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Technological Pedagogical Content Knowledge and Educational Technology Suitability in Chinese Language Education: A Structural Equation Modeling Study of Teacher Readiness in China

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Abstract

China's rapid expansion of digital education has increased the use of educational technology (EdTech) across primary, secondary, and tertiary teaching. Whether these tools are useful in practice, however, depends on more than access to technology. Teachers must be able to judge whether a digital tool fits the subject matter, the intended pedagogy, and the needs of their learners. This study examined the relationship between Technological Pedagogical Content Knowledge (TPACK), perceived EdTech suitability, and teacher readiness among 384 in-service Chinese language teachers in China. Six TPACK components, four dimensions of EdTech suitability, educational effectiveness, content fidelity, feedback, and professional development and three indicators of teacher readiness confidence, digital skills, and perceived barriers were assessed. Correlation, multiple regression, and Structural Equation Modeling (SEM) were used in the analysis. TPACK explained 45% to 55% of the variance in the four EdTech-suitability dimensions. EdTech suitability was also related to teacher readiness: more favourable evaluations of the technology were associated with greater confidence and stronger digital skills, while perceived barriers were lower. The findings suggest that teacher readiness is shaped not only by what teachers know about technology, pedagogy, and content, but also by whether the available technologies are seen as appropriate for Chinese language teaching. This provides a basis for professional development that combines TPACK development with critical evaluation of the pedagogical fit of EdTech.

Keywords: Tpack, Educational Technology, Teacher Readiness, Chinese Language Education, Structural Equation Modeling

Introduction

Digital technology is now part of the everyday infrastructure of education rather than an optional supplement. It is used for teaching, assessment, communication, professional learning, and increasingly for AI-supported and data-informed activities. Recent international

policy work has therefore moved beyond questions of access and infrastructure toward a broader concern with how technology, pedagogy, institutional capacity, and human expertise work together (OECD, 2021; Holmes et al., 2022).

China offers an important setting for examining these issues. The Smart Education of China platform, launched in 2022, has expanded rapidly and by 2025 had more than 164 million registered users (State Council of the People's Republic of China, 2025). At the same time, national policy has placed stronger emphasis on AI-enabled educational transformation. These developments mean that the practical question for teachers is no longer simply whether digital technology is available. A more difficult question is whether a particular tool is appropriate for a particular subject, class, and learning purpose.

That question is particularly relevant to Chinese language education. Digital resources may assist with character recognition, vocabulary, pronunciation, writing, feedback, and differentiated practice (Godwin-Jones, 2022). Yet Chinese language teaching also places demanding requirements on the accuracy of characters, tones, meanings, cultural references, and textual interpretation. A tool that is technically sophisticated but weak in these areas may add little educational value. Its usefulness depends on how well its features match the language content and the pedagogy used by the teacher.

TPACK provides a useful way to examine this problem because it treats technology integration as an interaction among technological, pedagogical, and content knowledge rather than as technical skill alone (Mishra & Koehler, 2006). The framework has remained influential across digital-learning research, and more recent work has extended it to AI-supported teaching, online learning, and teacher readiness (Celik, 2023). These developments make TPACK relevant to current classrooms, but they also raise a further issue: competent teachers still need technologies that are suitable for the disciplinary work they are expected to teach.

Two gaps are therefore important in the present study. First, studies of technology integration often concentrate on teacher competence and give less attention to the quality or disciplinary fit of the technology itself (Ertmer & Ottenbreit-Leftwich, 2020). Second, teacher readiness is frequently treated as a general willingness to use technology, although readiness may also depend on teachers' judgement of whether a tool is accurate, useful, manageable, and adequately supported. In Chinese language education, poor technological fit can have direct consequences, for example when pronunciation support is inaccurate, character representation is weak, or feedback is too superficial for the learning task.

The present study examines EdTech suitability as the link between teacher knowledge and readiness. The underlying proposition is straightforward: teachers with stronger TPACK should be better placed to evaluate whether a technology is educationally effective, faithful to subject content, capable of providing useful feedback, and supported by appropriate professional development. Those evaluations may then shape how confident and prepared teachers feel about using the technology in practice. The study therefore focuses on the relationship among TPACK, EdTech suitability, and readiness within the specific setting of Chinese language education.

Literature Review

Educational Technology in Contemporary Education

Educational technology now includes far more than presentation software or online repositories. AI applications, cloud services, learning-management systems, analytics, and interactive platforms have changed the ways teachers organise learning and communicate with students (Bond et al., 2021; Holmes et al., 2022). Policy discussions increasingly treat these technologies as part of the wider educational environment, with attention to teaching quality, access, and equity rather than technology use for its own sake (OECD, 2021).

This shift is clearly visible in China. National digital-education initiatives have created a large-scale infrastructure for online resources and services, including the Smart Education of China platform (State Council of the People's Republic of China, 2025). Such investment has increased the availability of digital resources, but access alone does not determine classroom value.

What teachers do with technology remains central. Previous work shows that technology integration is stronger when teachers can connect a tool to an instructional purpose and to the content being taught (Ertmer & Ottenbreit-Leftwich, 2020). In other words, the presence of technology in a school does not automatically result in better teaching or learning.

Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2006) developed the TPACK framework to explain the knowledge teachers require when technology becomes part of instruction. The framework builds on pedagogical content knowledge and brings together three core domains: technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). The value of the model lies in the intersections among these domains rather than in any one domain by itself. From this perspective, a teacher may be technically competent yet still struggle to use a digital tool well if it does not fit the pedagogy or the subject content. Stronger TPACK should therefore help teachers make more informed decisions about when, why, and how technology can support learning (Voogt et al., 2015).

TPACK has since been studied in online, blended, and technology-rich teaching environments (Koehler et al., 2014; Scherer et al., 2017). Research also indicates that teachers with stronger integrated knowledge are more likely to design purposeful technology-supported activities rather than use digital tools only for presentation or administration (Chai et al., 2022).

The framework has also been adapted to newer technological conditions. Recent work has considered teacher knowledge for AI-supported education and the ethical use of intelligent systems (Celik, 2023). This extension is important because the demands placed on teachers continue to change as digital tools become more complex.

Educational Technology Suitability

Teacher knowledge is only one side of the technology-integration problem. The tool itself must also be appropriate for the learning task. In this study, EdTech suitability refers to the extent to which a digital tool fits instructional goals, represents subject content accurately, supports useful feedback, and can be implemented with adequate professional support.

Four aspects are emphasised. Educational effectiveness concerns whether the technology helps teaching and learning (Bond et al., 2021). Content fidelity concerns the accuracy and appropriateness of the subject matter represented by the tool (Vanacore et al., 2025). Feedback refers to whether learners receive information that is timely and useful for improvement (Hattie & Timperley, 2007). Professional-development support concerns whether teachers receive the guidance needed to use the technology effectively.

Content fidelity deserves particular attention in language education. Digital systems can support pronunciation, vocabulary, grammar, and literacy, but errors or oversimplifications can also mislead learners (Godwin-Jones, 2022). Teachers therefore need to evaluate not only what a technology can do, but whether what it does is accurate enough for the language-learning purpose.

Teacher Readiness for Technology Integration

Teacher readiness in this study refers to being prepared to use digital technology in teaching, with particular attention to confidence, digital skills, and perceived barriers. Readiness is therefore broader than access to equipment. It also reflects whether teachers believe they can use a tool effectively and whether the surrounding conditions make use of that tool feasible.

Previous research links digital competence and self-efficacy with stronger adoption of technology-supported teaching (Tondeur et al., 2017). At the same time, insufficient training, limited technical support, workload, and other organisational constraints can discourage use even when technology is available (Ertmer, 1999; Hew & Brush, 2007).

Professional development is one practical response to these difficulties. Effective programmes need to move beyond basic technical instruction and help teachers connect technology with pedagogy, content, and classroom decision-making (Trust, 2020).

Technology Integration in Language Education

Language education has made increasing use of mobile applications, online platforms, speech-recognition tools, and intelligent tutoring systems (Godwin-Jones, 2022). These technologies can extend opportunities for practice and feedback, but their value depends on how well they address the linguistic demands of a particular learning task.

For Chinese language teaching, the potential uses are wide-ranging, including character recognition, pronunciation, vocabulary, and writing. Nevertheless, a digital resource is useful only when the teacher can judge whether its content and functions are appropriate for the intended learners and lesson.

Studies of technology-supported language teaching indicate that teachers' technological-pedagogical knowledge is closely related to their ability to design effective digital learning activities (Chai et al., 2022). This reinforces the need to examine not simply whether teachers use technology, but how they evaluate and apply it.

Within language education, TPACK has been used to examine how teachers combine digital tools with communication practice, collaboration, feedback, and other learning activities.

Recent studies in foreign- and English-language education continue to show the relevance of TPACK for technology integration (Humaera, 2025; Li et al., 2024).

Readiness adds a different dimension to the same issue. A teacher may understand a technology but still hesitate to use it if confidence is low or barriers are high. Current research links stronger digital self-efficacy and technological-pedagogical competence with a greater likelihood of adopting innovative digital practices (Ismail et al., 2025; Otom et al., 2025).

China's continuing investment in digital education makes this relationship especially relevant. Evidence from Chinese teachers suggests that TPACK is associated with attitudes toward ICT and willingness to use digital tools in teaching (Li, 2023). The present study extends this line of inquiry by asking whether teachers' evaluations of EdTech suitability help explain readiness within Chinese language education.

TPACK remains a useful foundation because it directs attention to the interaction of technology, pedagogy, and content. Mishra and Koehler (2006) argued that effective integration depends on understanding these interactions rather than treating technology as an independent teaching solution.

This distinction matters in practice. Teachers with stronger TPACK are more likely to design activities in which technology serves a clear learning purpose (Voogt et al., 2015). When integrated knowledge is weaker, digital tools may be used mainly for display, communication, or routine administration.

The emergence of AI and data-driven systems has made this issue more, rather than less, important. New technologies increase the range of possibilities available to teachers, but they also increase the need for informed professional judgement.
EdTech suitability complements TPACK by shifting some attention from the teacher to the technology being selected. A competent teacher still needs a tool that matches the content, the learners, and the instructional purpose.

Educational effectiveness refers to whether a tool contributes to the intended learning outcome. Content fidelity concerns whether subject matter is represented accurately. Feedback concerns whether the system gives learners information they can act on. Professional-development support concerns the training and guidance available to teachers. In Chinese language education, these dimensions are especially relevant because errors in characters, pronunciation, grammar, or contextual meaning can directly affect what students learn.

Conceptual Framework and Hypotheses

On the basis of the literature, the study proposes that TPACK influences how teachers judge the suitability of EdTech and that these judgements are related to teacher readiness. Figure 1 summarises this proposed sequence.

Table 1
Summary of Research Hypotheses

Hypothesis	Statement
H1	TPACK components significantly predict Educational Effectiveness of EdTech tools.
H2	TPACK components significantly predict Content Fidelity of EdTech tools.
H3	TPACK components significantly predict Feedback capability of EdTech tools.
H4	TPACK components significantly predict Professional Development support related to EdTech tools.
H5	EdTech suitability significantly predicts teacher confidence in using educational technology.
H6	EdTech suitability significantly predicts teachers' digital skills.
H7	EdTech suitability significantly predicts perceived barriers toward technology integration.

The framework contains three main elements: TPACK competencies, EdTech suitability, and teacher readiness. TPACK is represented by the knowledge domains used in the study; EdTech suitability is represented by educational effectiveness, content fidelity, feedback, and professional-development support; and readiness is represented by confidence, digital skills, and perceived barriers.

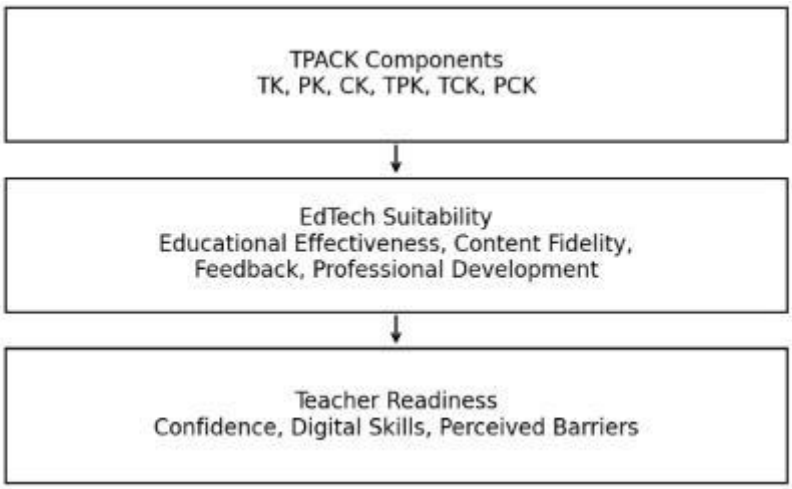

Figure 1 Conceptual framework of the relationships among TPACK, EdTech suitability, and teacher readiness

The model therefore treats EdTech suitability as the practical point at which teacher knowledge meets the characteristics of the technology. Teachers may possess strong knowledge, but readiness is expected to be higher when the tools available to them are also judged to be suitable for the work of teaching Chinese.

Methodology

Research Design

A quantitative cross-sectional survey was used to examine relationships among TPACK, EdTech suitability, and teacher readiness. The design was correlational because the purpose was to estimate associations and predictive relationships among the study constructs rather than to manipulate teaching conditions.

Participants and Sampling

Participants were 384 in-service Chinese language teachers working in primary, secondary, and tertiary institutions in China. Stratified random sampling was used so that teachers with different demographic and professional backgrounds were represented in the sample.
The sample was adequate for the planned SEM analysis. Hair et al. (2022) note that samples of 200 or more are commonly sufficient for many structural models, although adequacy also depends on model complexity.

Research Instrument

The questionnaire contained four sections covering demographic information, TPACK, EdTech suitability, and teacher readiness. All substantive items used a five-point response scale from 1 (strongly disagree) to 5 (strongly agree).

- Demographic information
- TPACK components
- EdTech suitability dimensions
- Teacher readiness and attitudes

Validity and Reliability

Confirmatory Factor Analysis (CFA) was used to examine the measurement model before the structural relationships were tested. Convergent validity was evaluated from standardised factor loadings, composite reliability (CR), and average variance extracted (AVE).

Following Hair et al. (2022), values above .50 for factor loadings, .70 for CR, and .50 for AVE were used as reference points when evaluating the measurement results. The retained constructs met these criteria at an acceptable level. CFA results were examined in terms of standardised loadings, CR, and AVE. Table 2 presents the measurement properties of the constructs used in the analysis. The purpose of this step was to establish whether the indicators provided an adequate basis for testing the structural relationships.

Table 2
Measurement properties of the study constructs

Construct	Indicator	Loading	CR	AVE
Technological Knowledge	TK1	0.78		
	TK2	0.81		
	TK3	0.75	0.88	0.60
Pedagogical Knowledge	PK1	0.80		
	PK2	0.83		
	PK3	0.79	0.89	0.63
Content Knowledge	CK1	0.77		
	CK2	0.84		

	CK3	0.81	0.90	0.65
EdTech Suitability	EE	0.82		
	CF	0.85		
	FB	0.74		
	PD	0.71	0.87	0.62
Teacher Readiness	Confidence	0.84		
	Digital Skills	0.82		
	Perceived Barriers	-0.68	0.86	0.61

Note: Loadings > .50 acceptable (Hair et al., 2022).

Data Analysis

The data were analysed in IBM SPSS and AMOS. Descriptive statistics and correlations were examined first, followed by multiple regression and SEM.

SEM was used because the study involved several related constructs and required estimation of both measurement and structural relationships. Analysis proceeded in two stages. CFA was first used to assess the measurement model; the structural model was then estimated to test the hypothesised paths. Model fit was considered using several indices, χ^2/df, CFI, TLI, RMSEA, and SRMR rather than a single statistic.

The six-factor TPACK measurement model showed acceptable fit ($\chi^2/df = 3.57$, CFI = .96, TLI = .95, RMSEA = .07, SRMR = .03). The EdTech-suitability model also showed acceptable-to-good fit. Some first-order TPACK dimensions, however, overlapped in the Fornell-Larcker assessment. This suggests that the TPACK dimensions were not completely distinct empirically and should be interpreted with appropriate caution.

Results

The results showed a consistent relationship between teachers' knowledge and their evaluation of educational technology. TPACK accounted for 47% of the variance in Educational Effectiveness, 55% in Content Fidelity, 45% in Feedback, and 49% in Professional Development. Content Fidelity had the largest R^2 value, indicating that teachers' integrated knowledge was particularly relevant when they judged whether digital tools represented Chinese language content appropriately.

The model linking EdTech suitability to readiness also fitted the data at an acceptable level ($\chi^2/df = 2.78$, CFI = .95, TLI = .94, RMSEA = .05, SRMR = .04). Educational Effectiveness and Feedback were associated with Confidence, while Content Fidelity and Professional Development were associated with Digital Skills. Educational Effectiveness and Professional Development were negatively related to Perceived Barriers. Taken together, the pattern suggests that readiness was stronger when teachers regarded available technologies as useful, accurate, supportive, and manageable.

Structural Equation Modeling Results

SEM was then used to test the overall structural relationships. The structural model showed acceptable fit, indicating that the proposed pattern of relationships was reasonably consistent with the observed data. Figure 2 presents the standardised paths.

Model fit: CFI = .93; TLI = .92; RMSEA = .052; X^2/df = 2.41

Figure 2 Structural equation model of the relationships among TPACK, EdTech suitability, and teacher readiness

Table 3 reports the structural path estimates. The path from TPACK to EdTech suitability was positive and significant (β = .67, p < .001), as was the path from EdTech suitability to teacher readiness (β = .58, p < .001).

Table 3
Structural Path Estimates and Hypothesis Testing Results

Hypothesis	Path	Standardized β	SE	CR	p-value	Decision
H1	TPACK → EdTech Suitability	0.67	0.05	11.24	< .001	Supported
H2	EdTech Suitability → Teacher Readiness	0.58	0.06	9.76	< .001	Supported

Table 4
Explained Variance (R^2)

Construct	R^2
EdTech Suitability	0.45
Teacher Readiness	0.39

Discussion

A central finding is that teacher readiness was related to both professional knowledge and the perceived fit of the technology. Teachers with stronger TPACK tended to evaluate EdTech more favourably, and more favourable evaluations of suitability were in turn associated with higher readiness. This suggests that readiness cannot be understood only as a matter of technical confidence; it also depends on whether teachers regard the tools available to them as appropriate for the educational task.

The SEM results therefore support a two-part interpretation. First, TPACK appears to shape how teachers judge EdTech. Second, those judgements are linked to readiness. This is important because it places teacher knowledge and technology quality within the same explanatory model rather than treating them as separate issues.

TPACK as a Predictor of EdTech Suitability

TPACK was positively related to the four dimensions of EdTech suitability: educational effectiveness, content fidelity, feedback, and professional-development support. This is

consistent with the basic TPACK proposition that meaningful technology use depends on the interaction of technological, pedagogical, and content knowledge (Mishra & Koehler, 2006).

The result also accords with previous work showing that teachers with stronger TPACK are better able to select and use technology for instructional purposes (Chai et al., 2022; Voogt et al., 2015). Such teachers are more likely to judge a tool in relation to the lesson objective, the way learning will be organised, and the accuracy of the subject content.

The finding has particular relevance for Chinese language teaching. A technology used in this context must handle characters, pronunciation, meaning, and cultural content with sufficient accuracy. TCK and TPK may therefore be important not simply for operating a tool, but for recognising when its content or functions are unsuitable for a language-learning purpose.

This interpretation is consistent with the argument that teacher competence matters at least as much as the availability of technology (Ertmer & Ottenbreit-Leftwich, 2020). Access creates the opportunity to use a digital tool; professional knowledge helps determine whether that opportunity becomes meaningful teaching.

The Role of EdTech Suitability in Teacher Readiness

EdTech suitability was also positively related to teacher readiness. Teachers were more confident when they regarded the technology as educationally useful and appropriate, and dimensions of suitability were also related to digital skills and perceived barriers.

This pattern is compatible with technology-adoption research showing that perceptions of usefulness and ease of use influence willingness to use digital systems (Scherer et al., 2017). In the present study, suitability is broader than usefulness alone because it also includes content fidelity, feedback, and professional support.

The negative relationships with perceived barriers are also informative. A tool that fits teaching needs, is supported by training, and behaves predictably may be easier for teachers to incorporate into their work. Conversely, even a technically advanced tool can become a barrier when its content is inaccurate or its use requires support that is not available.

Teacher Readiness and Technology Integration

The findings reinforce the importance of readiness as a practical condition for technology integration. Confidence and digital skills were not isolated personal qualities; they were related to teachers' evaluations of the technologies they were expected to use.

This is consistent with earlier studies linking digital competence and technological self-efficacy with technology-supported teaching (Tondeur et al., 2017). Teachers who feel capable of using a digital tool are more likely to experiment with it and incorporate it into instruction.

At the same time, readiness can be constrained by factors outside the individual teacher. Limited training, weak technical support, workload, and other organisational conditions may discourage adoption even when digital resources are available.

For this reason, efforts to strengthen readiness should address both teacher capability and the conditions in which technology is used. Professional development should include opportunities to evaluate tools, practise their use, and relate their features to subject-specific teaching problems.

Theoretical Contributions

The theoretical contribution of the study lies in bringing EdTech suitability into the relationship between TPACK and readiness. TPACK explains the professional knowledge teachers draw on when integrating technology, but it does not by itself specify whether the technology available to a teacher is suitable for a particular disciplinary task. The present model adds that evaluative step.

This distinction helps clarify why two teachers with similar access to technology may still differ in readiness. Knowledge influences how a teacher judges a tool, while the perceived quality and fit of that tool influence whether its use appears worthwhile and manageable. EdTech suitability therefore provides a practical bridge between professional knowledge and readiness.

The study also adds subject-specific evidence from Chinese language education. Because language technologies must handle characters, pronunciation, feedback, and culturally situated meaning, this context makes content fidelity especially important and illustrates why generic measures of technology availability may be insufficient.

Practical Implications

The findings have implications for teacher education, technology selection, and institutional support. Teacher development should strengthen TPACK while also giving teachers structured opportunities to evaluate digital resources. Training that focuses only on operating software may be inadequate if teachers are not also asked to consider content accuracy, instructional purpose, feedback quality, and learner needs.

Schools and other educational institutions should evaluate EdTech in relation to pedagogical and curricular requirements rather than technological novelty. For Chinese language teaching, this includes checking the accuracy of language content and whether the tool supports the type of practice or feedback required.

Professional-development programmes should also address confidence and digital skills alongside practical barriers. Teachers are more likely to use technology when they understand its purpose, have opportunities to practise, and can obtain support when problems arise.

At policy level, technology integration should therefore be approached as a combination of teacher capability, suitable technology, and institutional support. Investment in hardware or platforms alone is unlikely to produce consistent classroom use.

Summary of Findings

Overall, the results show that TPACK, EdTech suitability, and readiness are closely connected. Teacher knowledge was related to how technologies were evaluated, and those evaluations were related to confidence, digital skills, and barriers. The findings therefore support a view

of technology integration in which teacher competence and the quality of technological fit must be considered together.

Implications

Teacher Professional Development

Professional development should combine technical learning with subject-specific decisions about when and how a digital tool should be used.

Policy Development

Educational authorities should assess digital tools for pedagogical fit, content accuracy, feedback quality, and support requirements before large-scale adoption.

Classroom Practice

Teachers should be encouraged to evaluate digital resources critically and to select tools that match the intended learning outcome rather than using technology simply because it is available.

Limitations and Future Research

Three limitations should be considered when interpreting the findings. First, the study relied on self-report data, so responses may reflect perception as well as actual classroom behaviour. Future work could combine survey data with classroom observation, usage records, or measures of student learning.

Second, the cross-sectional design does not establish temporal or causal order. Although the structural model is consistent with the proposed relationships, longitudinal or intervention studies would provide stronger evidence about how TPACK, suitability judgements, and readiness develop over time.

Third, the sample consisted of Chinese language teachers in China. This provides useful subject-specific evidence, but the relationships may differ in other disciplines or educational systems. Replication across subjects, regions, and school contexts would help establish the wider applicability of the model.

Conclusion

This study examined how TPACK, EdTech suitability, and teacher readiness are related among Chinese language teachers in China. The results showed a strong positive path from TPACK to EdTech suitability and a further positive path from EdTech suitability to readiness. These findings suggest that knowing how to integrate technology is important, but teachers also need technologies that they regard as accurate, useful, and appropriate for their teaching context.

The findings therefore shift attention from technology access alone to the quality of fit between teacher knowledge, subject requirements, and the digital tools available. For Chinese language education, this means that professional development should help teachers evaluate content fidelity, feedback, and pedagogical usefulness as well as build technical skill.

For institutions and policymakers, the practical implication is similar. Technology should be selected and supported in relation to educational purpose. A technically advanced platform will not necessarily improve teaching if teachers do not trust its content, understand how to use it, or receive the support needed to integrate it into lessons.

Taken together, the study supports a more contextual view of digital readiness. Teacher competence matters, but readiness is also shaped by the suitability of the tools teachers are asked to use. This combined perspective offers a more useful basis for professional development and EdTech decision-making in Chinese language education.

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