LLT Journal, e-ISSN 2579-9533, p-ISSN 1410-7201, Vol. 28, No. 2, October 2025, pp. 942-963

LLT Journal: A Journal on Language and Language Teaching
http://e-journal.usd.ac.id/index.php/LLT
Sanata Dharma University, Yogyakarta, Indonesia

EXPLORING CHINESE EFL TEACHERS' KNOWLEDGE IN CONTENT, PEDAGOGY, AND TECHNOLOGY INTEGRATION (TPACK)

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https://doi.org/10.24071/llt.v28i2.9536
received 15 August 2024; accepted 26 August 2025

Abstract
This study investigates the Technological Pedagogical Content Knowledge (TPACK) of Chinese English as a foreign language (EFL) teachers from both student and teacher perspectives. As technology increasingly permeates education, understanding teachers' TPACK factors, encompassing the interplay of the primary knowledge of content (CK), pedagogy (PK), and technology (TK), is crucial. Teachers' perceptions of TPACK factors significantly impact the success of technology-integrated teaching. Equally important are students' beliefs, which directly influence motivation and satisfaction. Aligning both perspectives helps educators better address students' needs and expectations. A survey involving 694 university EFL students was compared with survey responses from 64 teachers, supplemented by interviews with nine teachers. Both cohorts acknowledged the importance of technology in facilitating CK delivery. PK and CK were deemed the most important, while TK was ranked lowest among the seven TPACK factors. However, teachers prioritised pedagogical content knowledge, whereas students emphasised technology integration. Moreover, teachers showed greater variability in their perceptions across most knowledge factors. These perceptions reflected the influence of demographic backgrounds and contextual factors. These findings underscore the significance of enhancing teachers' technology-integrated knowledge and implementation strategies to meet student expectations. The implications are significant for educators and professional development providers in designing training programs and support systems.

Keywords: content, knowledge, pedagogy, technology, TPACK

Introduction
The integration of technology into second language (L2) education, particularly in EFL contexts, has become increasingly prominent in recent years. This trend was accelerated by the global shift to remote teaching during the COVID-19 lockdowns and further influenced by the mainstream adoption of artificial intelligence (AI) tools, such as ChatGPT, following its public release in November 2022 (Xames & Shefa, 2023). These developments have heightened the need for teachers to possess strong Technological Pedagogical Content Knowledge

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(TPACK), a harmonious fusion of Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), to enable technology-enhanced instruction. As such, understanding and fostering teachers' TPACK has become essential for effectively utilising technology in EFL instruction and has attracted growing scholarly attention.

A growing body of literature has investigated the role of teachers' knowledge components in shaping teaching practices and student learning outcomes, reflecting a global interest in the TPACK framework (e.g., Alhamid & Mohammad-Salehi, 2024; Dalal et al., 2021; Ekrem & Recep, 2014; Hammond & Manfra, 2009; Lalbiakzuali & Mishra, 2024; Lehtinen et al., 2016; Liu, Liu, et al., 2014; Sierra et al., 2023; Wei & Gao, 2016). Similar trends have been observed in the Chinese context (e.g., Chen et al., 2022; Liu, Liu, et al., 2014; Liu, Zhang, et al., 2014). However, despite this rising interest, much of it has focused exclusively on teachers' perspectives, leaving a notable gap regarding how students perceive their teachers' TPACK, a perspective that remains underexplored.

A comprehensive exploration of teachers' TPACK requires insights from both teachers and students. Teachers' beliefs directly shape their instructional practices (Borg, 2003). However, students' beliefs about their teachers' TPACK components in teaching offer a valuable, yet often overlooked lens. These views are critical in identifying students' needs and expectations (Al-Mahrooqi et al., 2015) and can inform more responsive instructional approaches (Barnes & Lock, 2013). Moreover, the lack of alignment between student and teacher beliefs may lead to student disengagement, dissatisfaction, or misinterpretation of instructional intent, ultimately hindering learning outcomes (Chen et al., 2022). In this regard, comparing teachers' self-evaluations of TPACK with students' beliefs can reveal possible mismatches. These mismatches may stem from a lack of teacher awareness of students' expectations or inconsistencies between teachers' stated beliefs and actual classroom practice (Shi et al., 2019). As Kern (1995) emphasised, aligning teacher and student expectations are essential for effective teaching and learning. Mismatches between these beliefs may lead to student dissatisfaction or even disengagement.

To address these concerns, this study examines Chinese EFL students' beliefs about their teachers' knowledge in the core TPACK domains - content, pedagogy, and technology - and how these domains are integrated in constructing TPACK in practice. Findings obtained from students' perspectives will complement the current dominant body of TPACK research in the Chinese EFL context, which predominantly focuses on teachers' perspectives. These findings are then compared with those of teachers, as reported in a previously published paper (Shi & Jiang, 2022), which is part of the same larger project. This comparative analysis aims to identify key areas of alignment and divergence, examine the underlying factors, and explore implications for refining technology-integrated teaching practices and informing professional development in EFL contexts.

Given the increasing digitalisation of education and technological innovation, understanding both teacher and student perspectives on TPACK has become more critical than ever. This study contributes to the expanding TPACK literature and provides evidence-based insights that can inform the design of more effective and technology-enhanced instruction in EFL education. We address the following research questions:

1. How do Chinese EFL students perceive their teachers' knowledge of content, pedagogy, and technology, as well as the integration of these components in forming TPACK?
2. How do Chinese EFL students' beliefs about their teachers' TPACK compare with their teachers' self-evaluations?

Literature Review

TPACK: The integration of CK, PK, and TK

In Shulman's (1987) comprehensive categorisation of teachers' knowledge base, Pedagogical Content Knowledge (PCK) stands out as a critical component. PCK combines PK (how to teach) with CK (what to teach). It represents teachers' capability to blend effective teaching strategies with subject-specific content, ultimately making that content comprehensible to students, the primary goal of teaching. PCK constitutes one of the three second-layer knowledge components in forming TPACK.

Numerous studies have explored teachers' PCK and its associated components of CK and PK, often linking them to teaching practices and student achievement (Gess-Newsome et al., 2017). These investigations offer insights into enhancing PCK for professional development, alongside identifying influential factors affecting its enhancement (Grieser & Hendricks, 2018; Park & Oliver, 2008; Shi & Baker, 2022), from the perspectives of both students (Criu & Marian, 2014; Halim et al., 2014; Jang, 2011; Park & Oliver, 2008; Tuan et al., 2000) and/or teachers (Alhamid & Mohammad-Salehi, 2024; Gatbonton, 2008; Lalbiakzuali & Mishra, 2024; Park & Oliver, 2008; Sierra et al., 2023).

The surge in technology and distance learning since the late 1990s has propelled research interest in TK, and Mishra and Koehler (2006) proposed the TPACK framework (see Figure 1) as an extension of Shulman's (1987) PCK. The framework illustrates how the three primary knowledge components, namely CK, PK, and TK, combine to form TPACK, including their integration as Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK).

- TK refers to a teacher's understanding of how to use various technological tools, such as computers, the internet, and projectors.
- TCK stands for a teacher's ability to transform CK through the use of technology.
- TPK involves a teacher's competence in applying appropriate technologies for diverse pedagogical purposes.

The term TPACK encapsulates the complex interplay of PCK, TCK and TPK. It represents "a class of knowledge that is central to teachers' work with technology" (Mishra & Koehler, 2006, p. 1029). TPACK underscores the centrality of effective teaching with technology, emphasising the need for a comprehensive understanding of how technology intersects with pedagogy and content (Koehler & Mishra, 2005).

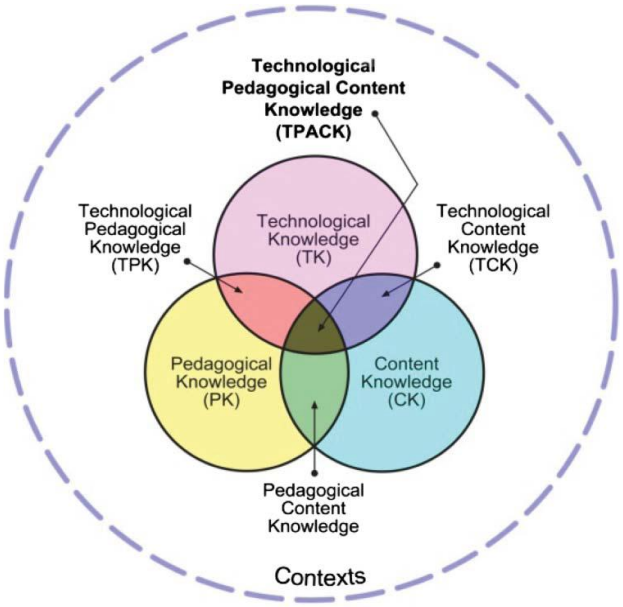


Figure 1. The Framework of TPACK (Source: http://tpack.org/)

Research on TPACK from teachers' perspective

TPACK has attracted considerable research attention due to its pivotal role in shaping teaching practices in this digital age. Existing literature has explored various dimensions related to TPACK, including the process of constructing teachers' TPACK, examining its components (Alhamid & Mohammad-Salehi, 2024; Bos, 2011; J. Chen et al., 2022; Dalal et al., 2021; Ekrem & Recep, 2014; Liu, Liu, et al., 2014), assessing teachers' TPACK proficiency (Alqurashi et al., 2017; Archambault & Crippen, 2009; Chai et al., 2013; Ekrem & Recep, 2014; Lehtinen et al., 2016; Lux & Whittier, 2011; Sahin, 2011; Schmidt et al., 2009), exploring its impact on teaching practices (Boschman et al., 2015; Wei & Gao, 2016), investigating gender differences and academic achievement in TPACK (Ekrem & Recep, 2014), and designing professional development programs to foster teachers' TPACK (Ali & Waer, 2023; Dalal et al., 2021; Koehler et al., 2007; Lehtinen et al., 2016; Liu, Zhang, et al., 2014; Sancar-Tokmak & Yanpar-Yelken, 2015). Additionally, investigations have considered perceptions of teachers' TPACK, from teachers' viewpoints (Alhamid & Mohammad-Salehi, 2024; Gatbonton, 2008; Sierra et al., 2023; Lalbiakzuali & Mishra, 2024; Lehtinen et al., 2016; Lin et al., 2013; Saudelli & Ciampa, 2014) and/or from students' perspectives (Ilmi et al., 2023; Taufik et al., 2023; Tseng, 2014a, 2014b). These studies predominantly adopt quantitative methodologies and primarily focus on teachers' perspectives.

This growing research interest in TPACK is evident across various disciplines worldwide. For instance, Alqurashi et al. (2017) evaluated the TPACK of teachers in Saudi Arabia and the United States, comparing factors affecting their TPACK. Ekrem and Recep (2014) examined pre-service English teachers' TPACK in Turkey, focusing on gender and academic achievement. In Finland, Lehtinen et al. (2016) studied the impact of an intervention on primary pre-service science teachers' TPACK through self-evaluations, highlighting the need to develop pre-

service teachers' beliefs about TK to encourage technology-integrated teaching models in science education. Recognising TPACK as a leading framework for technology-integrated instruction, Sierra et al. (2023) reviewed 16 studies between 2015 and 2021 on TPACK development and recommended Lesson Study as an effective strategy for shaping teachers' conceptions of teaching with technology. Building on this perspective, Alhamid and Mohammad-Salehi (2024) examined EFL teachers' TPACK and their attitudes towards online teaching in Iraq, demonstrating correlations between the two and further emphasising the significance of TPACK in guiding effective technology integration in educational contexts.

Research interest in TPACK is also illustrated in China. Liu, Liu, et al. (2014) discussed the integration of TK in EFL teachers' professional knowledge and the importance of TPACK in EFL teaching. They identified challenges in developing TPACK, including integrating TK into existing knowledge systems and teachers' willingness and ability to apply new technology. The study emphasised formal support from educational settings and the use of technology to gain practical knowledge as key sources for developing teachers' TPACK. Similarly, Chen et al. (2022) used activity theory to examine Chinese EFL teachers' TPACK development, identifying learning patterns, challenges, social resources, and conceptual subsystems. The study highlighted rich learning opportunities and bi-directional TPACK development, offering important implications for teacher development and language education. In our study (Shi & Jiang, 2022), we employed a combination of survey and in-depth interview methods to investigate EFL teachers' perceptions and self-evaluations of TPACK. Drawing on findings from the same project as the current paper, we discovered that Chinese EFL teachers exhibited high confidence in their CK, PK, and PCK. However, they expressed reservations regarding their TK, particularly in integrating it with PCK to effectively construct TPACK and offer sufficient support to their students. This finding is supported by more recent research conducted by Theodorio et al. (2024). Collectively, these studies underscore the critical importance of developing TPACK among teachers to enhance their ability to integrate technology effectively into their teaching practices.

Research on TPACK from students' perspective

Comprehending students' beliefs about their teachers' TPACK components is crucial for enhancing positive learning experiences and outcomes. Dalal et al. (2021) investigated the impact of a technology course on secondary school teachers, revealing significant improvements across all domains of teachers' TPACK, with the most notable gains in TPACK development. However, the study also identified resource constraints and student readiness as critical factors that may hinder teachers' ability to effectively integrate technology. By comprehending student perspectives, educators can refine course designs, methodologies, and engagement strategies, thereby fostering students' learning experiences (Vikas & Mathur, 2021) and learning outcomes (Chen et al., 2022).

Students commonly emphasise the significance of teachers' CK, PK, and PCK across various disciplines (e.g., Botas, 2004; Criu & Marian, 2014; Dalley-Trim, 2007; Fischer et al., 2017; Shi & Baker, 2022). However, investigations into

student beliefs about teachers' TK, TPK, TCK and TPACK remain limited (Ilmi et al., 2023; Taufik et al., 2023).

Existing research primarily focuses on computer-assisted contexts, particularly online instruction (e.g., Archambault & Crippen, 2009; Bolliger & Martin, 2018; Butnaru et al., 2021; Ilmi et al., 2023; Vikas & Mathur, 2021). For instance, Wang and Morgan (2008) discovered that instant messaging could serve as a supportive technique, effectively augmenting communication and collaborative learning. Similarly, Tan et al. (2021) underscored the impact of teachers' online instruction on student motivation and satisfaction after reviewing 61 articles. They asserted that students' perceptions of online instruction play a critical role in "determining learning attitudes, learning outcomes, and personal development" (p. 24). Considering student beliefs about teachers' TPACK becomes increasingly important, especially with the emergence of notable research on the application of AI, such as ChatGPT, as a tool in education since its release in November 2022.

Tseng's (2014a, 2014b) comprehensive examination of EFL teachers' TPACK from students' perspectives is particularly relevant to the present study. He developed a survey instrument (2014a) and utilised it to assess junior high school students' perceptions of their EFL teachers' TPACK factors in Taiwan (2014b). The survey revealed that teachers were perceived as more proficient in CK, PK, and TK, compared to the second-layer components of PCK, TPK, and TCK. Teachers' TPACK was perceived as the least competent domain. These studies align with the current research, which investigates students' perceptions of their EFL teachers' TPACK factors, particularly in Chinese-speaking contexts.

This growing body of research highlights the importance of considering students' views to effectively enhance the integration of technology in teaching practices. Understanding students' viewpoints on teachers' TPACK informs pedagogical practices.

Method

Context

To recruit participants for the project, we employed the strategy of snowball sampling, beginning with university EFL teachers in China through the second researcher's contacts. Using WeChat, China's predominant social media platform, we distributed survey questionnaires to initial teacher contacts. They were invited to: (1) complete the teacher questionnaire themselves, (2) share the student questionnaire with their classes, and (3) forward both questionnaires to colleagues to expand participation through snowball sampling.

In the section before the survey questions, all participants were provided with a detailed research explanation emphasising voluntary and anonymous participation. The submission of a completed questionnaire served as informed consent, ensuring that all subjects gave their informed consent for inclusion before they participated in the study. This approach enabled us to efficiently uphold ethical research standards.

Participants

A total of 64 EFL teachers and 694 students from 25 universities across Shandong Province, Shanghai, and Beijing in China completed the survey questionnaire, with nine teachers participating in follow-up interviews. The student

participants, ranging from 17 to 23 years old, were categorised into four cohorts based on their enrolled English subjects and locations:

Cohort 1: 480 College English (non-English major) students from Shanghai
Cohort 2: 88 College English students from Shandong
Cohort 3: 54 English major students from Shandong
Cohort 4: 72 Academic English students from Beijing

Instruments

Adapting from Tseng's (2014a) validated TPACK instrument, we designed semi-structured interview guiding questions for teachers and created two separate survey questionnaires - one for teachers and one for students. The interview questions aimed to gain insight into teachers' self-evaluation results through one-on-one interviews. Thirteen semi-structured questions, aligned with the seven TPACK factors, were designed to elicit teachers' perceptions of each TPACK component. For example: "What software do you often use or are you familiar with?"; "What technologies do you frequently use to support your teaching, and what are the main purposes of these applications?"; and "Do you often represent content with strategies that incorporate various technologies? Can you give some examples?" Through teachers' responses to such questions, in-depth information about their TPACK knowledge base and perceptions was obtained. This served effectively as triangulation for the questionnaire findings, providing deeper insight into teachers' perceptions. Each survey comprised 35 questions, encompassing seven TPACK factors. Each factor consisted of five Likert-scale items that collectively describe the teacher's relevant knowledge. The teacher and student participants were asked to self-rate or rate teachers' abilities regarding the seven TPACK factors across 35 items. Building upon previous discussions from the teachers' perspective (Shi & Jiang, 2022), this paper focuses on findings from students' perceptions revealed from their responses to the survey questions (see Appendix), and their correlations with corresponding findings from teachers' viewpoints.

Data analysis

Descriptive statistics were calculated for the 35 items associated with the seven TPACK components, based on the data collected from students' survey responses. These statistics provided an overview of students' beliefs about their teachers' knowledge in each domain. To gain deeper insights and compare these student responses with teacher responses, we conducted thematic analysis following the framework by Guest et al. (2012) to analyse interview data with teachers. The analysis began with individual case studies to identify evidence of teachers' content, pedagogy, and technology knowledge, their interactions, and influencing factors, as revealed in the interview transcripts. In this step, the teachers were pseudonymized as T1, T2, T3…T7. Findings were then compared across cases to identify emerging themes. Finally, survey and interview results from teachers were integrated and compared with student survey findings to explore consistencies and discrepancies in EFL teachers' and students' beliefs about each TPACK component and the underlying factors. Guest et al.'s (2012) qualitative approach involved identifying, analysing, and interpreting patterns or themes within

the data, enabling a nuanced comparison between student and teacher perspectives on TPACK.

Findings and Discussion

Findings

Teachers' perceptions of knowledge components in forming TPACK

In our earlier work (Shi & Jiang, 2022), we delved into teachers' perceptions and self-evaluations of the knowledge components contributing to TPACK formation. Here, we succinctly summarise those key findings for direct comparison with students' beliefs in our current research.

The teacher survey results revealed that all seven TPACK knowledge factors were deemed crucial for effective instruction, albeit at varying levels. The Mean (*M*) scores for all factors exceeded 4 out of 5. PK received the highest score, closely followed by CK. In contrast, TK received the lowest rating. Standard deviation (SD) results indicated high agreement among teachers regarding PK and CK, while TK elicited more variable opinions, suggesting it was perceived as the least significant among the seven factors.

Subsequent interviews provided profound insights into EFL teachers' self-evaluation of their TPACK domains and the underlying factors shaping their TPACK construction. Consistent with the survey outcomes, teachers demonstrated strong confidence in PK, CK, and PCK, particularly in designing student-centred and task-based instruction. For instance, T7 described student-centred teaching as "the most important strategy" and aimed to "improve the teaching efficiency by organising more activities." T5 and T8 regularly facilitated peer discussions, group presentations, and debates to promote active engagement with new CK, affirming that "learning a language is through using it" (T1, T5). Teachers' instructional designs were closely tied to content, as they "design activities depending on the topic and have students involved" (T1) and encouraged students "to ask each other questions related to the text content" (T9). Motivation was a central pedagogical goal, with efforts to create "fun" (T1) and "motivation" (T3, T5, T6), and T5 emphasised the importance of encouraging students "to speak, to write, to debate, to use the language…to encourage their teamwork, cooperate and communicate with their peers." These practices reflect teachers' strategic use of PK and CK to address students' needs and foster target language use.

However, despite widespread use of digital tools, teachers' technological integration remained basic. Technology was primarily used to "stimulate students' interest" and "enhance communication" via WeChat, or to "find online resources" and display content through PPT, with limited use of instructional or interactive tools. This suggests a lower level of confidence in TPACK, as digital applications were expressive but not pedagogically expansive (Wozney et al., 2006). Factors contributing to reduced confidence in technology-involved instruction encompass contextual constraints, student characteristics, demographic backgrounds, and the availability of quality training. Together, the aforementioned survey and self-evaluation findings represent teachers' perceptions, facilitating comparisons with students' perceptions.

Students' beliefs about knowledge components in forming teachers' TPACK

RQ1 reveals students' perceptions of their teachers' TK, PK, CK, and the integration of these primary knowledge components in constructing TPACK. Figure 2 and Table 1 present the *M* scores of the seven TPACK factors and their associated components, offering a comprehensive overview of students' perceptions across four distinct cohorts. Analysis of the *M* scores showed that Cohorts 1, 2, and 3 exhibited comparable ranges, although Cohort 1's scores were generally lower than the others, while Cohort 4 displayed notably lower overall scores. Comparative findings of the 35 TPACK component items aligned with the primary (TK, PK and CK), second-layer (TPK, TCK and PCK) and TPACK levels.

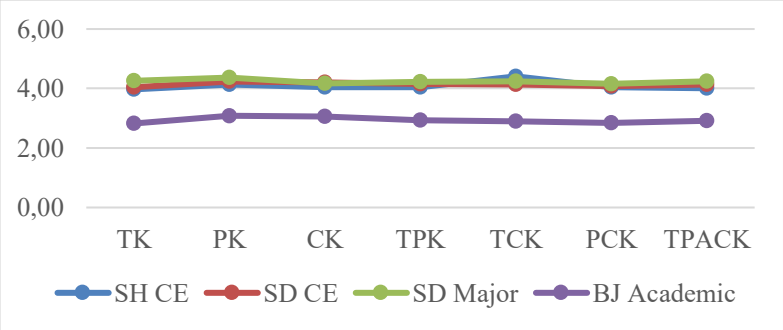


Figure 2. Comparison of Means of seven TPACK factors between student cohorts

Table 1 reveals variations in students' beliefs about teachers' TK, PK, and CK, despite some agreements. Notably, students across all cohorts identified teachers' knowledge of basic computer software (TK2) as the most important among the TK items. Nevertheless, Cohort 3 stood out with the highest *M* scores for all five TK items, indicating their strong belief in the importance of teachers' technological expertise. Similarly, Cohort 3 surpassed others in PK ratings. Among the five PK items, all cohorts agreed in assigning PK7 (e.g., explanation, raising questions, and group work) the lowest ratings. Regarding CK items, while no significant differences were found in *M* scores, it is noteworthy that the use of the English language for natural classroom delivery (CK13) was perceived as the least important among the five CK items across all cohorts.

Table 1. Means of TPACK factor components

Factor	Items	Cohort 1 n = 480	Cohort 2 n = 88	Cohort 3 n = 45	Cohort 4 n = 72	*M* (four cohorts)	*M* of Factors
TK	1	4.077	4.136	4.259	2.730	3.801	3.773
	2	4.213	4.318	4.407	3.110	4.012	
	3	3.738	3.830	4.148	2.630	3.586	
	4	3.860	3.943	4.259	2.910	3.743	
	5	3.971	3.989	4.259	2.740	3.740	
PK	6	4.031	4.102	4.278	2.990	3.850	3.954
	7	3.971	4.080	4.204	2.980	3.809	
	8	4.269	4.341	4.593	3.260	4.116	
	9	4.179	4.261	4.389	3.090	3.980	
	10	4.208	4.386	4.370	3.100	4.016	

Factor	Items	Cohort 1 n = 480	Cohort 2 n = 88	Cohort 3 n = 45	Cohort 4 n = 72	*M* (four cohorts)	*M* of Factors
CK	11	4.325	4.375	4.463	3.050	4.053	3.871
	12	4.331	4.477	4.463	3.300	4.143	
	13	3.396	3.830	3.481	2.780	3.372	
	14	4.083	4.148	4.204	2.950	3.846	
	15	4.083	4.227	4.241	3.220	3.943	
TPK	16	3.983	4.114	4.222	2.890	3.802	3.837
	17	4.067	4.216	4.259	2.930	3.868	
	18	4.013	4.205	4.167	2.890	3.818	
	19	4.063	4.068	4.167	2.960	3.814	
	20	4.090	4.182	4.296	2.960	3.882	
TCK	21	4.040	4.159	4.167	2.860	3.806	3.826
	22	4.004	4.080	4.204	2.810	3.774	
	23	4.058	4.102	4.222	2.900	3.821	
	24	4.073	4.125	4.278	2.970	3.861	
	25	4.065	4.170	4.315	2.910	3.865	
PCK	26	4.044	4.114	4.111	2.870	3.785	3.786
	27	3.935	4.057	4.056	2.790	3.709	
	28	4.429	3.989	4.167	2.810	3.849	
	29	3.927	4.114	4.259	2.890	3.797	
	30	3.919	4.148	4.204	2.890	3.790	
TPACK	31	3.985	4.148	4.222	2.850	3.801	3.821
	32	4.040	4.148	4.259	3.000	3.862	
	33	4.027	4.125	4.259	2.970	3.845	
	34	3.933	4.034	4.222	2.860	3.762	
	35	4.038	4.193	4.204	2.900	3.834	

The small ranges of *M* scores indicated that students' beliefs about teachers' TPK, TCK and PCK exhibited minor disparities, except for Cohort 4, which consistently scored lower. For instance, Cohort 2 emphasised achieving clear explanations through technology application (TPK17) as the most important, while Cohorts 1, 3 and 4 prioritised teachers' capability to employ appropriate technology for teaching (TPK20). Similarly, slight variations emerged in beliefs about TCK and PCK, reflecting nuanced opinions regarding their importance. For example, the *M* scores of TCK items for Cohorts 1 to 3 ranged from 4.004 to 4.315.

Slight disparities were also evident regarding the value of TPACK items, albeit with the existence of a degree of consensus. Cohorts 1, 3, and 4 prioritised providing students with opportunities to practice English through the appropriate use of technological strategies (TPACK32), while Cohorts 1, 2, and 4 unanimously considered computer-assisted teaching engagement (TPACK34) the least important. Cohort 3 viewed the efficacy of technology in facilitating English learning (TPACK35) as paramount, contrasting with Cohort 2's perspective.

Comparison of teachers' and students' beliefs about knowledge components in forming teachers' TPACK

RQ2 delves into the comparative findings between teacher and student perceptions of TPACK. Table 2 illustrates the comparison of *M* scores for the seven

TPACK factors, revealing both similarities and differences in teachers' and students' perceptions. Firstly, teachers generally rated all seven TPACK factors higher than their students, as evidenced by the *M* scores shown in Table 2. Secondly, students' TPACK factors exhibited a more even distribution, ranging from 3.773 (TK) to 3.954 (PK), while teachers' *M* scores ranged from 4.092 (TK) to 4.598 (PK). Thirdly, both teachers and students agreed that PK and CK were the two most important knowledge factors, with TK perceived as the least important of all TPACK factors. However, disparities arose in the comparison results of *M* scores concerning the integration factors. From the students' perspective, PCK (3.786) was considered the least important among the integration factors, with *M* scores ranging from 3.821 for TPACK to 3.837 for TPK, despite TK having the lowest *M* score among the three primary knowledge components. By contrast, teachers prioritised PCK (4.438) as the most crucial integration factor, with the other three factors falling between 4.232 (TCK) and 4.314 (TPACK).

Figure 3 outlines the comparison between the SDs of the seven TPACK factors for teachers and students, showcasing both the similarities and differences. Notably, teachers exhibited consistently low variability at a similar level, except for the two extremes of TK (SD = .388) as the highest and PK (SD = .034) as the lowest. Among students, the variability of the four knowledge integrations remained consistently low, while that of the three primary knowledge factors was comparatively higher. In particular, higher variability was found among students than teachers regarding the value of PK and CK, as reflected in the significantly higher SD of CK.

Table 2. Comparison of *M* scores of seven TPACK factors between teachers and students

TPACK Factors	TK	PK	CK	TPK	TCK	PCK	TPACK
Students *M*	3.773	3.954	3.871	3.837	3.826	3.786	3.821
Teachers *M*	4.092	4.598	4.532	4.312	4.232	4.438	4.314

Furthermore, the variability in students' beliefs about the seven TPACK factors also displayed both the similarities and differences with their teachers. Students largely agreed with teachers on the importance of the integration factors - TPK, TCK, PCK, and TPACK - albeit with generally higher variability among teachers. Additionally, higher variability was observed among teachers regarding TK compared to students. Conversely, regarding teachers' PK and CK, students showed higher variability, while teachers demonstrated high agreement.

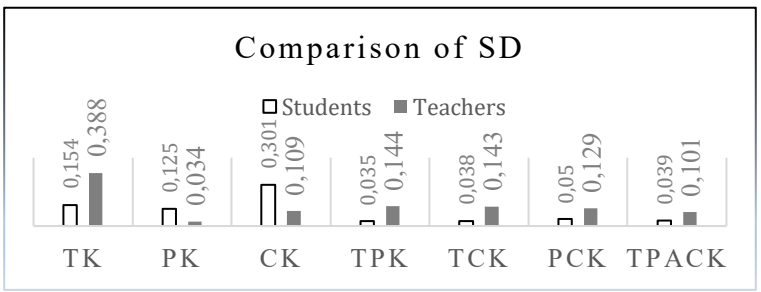


Figure 3. SD Comparison of seven TPACK factors between teachers and students

In summary, while some shared beliefs existed between teachers and students regarding certain TPACK factors, disparities were evident. These findings underscore the importance of understanding and addressing these gaps in pedagogical practices.

Discussion

The findings provided valuable insights into the perceptions of both teachers and students regarding the components forming EFL teachers' TPACK in the context of EFL instruction. These insights contributed to understanding how various knowledge components were valued and integrated into the teaching and learning process, especially within the context of EFL instruction in China.

Consistencies in teachers' and students' beliefs

Both educators and students concurred on the paramount importance of PK and CK as the primary factors shaping effective instruction, and TK as the least influential among the seven TPACK components. Teachers' technology applications were primarily expressive and informative (Wozney et al., 2006), involving activities such as sourcing materials online and utilising PowerPoint presentations during lectures. Findings from students' perceptions support Al-Mahrooqi et al.'s (2015) assertion that students deem EFL teachers' TK relatively unimportant. Our findings also align with Moradia and Sabeti's (2014) work, indicating that both EFL teachers and students prioritise PK as the most important. Furthermore, unanimous agreement prevailed on the necessity of integrating technology seamlessly with content and pedagogy to achieve effective teaching outcomes. Both teachers and students exhibited comparable engagement levels across the four integration factors, as reflected in *M* scores, signifying alignment within and between these two groups within an educational environment. Our study diverges from previous research, which suggested that teachers felt most competent in CK but least competent in TPACK (Chai et al., 2013; Xiang & Ning, 2014).

Discrepancies in teachers' and students' beliefs

However, more discrepancies emerged. Firstly, despite the agreement on *M* scores reflecting shared views of PK and CK as the top two important factors, and TK as the least important among the seven TPACK components, notable disagreements existed in related variability outcomes and individual knowledge items. For instance, teachers exhibited similar levels of variability regarding CK and the four integration factors, but the variabilities of TK and PK were at two significant extremes. This indicated that teachers widely considered PK the most important and felt most confident in this knowledge factor of all seven TPACK components, whereas they exhibited the most variability regarding TK.

Comparatively, the variabilities of the three primary knowledge factors among students were all notably higher than those of the integration factors, suggesting that primary knowledge factors were of lesser concern to some students. Instead, Chinese EFL students generally placed greater value on how their teachers conveyed CK through effective integration with appropriate PK and TK in instruction. Moreover, typical disagreements between teachers and students were observed in specific knowledge items such as CK13. This item pertains to using

English for class delivery and was prioritised by teachers as a crucial strategy, whereas students considered it the least important among CK items.

Secondly, regarding knowledge integrations, teachers exhibited greater confidence in PCK and prioritised it as the most important, aligning with Xiang and Ning's (2014) findings. Conversely, *M* scores indicated that students viewed PCK as the least important of all integrations, but they placed greater emphasis on teachers' ability to employ technologies to enhance pedagogy (TPK) and to deliver subject content (TCK and TPACK). Consistently, the SD scores associated with students' beliefs about teachers' knowledge integrations were notably lower than those of TK, PK, and CK factors. This discrepancy underscored students' consistently higher expectations for their teachers' capability to integrate the three primary knowledge factors, compared to their expectations for the primary knowledge factors themselves. This trend was particularly pronounced concerning the three technology-involved knowledge integrations, as reflected in both the *M* and SD scores, corroborating Xiang and Ning's (2014) findings. These results suggested that Chinese EFL teachers are generally less attentive to the deep integration of TK in instruction, while students tended to hold high expectations for such integration. This highlighted a misalignment between teachers' practices and students' expectations, indicating the need to enhance EFL teachers' awareness and competence in using technology-assisted teaching resources and instructional strategies.

Thirdly, teachers' perceptions exhibited greater variability than students' across most knowledge factors, except for PK and CK. This suggested that teachers held a heightened sense of concern and self-imposed requirements regarding the development of their knowledge base for effective teaching - a concern more pronounced than that among students. Notably, this phenomenon was particularly evident in the realm of TK, where teachers exhibited the greatest variability among all seven factors. Lastly, teachers reached the highest agreement in perceiving PK as the most important factor, reflecting their strong beliefs and confidence in this knowledge component. In contrast, students had more diverse views than teachers regarding the value of PK and CK in particular.

Considering teachers' TPACK from both students' and teachers' perspectives provided a balanced assessment, compensated for individual method drawbacks and enhanced teachers' understanding of their students (Tseng, 2014b; Willermark, 2018). These discrepancies underscore the need for further alignment between teacher and student perspectives on knowledge factors to achieve effective instruction.

Underlying factors influencing students' perceptions

Students' beliefs about their teachers' TPACK components were shaped by contextual factors and demographic backgrounds. Notably, we identified distinct differences among student cohorts. For instance, Cohort 4 consistently showed lower overall M scores compared to the other three cohorts. In contrast, Cohort 3 achieved the highest M scores for 28 out of the total 35 knowledge items. These cohort differences reflected varying expectations, with some cohorts placing higher demands on their teachers' knowledge base, highlighting the influence of contextual factors.

These findings align with Koehler and Mishra's (2009) assertion that TPACK "exists and functions within specific contexts", requiring teachers to adapt their teaching approaches by aligning TPACK components with contextual nuances (p. 17). Our findings also echo Butnaru et al. (2021), who found that students respond differently to online instruction depending on their digital skills and teachers' strategies. Together, these results underscore the importance of understanding and addressing contextual and demographic factors that shape students' perceptions of TPACK in EFL instruction. To effectively meet students' needs, teachers are therefore required to pursue sustainable and context-sensitive development of their TPACK (Chen et al., 2022).

It is also important to recognise that similar underlying factors influenced teachers' confidence in technology-integrated instruction, as discussed in a previous paper from the same project (Shi & Jiang, 2022). From the Chinese EFL teachers' perspective, contextual constraints, student characteristics, demographic backgrounds, and the availability of quality training directly impacted their ability to integrate technology into instruction. These findings support arguments that TPACK functions are strongly affected by teachers' demographic characteristics (Lin et al., 2013) and their attitudes towards technological integration (Saudelli & Ciampa, 2014). Moreover, this study suggested that students' and teachers' characteristics and demographic backgrounds interacted within specific contexts, collectively shaping teachers' TPACK performance and students' perceptions of their teachers' technology-supported instruction.

Students' strong agreement on specific knowledge items reflected shared expectations for their EFL teachers, which warrant attention. Typical instances were observed across the three primary knowledge factors. For example, TK2 was consistently rated highest, while PK7 and CK13 were rated lowest among the five items within each knowledge factor by all student cohorts. This indicates that students commonly perceived knowledge of basic computer software (TK2) as the most important TK component that their EFL teachers should possess. Conversely, they regarded the application of varied evaluation methods and techniques (PK7) and the use of English to deliver classes (CK13) as the least important among the PK and CK components. Students' low expectations for their teachers' L2 use for instruction support existing research (Li, 2018), which emphasises the value of the first language as a mediation tool in enhancing L2 acquisition.

High agreement among student cohorts underscores the importance of addressing these expectations. Enhancing student satisfaction and meeting educational needs requires thoughtful consideration of TPACK components within their specific instructional contexts.

Implications for professional development and pedagogical practices

The consistencies and discrepancies in perceptions between teachers and students provide valuable insights for teachers' professional growth. Addressing these disparities is crucial for enhancing students' learning experiences and satisfaction in technology-integrated education. Specifically, emphasis should be placed on strengthening teachers' TPACK components and bridging gaps in pedagogical practices.

To address these gaps, it is essential to transform teachers' beliefs about TPACK components and enhance their confidence in technology use and

integration. Changing teachers' beliefs is crucial, despite occasional inconsistencies between teachers' perceptions and their actual teaching practices (Shi et al., 2019). Teachers act as decision-makers, drawing upon "complex, practically-oriented, personalised, and context-sensitive networks of knowledge, thoughts, and beliefs" when making instructional choices (Borg, 2003, p. 81). Encouraging teachers to recognise the interrelated nature of challenges – such as acquiring new TK and integrating it into their existing knowledge base – can foster a more holistic approach to TPACK development (Liu, Liu, et al., 2014).

Moreover, teachers' confidence in integrating technology directly influences their application of technology in teaching practices. Therefore, professional development efforts should address confidence-building and TPACK training (Chen, 2010). This approach involves acknowledging teachers as decision-makers and recognising the interrelated nature of challenges in acquiring and integrating new TK (Joshi, 2023; Schmidt et al., 2009).

To achieve sustainable growth, educational institutions must equip EFL teachers with updated TPACK that extends beyond traditional PCK. Ongoing evaluation and relevant development opportunities are critical in this endeavour. By prioritising these points, we can empower teachers to navigate the complexities of TPACK and enhance their pedagogical practices in technology-integrated education.

Conclusion

This study explored the perspectives of both teachers and students regarding the components constituting TPACK within the realm of EFL instruction. Our findings revealed that teachers consistently assigned a higher value to all TPACK factors compared to students. Notably, both educators and learners emphasised the paramount importance of PK and CK, while TK was perceived as the less influential component.

Despite a shared understanding of the necessity to integrate technology with content and pedagogy, discrepancies persisted, particularly in the prioritisation of specific knowledge integrations (e.g., PCK) and individual knowledge items (e.g., CK13). These disparities highlight the need to align teacher and student perspectives to optimise instructional effectiveness, because students' views of their teachers' instruction significantly impact their learning experiences, satisfaction, attitudes, and overall outcomes (J. Chen et al., 2022). Underlying factors, such as demographics and contextual elements, played a considerable role in shaping perceptions of teachers' TPACK components. Tailored approaches are essential to address the diverse expectations and needs of students.

Enhancing teachers' TPACK competencies requires coordinated and sustained efforts. Professional development programs can facilitate changes in teachers' classroom practices, attitudes, and beliefs, ultimately impacting student learning outcomes (Guskey, 2002). Addressing gaps in pedagogical practices involves shifting teachers' beliefs about TPACK, fostering their confidence in technology integration, and offering ongoing support and relevant development opportunities. Continuous professional development and institutional support are critical for equipping EFL teachers with up-to-date and well-integrated knowledge competencies. Bridging the gap between theoretical understanding and practical application empowers educators to navigate the complexities of TPACK and meet

the evolving needs of diverse learners in the EFL context. Further studies could explore student perceptions through in-depth interviews, further enhancing our understanding of how these views relate to teachers' perspectives on TPACK factors.

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Appendix: Survey Questionnaire for Students

TK	1.	My teacher should know about basic computer hardware (e.g., RAM, network cable, and projector).
	2.	My teacher should know about basic computer software (e.g., media players, word processing programs, and web page browsers).
	3.	My teacher should know how to solve technical problems associated with hardware (e.g., setting up printers, using webcams, and changing hard drives).
	4.	My teacher should know how to deal with technical problems related to software (e.g., installing drivers, setting up Internet connection, and sharing files in the cloud).
	5.	My teacher should keep up with important new technologies (e.g., e-books, Facebook, and whiteboard).
PK	6.	My teacher should use a variety of teaching strategies in class (e.g., explanation, raising questions, and group work).
	7.	My teacher should use different evaluation methods and techniques (e.g., quiz, report, and role-playing).
	8.	My teacher should understand students' learning difficulties.
	9.	My teacher should adjust the ways he/she teaches according to student performance and feedback.
	10.	My teacher should know how to manage his/her class (e.g., drawing up clear class rules, creating a friendly atmosphere in class, and developing a good relationship between students and the teacher).
CK	11.	My teacher should have sufficient knowledge of English grammar.
	12.	My teacher should have good pronunciation.
	13.	My teacher should teach class naturally in English.
	14.	My teacher should create materials that can enhance my learning.
	15.	My teacher should answer students' questions about English.
TPK	16.	My teacher should use technologies to motivate me to learn.
	17.	My teacher should use technologies to explain clearly.
	18.	My teacher should use technologies to interact more with us.
	19.	My teacher should use technologies to facilitate teaching activities.
	20.	My teacher should use technologies appropriate for his/her teaching.
TCK	21.	My teacher should use digitalized teaching materials with which I can learn vocabulary better.
	22.	My teacher should use digitalized teaching materials with which I can learn grammar better.
	23.	My teacher should use digitalized teaching materials with which I can read better.
	24.	My teacher should use digitalized teaching materials with which I can speak better.
	25.	My teacher should use digitalized teaching materials with which I can understand the target culture better.

PCK	26. My teacher should conduct lectures in which I can understand English better.
	27. My teacher should conduct quizzes in which I can practice English more.
	28. My teacher should conduct games in which I can practice English more.
	29. My teacher should conduct group activities in which I can use English more.
	30. My teacher should conduct discussion activities in which I can use English more.
TPACK	31. My teacher should represent content with appropriate strategies via the use of various technologies.
	32. My teacher should provide us with the opportunity to practice English with appropriate strategies via the use of various technologies.
	33. My teacher should provide us with the opportunity to use English with appropriate strategies via the use of various technologies.
	34. The way my teacher teaches English with the computer should be engaging.
	35. The way my teacher teaches English with the computer should be of help to my learning of English.