models. Though each reviewed study had a unique training model and focus, they consistently reported improvements in Chinese-language teachers' TK and TPK. All the teacher-training models were also found to contain three similar core components, relating to training, practice, and reflection. Along with TPACK, these three components should be integrated into a Chinese-language teacher training model that is more clearly rooted in research on computer-assisted language learning (CALL) training, either in teacher education generally (Arnold & Ducate, 2015) or in Chinese-language teacher education specifically (see Cheng 2017). The review also revealed that informal training is an important under-researched area at the intersection of technology and Chinese-language teacher education, despite its demonstrated promise in facilitating skills development and knowledge acquisition (Arnold & Ducate, 2015).

The third theme that emerged from the present review regarded barriers to technology adoption. Based on the literature (see especially Liu et al. 2017a; 2017b), we classified such barriers into two main types: external factors (i.e., resources, support) and internal factors (i.e., pedagogical beliefs, technology knowledge, and demographics), and analyzed how each factor could affect teachers' decisions about technology adoption.

The three main identified themes imply that teacher development in CALL is multifaceted. Though this review has identified vital components of Chinese-language teacher training, we acknowledge that they are unlikely to be the best or only ways of training such teachers, as teacher development depends heavily on teachers' prior knowledge and training as well as their current contexts (Larsen-Freeman, 2012). In addition, it is important to stress that these three themes should not be taken in isolation from one another, as their interrelationship also plays an important role in teachers' ability to capitalize on the benefits that technology may bring to language learning. Therefore, a new, more transparent standard for Chinese-language teachers' TK is clearly needed if teacher educators are to align their teacher-training programs with the outcomes that the existing standards are aimed at supporting. In short, to facilitate teachers' development of knowledge and skills for technology integration, it is critical to understand their motivations and sources of resistance; to address those issues during the teacher-training process; and provide sustained support, even long after that process has ended.

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