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Examining the Relationship Between TPACK Knowledge and Integration of Educational Technology Tools Among In-Service Chinese Language Teachers in Rural China

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Abstract: This study examines the role of Technological Pedagogical Content Knowledge (TPACK) in Educational Technology (EdTech) integration among in-service Chinese language teachers in rural China. Using a cross-sectional survey of 506 teachers, findings indicate that Technological Pedagogical Knowledge (TPK) is the strongest predictor of EdTech adoption, significantly enhancing instructional efficacy and adaptability. Technological Knowledge (TK) and Technological Content Knowledge (TCK) also contribute, while Pedagogical Knowledge (PK) and Content Knowledge (CK) show minimal impact. The study highlights the need for TPK-focused professional development and cost-effective digital solutions to bridge rural resource gaps and promote equitable digital learning.

Keywords: TPACK, educational technology integration, in-service teachers, rural education, teacher professional development

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Introduction

The integration of technology into education has gained momentum globally, especially in the wake of the COVID-19 pandemic (UNESCO, 2020, April 22). The Chinese Ministry of Education has encouraged the adoption of Educational Technology (EdTech) tools to bridge educational disparities, particularly in rural areas(Jisc, 2020). However, the successful implementation of these tools requires teachers to possess Technological Pedagogical Content Knowledge (TPACK), which involves the intersection of technology, pedagogy, and content knowledge (Mishra & Koehler, 2006). In rural China, in-service teachers face unique challenges, including limited access to infrastructure and insufficient training, which affect their ability to integrate EdTech effectively (Abowitz & Toole, 2010). This study investigates the relationship between TPACK knowledge and the use of EdTech tools among in-service Chinese language teachers in rural areas (Abowitz & Toole, 2010).

While Chinese policies support the integration of technology in classrooms, many in-service teachers in rural areas lack the necessary TPACK skills to fully leverage these tools (Bates, 2015). This gap in knowledge and resources hinders the potential benefits of EdTech, particularly for older teachers who were not exposed to such technologies during their pre-service training (Akpabio & Ogiriki, 2017).

Research Hypotheses:

H1: There is a positive relationship between in-service teachers' TPACK knowledge and their effective use of EdTech tools in the classroom.
H2: In-service Chinese language teachers' self-reported Technological Knowledge (TK) will be a more significant predictor of their actual use of EdTech tools for language learning in the classroom compared to any other component of the TPACK framework (PK, CK, PCK, TCK, TPK).
H3: Pedagogical Knowledge (PK) and Technological Pedagogical Knowledge (TPK) are significant predictors of teachers' ability to integrate EdTech into their lessons.

Literature review

TPACK framework

The Technological Pedagogical Content Knowledge (TPACK) framework, introduced by Mishra and Koehler (2006), highlights the intersection of three core types of teacher knowledge: Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK)

(Bagozzi & Yi, 2012). This framework serves as a foundation for understanding how technology can be successfully integrated into teaching practices, ensuring that teachers are not just familiar with the content but also capable of using technology effectively within pedagogical strategies (Al-Mhasnah et al., 2018; Dalal et al., 2021).

The TPACK framework has been widely adopted in educational research as a tool to study the effective integration of technology in the classroom. Researchers like Angeli and Valanides (2009) emphasize that successful technology integration requires teachers to not only possess strong content knowledge but also understand the pedagogical implications of technological tools(Angeli & Valanides, 2009). The TPACK framework ensures that these elements work in harmony to promote effective teaching and learning (Başaran et al., 2020; Njiku et al., 2021).

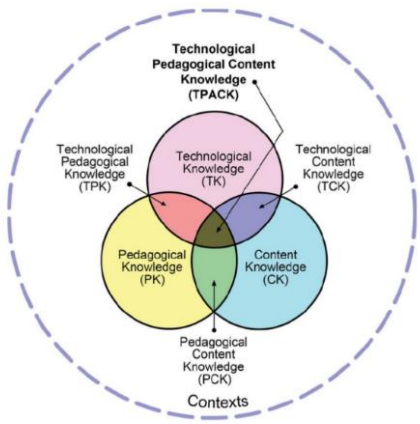

Figure 1. The TPACK framework (Mishra & Koehler, 2006)

Challenges in Technology Integration

In rural areas, particularly in countries like China, educators face unique challenges when attempting to integrate technology into their teaching. Limited infrastructure, lack of access to high-speed internet, and insufficient technical support often hinder the implementation of EdTech tools. Studies by Zhao et al. (2019) show that while urban areas benefit from greater access to resources and training, rural teachers struggle to keep up with rapid technological advancements(Morehead & LaBeau, 2005; Zhao et al., 2020). In addition to these infrastructural challenges, research by Wu (2019) indicates that older teachers often lack the Technological Knowledge (TK) necessary to adapt to modern educational technologies, a key component of the TPACK framework (Wu et al., 2019). Without sufficient professional development, these teachers remain reliant on traditional methods of instruction, which may not engage students as effectively in the digital age (Ramorola, 2013)(Karakaya Cirit & Canpolat, 2019)(Graham, 2011; Kiray, 2016).

Importance of Professional Development

Professional development plays a crucial role in enhancing teachers' TPACK knowledge (Agustini et al., 2019). In-service training programs aimed at increasing teachers' Technological Pedagogical Knowledge (TPK) have been shown to improve their confidence and ability to integrate EdTech tools into the classroom. Research by Koh et al. (2015) suggests that teachers who receive comprehensive training in technology integration are more likely to adopt innovative teaching practices, which can lead to improved student outcomes (Koh, 2024; Mundry, 2005).

However, there remains a gap in the literature regarding the effectiveness of such programs in rural areas. While there is significant evidence of the positive impact of professional development in well-resourced schools, studies on rural schools suggest that the lack of ongoing support and resources may limit the long-term impact of training (Kilag & Sasan, 2023).

Methodology

This section outlines the research design and methodology utilized to investigate the relationship between in-service Chinese language teachers' Technological Pedagogical Content Knowledge (TPACK) and their integration of Educational Technology (EdTech) tools in rural public primary and secondary schools in China. This comprehensive methodology includes the research philosophy, ethical considerations, population and sampling methods, data collection procedures, and data analysis techniques.

Research Design

This study employs a quantitative research design focused on assessing the relationships between variables to establish cause-and-effect relationships(Tranfield et al., 2003). The design utilizes both descriptive and causal-comparative methods, with a cross-sectional survey administered to gather data on the TPACK knowledge and EdTech integration levels of in-service Chinese language teachers(Saunders et al., 2015; Sekaran & Bougie, 2016).. Using a cross-sectional survey method, data were collected at a single point in time to assess the TPACK knowledge and EdTech tool usage among teachers in rural Anhui province, China. Surveys are effective for capturing a wide array of attitudes and behaviors, allowing for high levels of generalizability in findings (Earl-Babbie, 2013; Flick, 2015)

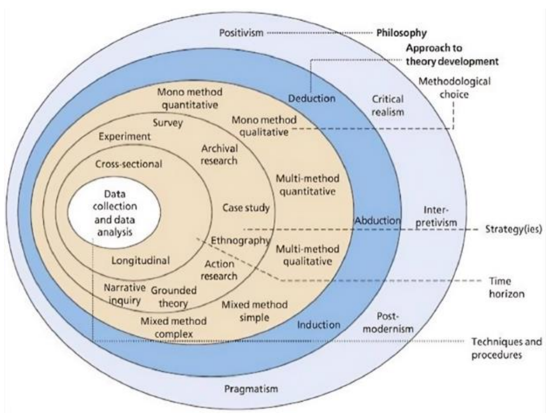

Figure 2. The research onion, Sources: (Saunders et al.)

This figure illustrates the different layers influencing the research methodology, including research philosophy, approaches, strategies, and data collection methods.

Population and Sampling

The target population for this study consists of in-service Chinese language teachers currently teaching in rural public primary and secondary schools in Anhui province. The study will employ a stratified random sampling method to ensure representation across different geographical regions (West, East, South, and North) of Anhui province. This method will enhance the validity of generalizations made about the population(Fraenkel et al., 1993; Nieveen & Folmer, 2013).

The sample will include 506 teachers, exceeding the minimum recommended sample size of 480 as calculated using Krejcie and Morgan's (1970) table for determining sample sizes from a given population. An additional 26 responses were collected beyond the targeted sample size of 480 to ensure data reliability and account for any incomplete or unusable responses. This increase accounts for potential non-responses and incomplete surveys (Chuan & Penyelidikan, 2006; Krejcie, 1970).

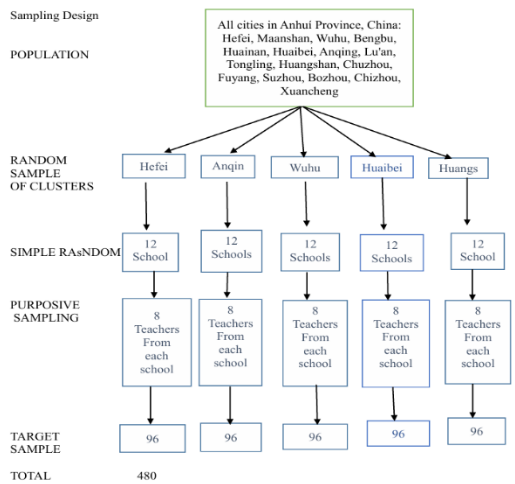

Figure 3. Stratified random sampling(Krejcie,1970)

This figure depicts the stratified random sampling approach, illustrating how various clusters of teachers are selected for inclusion.

Data Collection Procedures

Data have been collected using an online survey administered through a widely used platform in China. The survey will consist of three sections:

- **Section A**: TPACK Survey, adapted from Schmidt et al. (2009), containing items measuring Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), and Technological Content Knowledge (TCK)(Schmidt et al., 2009).
- **Section B:** EdTech Tools Usability Survey, adapted from Christensen & Knezek (2017), measuring teachers' confidence in using various EdTech tools(Christensen & Knezek, 2017).

- **Section C:** Demographic Profile, collecting relevant information about the respondents.

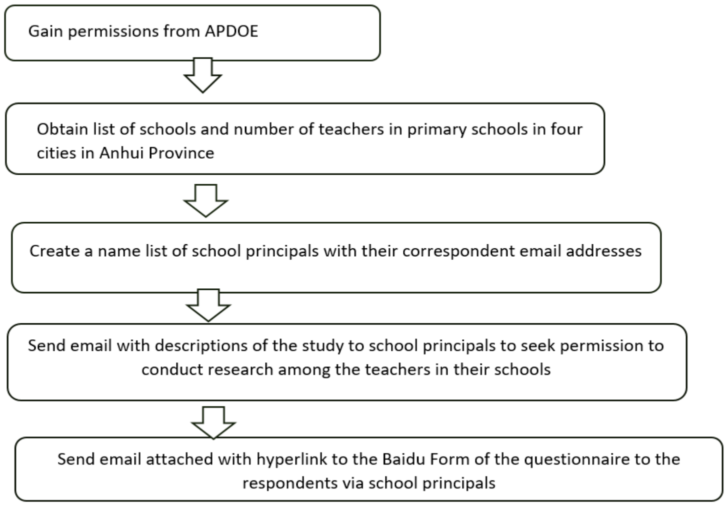

Figure 4. Summary of the procedures in data collection

To ensure reliability and validity, the survey instruments will undergo a pilot test with a small group of teachers prior to full deployment.

Results and analysis

The first stage of data analysis was to identify and classify the types of all variables. The survey questions employed a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) to quantitatively assess the participants' responses. Data collected from the TPACK and EdTech surveys through WJX (Wen Juan Xing) were coded and entered into SPSS for analysis. The primary objective was to examine the correlation between the different elements of TPACK—specifically Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), and Technological Content Knowledge (TCK)—and the teachers' reported use of EdTech tools in language education. Participants responded to survey items that addressed the perceived opportunities, benefits, challenges, and external factors influencing the integration of EdTech tools in their classrooms. These responses were analyzed and compared with their corresponding TPACK survey results to evaluate correlations across multiple dimensions.The variables were organized as distinct elements of the TPACK framework (CK, PK, PCK, TK, TPK, and TCK) and were further explored for their relationship to the use of EdTech tools in language instruction. The findings were represented in correlation matrices and figures, highlighting the key relationships among the different variables.

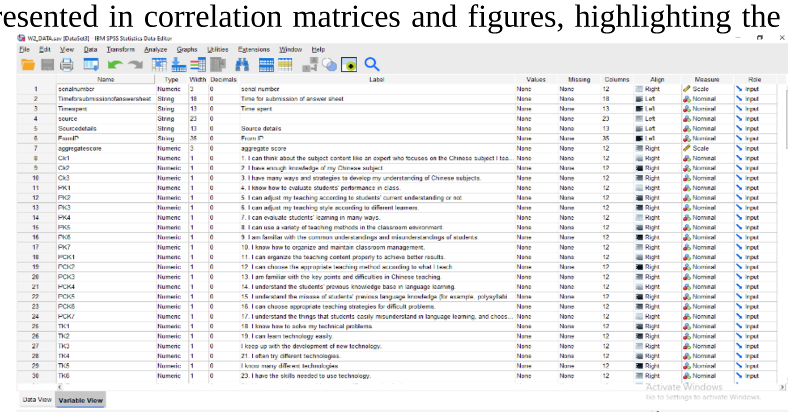

Figure 5. SPSS data coding screenshot

A total of 506 valid responses were received for the survey, representing a 100% response rate. The analysis is organized into case processing summaries, descriptive statistics, and advanced statistical tests such as normality and correlation assessments to understand the relationship between TPACK knowledge and the integration of educational technology tools (Table 1).

Table 1. Case processing summary

Case Processing Summary						
	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
TPACK	506	100.0%	0	0.0%	506	100.0%
EdTech	506	100.0%	0	0.0%	506	100.0%

Table 2. Descriptive table for Skewness & Kurtosis

Descriptive				
			Statistic	Std. Error
TPACK	Mean		4.0308	0.02714
	95% Confidence Interval for Mean	Lower Bound	3.9774	
		Upper Bound	4.0841	
	5% Trimmed Mean		4.0402	
	Median		4.0000	
	Variance		0.373	
	Std. Deviation		0.61053	
	Minimum		2.54	
	Maximum		5.00	
	Range		2.46	
	Interquartile Range		0.86	
	Skewness		0.031	0.109
	Kurtosis		-0.739	0.217
EdTech	Mean		3.9615	0.02738
	95% Confidence Interval for Mean	Lower Bound	3.9077	
		Upper Bound	4.0153	
	5% Trimmed Mean		3.9656	
	Median		3.9750	
	Variance		0.379	
	Std. Deviation		0.61584	
	Minimum		2.17	
	Maximum		5.00	

	Range	2.83	
	Interquartile Range	0.88	
	Skewness	0.019	0.109
	Kurtosis	-0.572	0.217

Table 2 provides descriptive statistics for TPACK and EdTech scores. The mean scores are 4.03 and 3.96, with standard deviations of 0.61 and 0.62, respectively, indicating moderate variability around the means. Both skewness and kurtosis values fall within the accepted thresholds (absolute skewness < 0.8 and kurtosis < 2), suggesting normality: TPACK shows a skewness of 0.031 and kurtosis of -0.739, while EdTech has a skewness of 0.019 and kurtosis of -0.572. Both variables have similar ranges and interquartile ranges, indicating a consistent spread and normal distribution suitable for further analysis.

Table 3. Tests of normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TPACK	0.091	506	<0.001	0.956	506	<0.001
EdTech	0.106	506	<0.001	0.965	506	<0.001

a. Lilliefors Significance Correction

The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to assess normality for TPACK and EdTech scores, with significance values (Sig.) of less than 0.001 for both tests, as shown in Table 3. These statistically significant results indicate that the data deviated from a normal distribution. To address this, three outlier cases were identified and removed to improve normality (Table 3). Additionally, a histogram (Figure 6) was generated to visualize the distribution, and a normal Q-Q plot of the residuals was examined (see Figure 7).

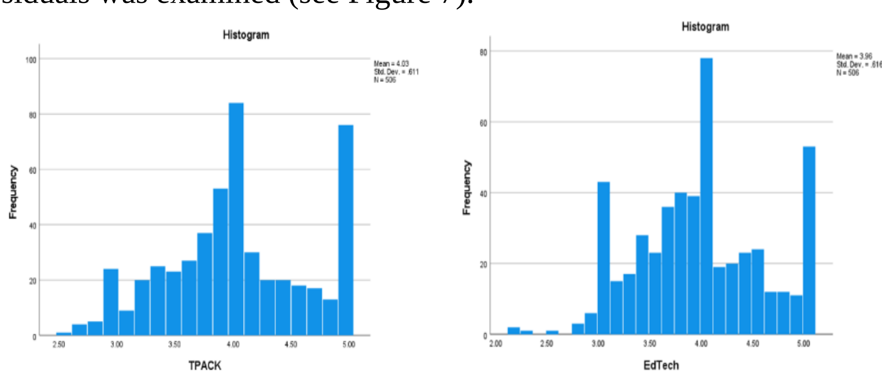

Figure 6. Distribution histogram

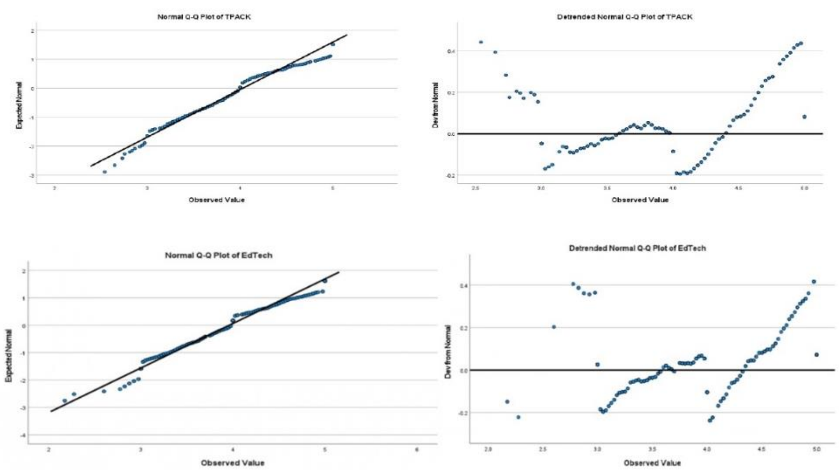

Figure 7. Normal Q-Q plot of difference chart

The Q-Q plots for TPACK and EdTech show that while most points closely follow the diagonal line, indicating approximate normality, the deviations at the tails suggest some departure from a perfectly normal distribution. The detrended plots further highlight these deviations, particularly in the upper and lower values.

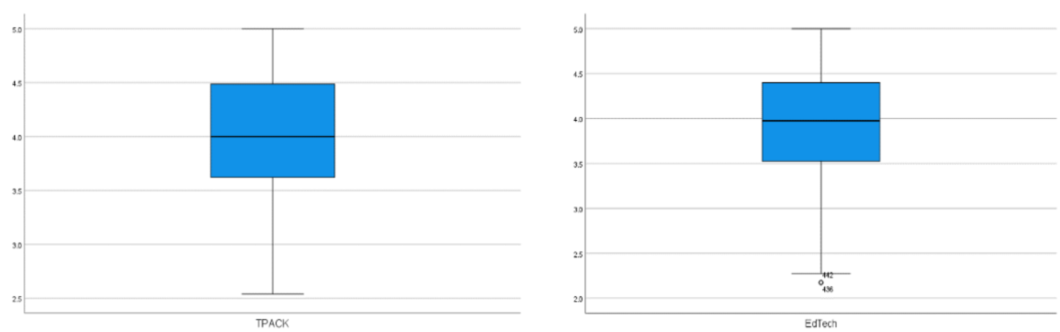

Figure 8. Boxplot of normal distribution

Research Question 1: *What is the relationship between in-service teachers' knowledge of TPACK [(i)Technology Knowledge (TK); (ii) Pedagogy Knowledge (PK); (iii) Content Knowledge (CK); (iv)Pedagogy Content Knowledge (PCK); (v)Technology Content Knowledge (TCK); (vi)Technology Pedagogy Knowledge (TPK)] and suitability of Education Technology (EdTech) tools in the Teaching and Learning Process in the Classroom.*

Following Research Question 1, the table (Table 4) aligns the six TPACK components (e.g., CK, PK, TPK) with stages of EdTech adoption (e.g., awareness, implementation, advanced application). Each TPACK domain (measured by variables like *CK_Q1* or *TPK_Q1*) corresponds to specific EdTool integration stages, captured through survey items such as *PO_Q1* (Possibilities) and *B_Q1* (Benefits). Early stages (1–2) focus on foundational knowledge (CK, PK) and exploring EdTech potential, while intermediate stages (3–6) link pedagogical-content benefits (PCK) to implementation. Advanced stages (7–10) prioritize technological preferences (TCK, TK) and external influences (TPK), reflecting teachers' progression from basic awareness to sophisticated, context-driven EdTech application. The framework underscores how TPACK competencies scaffold incremental adoption, with TPK emerging as pivotal for adapting tools to rural constraints.

	Content Knowledge (CK) With Possibility	**Pedagogy Knowledge (PK) with Benefit _a (B)**	**Pedagogy Content Knowledge (PCK) with Benefit _b (B)**	**Technology Knowledge (TK) with Preference _a (PR)**	**Technology Content Knowledge (TCK) with Preference _b (PR)**	**Technology Pedagogy Knowledge (TPK) with External Influence (EI)**
Variables from TPACK survey	Ck_Q1 Ck_Q2 Ck_Q3	PK_Q1 PK_Q2 PK_Q3 PK_Q4 PK_Q5 PK_Q6 PK_Q7	PCK_Q1 PCK_Q2 PCK_Q3 PCK_Q4 PCK_Q5 PCK_Q6 PCK_Q7	TK_Q1 TK_Q2 TK_Q3 TK_Q4 TK_Q5 TK_Q6 TK_Q7	TCK_Q1 TCK_Q2 TCK_Q3 TCK_Q4	TPK_Q1 TPK_Q2 TPK_Q3 TPK_Q4 TPK_Q5
Variables from EdTech survey	Factor 1 (Possibilities) Possibilities of using Edtech PO_Q1 PO_Q2 PO_Q3 PO_Q4 PO_Q5 PO_Q6 PO_Q7 PO_Q8 PO_Q9 PO_Q10 PO_Q11	Factor 2a (Pedagogical Benefits in EdTech Integration) B_Q1 B_Q2 B_Q3 B_Q4 B_Q5 B_Q6	Factor 2b (Content-Specific Benefits in EdTech Integration) B_Q7 B_Q8 B_Q9 B_Q10 B_Q11 B_Q12	Factor 3a (Technological Preferences in EdTech Usage) PR_Q1 PR_Q2 PR_Q3 PR_Q4 PR_Q5 PR_Q6 PR_Q7 PR_Q8 PR_Q9	Factor 3b (Advanced Technological Preferences) PR_Q10 PR_Q11 PR_Q12 PR_Q13	Factor 4 (Influence of External Factors on EdTech Adoption) EI_Q1 EI_Q2 EI_Q3 EI_Q4
Frequencies of stage of adoption for participants	Stage 1: Awareness Stage 2: Exploring tools	Stage 3: Implementation Stage 4: Identifying benefits	Stage 5: Combining Methods with Content Stage 6: Using Tools to Enhance Learning	Stage 7: Acquiring Knowledge about different technology Stage 8: Applying Tools to specific method	Stage 9: Accessing and prioritizing preferences Stage 10: Advance application	Stage 10: Adapting to external influence

Table 4. Complete data variables analysis aligned with the research questions

Correlations

			PO	CK
Kendall's tau_b	PO	Correlation Coefficient	1.000	.552**
		Sig. (2-tailed)	.	<.001
		N	506	506
	CK	Correlation Coefficient	.552**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(a)

Correlations

			B_a	PK
Kendall's tau_b	B_a	Correlation Coefficient	1.000	.567**
		Sig. (2-tailed)	.	<.001
		N	506	506
	PK	Correlation Coefficient	.567**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(b)

Correlations

			B_b	PCK
Kendall's tau_b	B_b	Correlation Coefficient	1.000	.550**
		Sig. (2-tailed)	.	<.001
		N	506	506
	PCK	Correlation Coefficient	.550**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(c)

Correlations

			PR_a	TK
Kendall's tau_b	PR_a	Correlation Coefficient	1.000	.586**
		Sig. (2-tailed)	.	<.001
		N	506	506
	TK	Correlation Coefficient	.586**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(d)

Correlations

			PR_b	TCK
Kendall's tau_b	PR_b	Correlation Coefficient	1.000	.608**
		Sig. (2-tailed)	.	<.001
		N	506	506
	TCK	Correlation Coefficient	.608**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(e)

Correlations

			EI	TPK
Kendall's tau_b	EI	Correlation Coefficient	1.000	.529**
		Sig. (2-tailed)	.	<.001
		N	506	506
	TPK	Correlation Coefficient	.529**	1.000
		Sig. (2-tailed)	<.001	.
		N	506	506

**. Correlation is significant at the 0.01 level (2-tailed).

(f)

Figure 9. Correlation statistics for research question, (a) PO and CK, (b) B_a and PK, (c) B_b and PCK, (d) PR_a and TK, (e) PR_b and TCK, (f) EI and TPK

Note: N = 506, Kendall's tau-b correlation coefficient is significant at the 0.01 level (2-tailed).

A Kendall's Tau-b test was conducted to examine the correlation between PO (M = [mean], SD = [SD]) and CK (M = [mean], SD = [SD]) across 506 participants. The correlation between PO and CK was statistically significant ($\tau b = 0.552$, $p < 0.001$), as shown in Table X. Therefore, there is a positive and significant relationship between PO and CK, with the correlation coefficient $\tau b = 0.552$, indicating a moderate positive association. A Kendall's Tau-b test was run to assess the correlation between B_a (M = [mean], SD = [SD]) and PK (M = [mean], SD = [SD]) among 506 participants. There was a statistically significant correlation between B_a and PK ($\tau b = 0.567$, $p < 0.001$) as shown in Table X. This suggests a moderate positive relationship between B_a and PK. To investigate the relationship between B_b (M = [mean], SD = [SD]) and PCK (M = [mean], SD = [SD]), a Kendall's Tau-b test was used among 506 participants. Results indicate a statistically significant correlation ($\tau b = 0.550$, $p < 0.001$), as shown in Table X. This positive correlation suggests a moderate association between B_b and PCK. A Kendall's Tau-b correlation test was performed to determine the relationship between PR_a (M = [mean], SD = [SD]) and TK (M = [mean], SD = [SD]) for 506 participants. A significant correlation was found ($\tau b = 0.586$, $p < 0.001$), as shown in Table X. This indicates a moderate positive relationship between PR_a and TK. Using Kendall's Tau-b test, the correlation between PR_b (M = [mean], SD = [SD]) and TCK (M = [mean], SD = [SD]) was examined across 506 participants. The correlation was statistically significant ($\tau b = 0.608$, $p < 0.001$), as shown in Table X, suggesting a moderate positive association between PR_b and TCK. Finally, a Kendall's Tau-b test was conducted to analyze the correlation between EI (M = [mean], SD = [SD]) and TPK (M = [mean], SD = [SD]) among 506 participants. The correlation was statistically significant ($\tau b = 0.529$, $p < 0.001$), as indicated in Table X, signifying a moderate positive relationship between EI and TPK.

Research Question 2: *Which elements of the TPACK framework (CK, PK, PCK, TK, TCK, TPK) are most critical in influencing the successful integration of EdTech tools by in-service Chinese language teachers in rural public primary and junior secondary schools under compulsory education in China?*

This question investigates the Technological Pedagogical Content Knowledge (TPACK) framework—specifically, its six core elements: Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Knowledge (TK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK). The primary goal is to assess the impact of each component on EdTech tool integration among in-service Chinese language teachers in rural, compulsory education settings in China.

H2: *In-service Chinese language teachers' self-reported Technological Knowledge (TK) will be a more significant predictor of their actual use of EdTech tools for language learning in the classroom compared to any other component of the TPACK framework (PK, CK, PCK, TCK, TPK).*

Hypothesis (H2) suggests that teachers' Technological Knowledge (TK) will be a significant predictor of EdTech tool usage for language learning in classrooms, surpassing other TPACK elements.

Table 5. Descriptive analysis of TPACK elements in EdTech integration explanation

	N	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
PO	506	1.64	5.00	4.0963	.02881	.64797	.420
B	506	1.83	5.00	4.0728	.02893	.65065	.423
PR	506	2.08	5.00	3.7796	.03190	.71747	.515
EI	506	2.00	5.00	3.8483	.03131	.70419	.496
CK	506	1.33	5.00	4.0158	.03377	.75966	.577
PK	506	2.43	5.00	4.1894	.02709	.60932	.371
PCK	506	2.57	5.00	4.1533	.02697	.60677	.368
TK	506	1.57	5.00	3.8560	.03267	.73495	.540
TCK	506	2.00	5.00	3.9382	.03181	.71564	.512
TPK	506	2.00	5.00	3.9711	.03072	.69102	.478
Valid N (listwise)	506						

Table 5. displays descriptive statistics for 506 teachers across various TPACK components. Each row lists the minimum, maximum, mean, standard deviation, and variance for components such as Pedagogical Knowledge (PK) and Technological Knowledge (TK). PK exhibits the highest mean score (4.1894), indicating it is a key strength among teachers, while TK has higher variance (0.73495), pointing to greater variability in technological proficiency.

Figure 10. Multiple linear regression

Table 6. Regression analysis of TPACK predictors on EdTech tool categories (PO, B, PR, EI)

EdTech Tool	Predictor	Unstandardized Coefficients (B)	Standardized Coefficients (Beta)	t-value	p-value (Sig.)	Significance
Possibility (PO)	CK	0.074	0.086	1.880	0.061	Not Significant
	PK	0.085	0.080	1.199	0.231	Not Significant
	PCK	0.158	0.147	2.176	0.030	Significant
	TK	-0.143	-0.162	-2.522	0.012	Significant
	TCK	0.265	0.293	4.054	< 0.001	Significant
	TPK	0.370	0.395	5.609	< 0.001	Significant
Benefits (B)	CK	0.080	0.093	2.001	0.046	Significant
	PK	0.031	0.029	0.436	0.663	Not Significant
	PCK	0.208	0.194	2.829	0.005	Significant
	TK	-0.097	-0.110	-1.689	0.092	Not Significant
	TCK	0.247	0.272	3.719	< 0.001	Significant
	TPK	0.339	0.360	5.050	< 0.001	Significant
Preference (PR)	CK	0.036	0.038	0.836	0.404	Not Significant
	PK	-0.124	-0.105	-1.590	0.112	Not Significant
	PCK	0.160	0.136	2.012	0.045	Significant
	TK	0.253	0.259	4.062	< 0.001	Significant
	TCK	0.243	0.243	3.382	< 0.001	Significant
	TPK	0.272	0.262	3.747	< 0.001	Significant
External Influence (Ei)	CK	0.048	0.052	0.912	0.362	Not Significant
	PK	-0.005	-0.004	-0.049	0.961	Not Significant
	PCK	0.221	0.190	2.285	0.023	Significant
	TK	0.069	0.072	0.906	0.365	Not Significant
	TCK	0.144	0.147	1.653	0.099	Not Significant
	TPK	0.254	0.249	2.882	0.004	Significant

The regression analysis highlights the role of TPACK components in influencing EdTech tool adoption, with Technological Pedagogical Knowledge (TPK) emerging as the most critical factor across all four categories: Possibility (PO), Benefits (B), Preference (PR), and External Influence (EI). TPK demonstrates statistically significant effects in each category, with the highest standardized Beta values among predictors, indicating its robust impact on successful EdTech integration. For instance, in the PO category, TPK yields a Beta of 0.395 with a p-value of <0.001, underscoring its importance. Similarly, TPK remains significant in the B, PR, and EI categories, consistently showing higher Beta values than other components. This suggests that TPK—a blend of technological and pedagogical expertise—is crucial for EdTech adoption, as it enables teachers to effectively integrate technology into pedagogy. In contrast, other predictors, such as Pedagogical Content Knowledge (PCK) and Technological Content Knowledge (TCK), show significant but comparatively lower Beta values, indicating their secondary role. Components like Content Knowledge (CK) and Pedagogical Knowledge (PK) exhibit limited significance, suggesting minimal impact on EdTech tool usage. Overall, the analysis positions TPK as the key component for driving EdTech integration, reflecting the necessity of merging technological and pedagogical knowledge in educational practices.

Research Question 3: *What are the alternative approaches that can be used by in-service teachers in implementing and integrating (effectively and cost-effective) Education Technology (EdTech) tools in the classroom despite undergo challenges of implementing them in public rural primary and secondary schools in China?*

In-service teachers in rural China can consider alternative, cost-effective approaches to integrating EdTech tools in classrooms despite challenges. Key strategies include (1) utilizing free or low-cost digital resources and open-source platforms that provide curriculum-aligned content, (2) creating peer networks for sharing tech-based instructional methods and resources, and (3) prioritizing professional development programs focusing on Technological Pedagogical Knowledge (TPK) to improve teachers' capability to adapt EdTech tools without relying on expensive infrastructure. Collaborations with local community organizations can also help supplement technical support.

Conclusion

This study underscores the importance of Technological Pedagogical Content Knowledge (TPACK), particularly Technological Pedagogical Knowledge (TPK), in enabling rural Chinese language teachers to integrate Educational Technology (EdTech) tools effectively. The findings highlight that while infrastructure and resource limitations pose significant challenges, TPK can empower teachers to overcome these barriers, allowing them to adapt and use EdTech in pedagogically sound ways. Cost-effective strategies, such as using open-source resources, building peer support networks, and prioritizing TPK-focused professional development, are essential for sustainable EdTech adoption in rural settings. Strengthening TPACK, especially TPK, equips teachers not only with practical skills but also with the confidence to leverage technology in enhancing student engagement and learning outcomes. This study supports the continued development of training programs and EdTech resources aligned with rural needs, promoting a more inclusive digital learning environment across China's diverse educational landscape.

Disclosure Statement

The authors declare no conflict of interest. The study was conducted independently, and no external organization influenced the design, data collection, analysis, interpretation, writing, or publication of the results.

Ethical Approval

This study received ethical approval from the Survey and Behavioral Research Ethics Committee of the authors' affiliated institution.

Informed Consent Statement

All participants were informed about the purpose and procedures of the study and provided written voluntary informed consent before participation.

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References

Abowitz, D. A., & Toole, T. M. (2010). Mixed method research: Fundamental issues of design, validity, and reliability in construction research. *Journal of construction engineering and management*, *136*(1), 108-116.

Agustini, K., Santyasa, I., & Ratminingsih, N. (2019). Analysis of competence on “TPACK”: 21st century teacher professional development. Journal of Physics: Conference Series,

Akpabio, E., & Ogiriki, I. B. (2017). Teachers use of information and communication technology (ICT) in teaching English language in senior secondary schools in Akwa Ibom state. *Equatorial journal of education and curriculum studies*, *2*(2), 28-23.

Al-Mhasnah, A., Salleh, F., Afthanorhan, A., & Ghazali, P. (2018). The relationship between services quality and customer satisfaction among Jordanian healthcare sector. *Management Science Letters*, *8*(12), 1413-1420.

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & education*, *52*(1), 154-168.

Bagozzi, R. P., & Yi, Y. (2012). Specification, evaluation, and interpretation of structural equation models. *Journal of the academy of marketing science*, *40*, 8-34.

Başaran, M., Doğan, E., Karaoğlu, E., & Şahin, E. (2020). Koronavirüs (Covıd-19) pandemi sürecinin getirisi olan uzaktan eğitimin etkililiği üzerine bir çalışma. *Academia Eğitim Araştırmaları Dergisi*, *5*(2), 368-397.

Bates, T. (2015). Teaching in a digital age: Guidelines for designing teaching and learning. BCcampus Open Education. In.

Christensen, R., & Knezek, G. (2017). Readiness for integrating mobile learning in the classroom: Challenges, preferences and possibilities. *Computers in human behavior*, *76*, 112-121.

Chuan, C. L., & Penyelidikan, J. (2006). Sample size estimation using Krejcie and Morgan and Cohen statistical power analysis: A comparison. *Jurnal Penyelidikan IPBL*, *7*(1), 78-86.

Dalal, M., Archambault, L., & Shelton, C. (2021). Fostering the growth of TPACK among international teachers of developing nations through a cultural exchange program. *Australasian Journal of Educational Technology*, *37*(1), 43-56.

Earl-Babbie, M. (2013). The practice of social research. *Wadsworth, Thomson Learning Inc*.

Flick, U. (2015). *Introducing research methodology: A beginner's guide to doing a research project*. Sage.

Fraenkel, J., Wallen, N., & Hyun, H. (1993). *How to Design and Evaluate Research in Education 10th ed*. McGraw-Hill Education.

Graham, C. R. (2011). Theoretical considerations for understanding technological pedagogical content knowledge (TPACK). *Computers & Education*, *57*(3), 1953-1960.

Jisc. (2020). *Digital capabilities in the UK FE and HE workforce: An exploration of staff confidence and practice.* . Jisc. https://www.jisc.ac.uk/reports/student-digital-experience-insights-survey-2020-uk-higher-education-findings

Karakaya Cirit, D., & Canpolat, E. (2019). A study on the technological pedagogical contextual knowledge of science teacher candidates across different years of study. *Education and Information Technologies*, *24*, 2283-2309.

Kilag, O. K. T., & Sasan, J. M. (2023). Unpacking the role of instructional leadership in teacher professional development. *Advanced Qualitative Research*, *1*(1), 63-73.

Kiray, S. A. (2016). Development of a TPACK self-efficacy scale for preservice science teachers. *International Journal of Research in Education and Science*, *2*(2), 527-541.

Koh, S. Y. (2024). Lifestyle migrants' urban citizenship and right to have rights: The Malaysia My Second Home (MM2H) programme during a time of crisis. *Cities*, *153*, 105308.

Krejcie, R. (1970). Determining sample size for research activities. *Educational Psychol Meas*.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers college record*, *108*(6), 1017-1054.

Morehead, P., & LaBeau, B. (2005). The continuing challenges of technology integration for teachers. *Essays in Education*, *15*(1), 10.

Mundry, S. (2005). Changing perspectives in professional development. *Science educator*, *14*(1), 9-15.

Nieveen, N., & Folmer, E. (2013). Formative evaluation in educational design research. *Design Research*, *153*(1), 152-169.

Njiku, J., Mutarutinya, V., & Maniraho, J. F. (2021). Building Mathematics Teachers' TPACK through Collaborative Lesson Design Activities. *Contemporary Educational Technology*, *13*(2).

Ramorola, M. Z. (2013). Challenge of effective technology integration into teaching and learning. *Africa Education Review*, *10*(4), 654-670.

Saunders, L., Zhu, H., Bunce, C., Doré, C., Freemantle, N., Crabb, D., & Group, O. S. *(2015)*.

Saunders, M. N., Lewis, P., Thornhill, A., & Bristow, A. (2015). Understanding research philosophy and approaches to theory development.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of research on Technology in Education*, *42*(2), 123-149.

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. john wiley & sons.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), 207-222.

UNESCO. (2020, April 22). *COVID-19 educational disruption and response.* UNESCO. Retrieved 22-06-2024 from https://geo.uis.unesco.org/covid-19

Wu, D., Li, C.-C., Zhou, W.-T., Tsai, C.-C., & Lu, C. (2019). Relationship between ICT supporting conditions and ICT application in Chinese urban and rural basic education. *Asia Pacific education review*, *20*, 147-157.

Zhao, S., Lin, Q., Ran, J., Musa, S. S., Yang, G., Wang, W., Lou, Y., Gao, D., Yang, L., & He, D. (2020). Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. *International journal of infectious diseases*, *92*, 214-217.