ISSN: 2584-0231(Online)
International Journal of Multidisciplinary Research in Arts, Science and Technology
© IJMRAST | Vol. 4 | Issue 1 | January 2026
Available online at: https://ijmrast.com
DOI: https://doi.org/10.61778/ijmrast.v4i1.221

Exploring C-TPACK (TPACK with Contextual Knowledge) in Asian Educational Perspectives: A Review Study

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Abstract

The integration of Technological Pedagogical Content Knowledge (TPACK) into educational practices has gained significant attention, particularly in Asian contexts where cultural, institutional, and technological factors shape its application. This systematic literature review examines how TPACK and contextual knowledge (C-TPACK) interact within Asian educational settings, addressing gaps in understanding the region-specific adaptations and challenges. We focus on five key dimensions: TPACK scale development and validation, its application across subject areas, influencing factors, developmental strategies, and technological integration in education. By synthesizing existing research, we identify patterns and disparities in how TPACK frameworks are conceptualized, implemented, and evaluated across diverse Asian environments. The review reveals that while TPACK adoption aligns with global trends, localized contextual knowledge profoundly influences its effectiveness, often necessitating modifications to standard models. Methodologically, we employed a rigorous screening process to select relevant studies, ensuring a comprehensive analysis of theoretical and empirical contributions. Findings highlight the critical role of teacher training, institutional support, and cultural alignment in fostering TPACK competence, while also underscoring the need for more context-sensitive assessment tools. The study concludes by proposing directions for future research, emphasizing the importance of culturally grounded TPACK frameworks to better address the unique educational landscapes of Asia. This review contributes to the broader discourse on technology-enhanced teaching by offering insights into the interplay between universal TPACK principles and regional contextual dynamics

Keywords: *TPACK, contextual knowledge, Asia*

Introduction

The rapid evolution of digital technologies has transformed educational landscapes worldwide, necessitating a re-examination of teachers' professional knowledge frameworks. Among these, the Technological Pedagogical Content Knowledge (TPACK) model, introduced by (Mishra and Koehler,

2006), has emerged as a pivotal construct for understanding how educators integrate technology into subject-specific pedagogy. TPACK posits that effective technology integration requires an interplay between content knowledge, pedagogical knowledge, and technological knowledge, forming a dynamic intersection that is context-dependent. While this framework has been widely adopted globally, its application in Asian educational contexts presents unique challenges and opportunities due to region-specific cultural, institutional, and infrastructural factors. In Asia, educational systems are often characterised by centralised curricula, high-stakes examinations, and varying levels of technological infrastructure (Ziguras, 2001). These contextual elements influence how teachers perceive and enact TPACK, often diverging from Western models where the framework was originally conceptualised. For instance, Confucian heritage cultures emphasise teacher-centred instruction and hierarchical classroom dynamics, which may conflict with the student-centred, collaborative approaches typically associated with technology-enhanced learning (Nguyen et al., 2006). Moreover, disparities in digital access between urban and rural areas further complicate equitable TPACK implementation across the region. Such contextual nuances underscore the need to investigate how TPACK is adapted, validated, and operationalised in Asian settings. Despite growing interest in TPACK research, significant gaps remain in understanding its contextualised manifestations in Asia. First, most TPACK scale validation studies have been conducted in Western contexts, raising questions about their cross-cultural applicability (Aleman-Saravia et al., 2023). Second, while subject-specific TPACK studies exist, few systematically compare how disciplinary differences interact with regional educational policies and practices (Tseng et al., 2022). Third, the role of macro-level factors such as national ICT policies, school leadership, and socio-economic conditions in shaping TPACK development remains underexplored (Castera et al., 2020). These gaps highlight the need for a comprehensive synthesis of how contextual knowledge mediates TPACK theorisation and implementation across diverse Asian environments. The motivation for this study stems from three key observations. First, Asia's educational systems are undergoing rapid digital transformation, yet the effectiveness of these initiatives depends on teachers' ability to contextualise TPACK principles. Second, the region's cultural and institutional diversity offers a rich ground for examining how universal TPACK constructs are localised. Third, existing reviews have predominantly focused on Western contexts, leaving Asian perspectives underrepresented in the global TPACK discourse. By addressing these gaps, this review contributes to both theoretical and practical dimensions of technology integration. Theoretically, it advances understanding of how cultural and systemic factors reshape TPACK frameworks. Practically, it provides evidence-based insights for policymakers and educators seeking to design contextually relevant professional development programmes.

Methodology

This literature review adheres to the PRISMA guidelines to ensure methodological rigor and transparency. We conducted searches across six major academic databases and search engines, prioritized based on their relevance to educational technology research. IEEE Xplore was selected for its extensive coverage of technology-focused education studies, while ACM Digital Library provided access to computer

science perspectives on pedagogical applications. Web of Science and Scopus were included for their comprehensive multidisciplinary coverage and robust citation tracking capabilities. ScienceDirect was chosen for its strong collection of education research articles, and SpringerLink for its specialized education technology journals. Google Scholar served as a supplementary source to identify potentially overlooked studies. The search strategy employed consistent keyword combinations across all databases, focusing on three core elements: TPACK ("TPACK" OR "Technological Pedagogical Content Knowledge"), contextual knowledge ("Contextual Knowledge"), and regional scope (Asia OR Asian). To maintain focus on primary research, we excluded review articles, meta-analyses, and survey papers using Boolean operators. The search was limited to peer-reviewed journal articles to ensure quality, with no restrictions on publication date to capture the full evolution of TPACK research in Asian contexts.

Analytical Framework

The review organizes findings along various research dimensions that emerged as central to understanding TPACKs contextualization in Asia. TPACK Scale Development and Validation examines how measurement tools have been adapted for Asian educational settings, considering cultural and linguistic factors. TPACK in Different Subject Areas explores discipline-specific manifestations of the framework, highlighting how subject epistemologies intersect with regional curricula. Factors Influencing TPACK investigates institutional, cultural, and individual variables that shape technology integration practices. TPACK Development and Application analyzes professional learning approaches and classroom implementation strategies. Finally, TPACK and Technological Integration in Education assesses how infrastructure and digital policies mediate the framework's effectiveness. These dimensions collectively provide a comprehensive lens for analyzing the interplay between universal TPACK principles and localized educational contexts.

Inclusion and Exclusion Criteria

Studies were included if they: (1) empirically investigated TPACK in Asian educational contexts, (2) explicitly addressed contextual knowledge factors, (3) were published in English-language peer-reviewed journals, and (4) provided sufficient methodological detail for quality assessment. We excluded theoretical papers without empirical data, studies focused solely on technological tools without TPACK integration, and articles lacking clear relevance to Asian contexts. No time restrictions were applied to capture the historical development of TPACK research in the region. The criteria ensured selected studies contributed meaningful insights about contextual adaptations while maintaining methodological diversity across qualitative, quantitative, and mixed-methods approaches.

Study Selection Process

The selection process followed a staged screening protocol to ensure rigor. Initial database searches yielded 1,132 records, which were reduced to 247 after duplicate removal and preliminary filtering. Title/abstract screening excluded 151 irrelevant studies, leaving 96 for full-text evaluation. Of these, 45 met basic eligibility criteria and were assessed for methodological quality using a checklist adapted from

Twenty-seven studies were excluded due to insufficient focus on contextual factors or weak research design, resulting in 18 high-quality articles for final analysis.

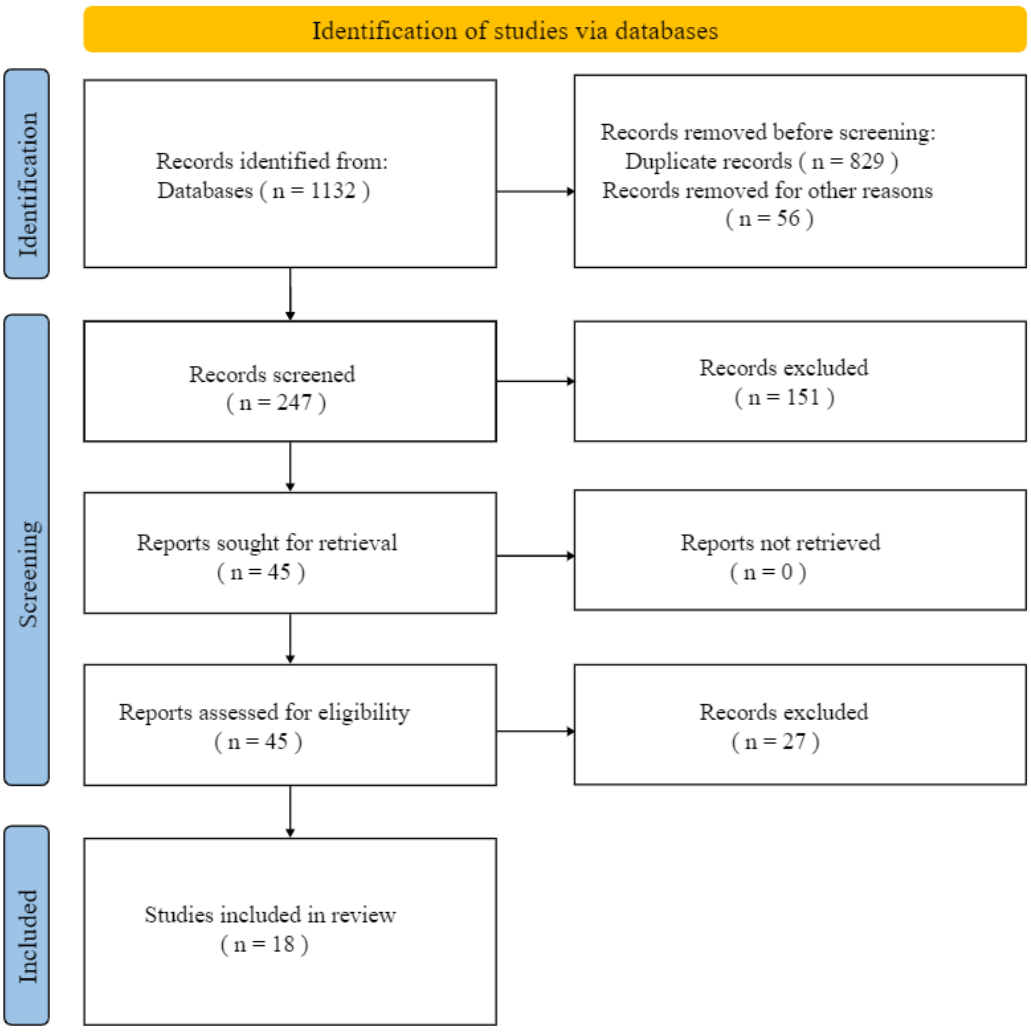

Figure 1: PRISMA Flowchart

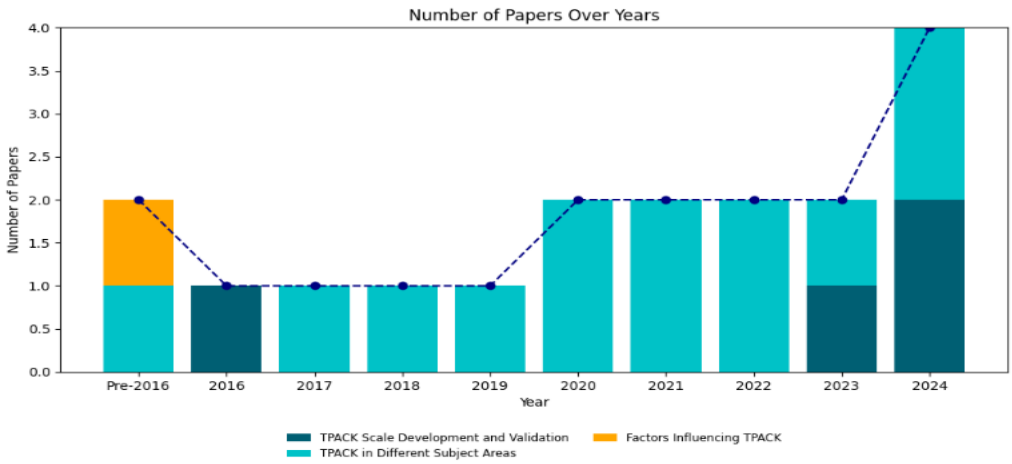

Figure 2. Research trends in TPACK and contextual knowledge studies from Asian perspectives

The temporal distribution of publications reveals distinct patterns in the evolution of TPACK research within Asian contexts. As illustrated in *Figure 2,* scholarly interest has shown consistent growth since 2016, with a notable acceleration in recent years. The period before 2016 accounted for only two studies,

suggesting that TPACK research in Asia was still in its nascent stages during this time. From 2016 to 2022, the field maintained steady progress with one to two publications annually, indicating gradual but sustained academic engagement with the framework. A significant surge occurred in 2024, with four studies published within the first half of the year alone. This upward trajectory suggests growing recognition of TPACKs relevance to Asian educational systems, possibly driven by increased digital transformation efforts across the region. The temporal distribution also reflects how global technological advancements and regional policy shifts have influenced research priorities over time. Early studies tended to focus on foundational aspects of TPACK conceptualization, while more recent works demonstrate greater methodological sophistication and contextual specificity.

Thematic analysis of publication trends reveals two dominant research strands- TPACK scale development and validation emerged as a persistent focus, with studies appearing in 2016, 2023, and 2024. This pattern indicates ongoing efforts to adapt measurement tools to Asian educational contexts, addressing cultural and linguistic particularities that may affect TPACK assessment The second major strand, TPACK application across subject areas, demonstrates remarkable consistency from 2017 through 2024. The sustained attention to discipline specific implementations suggests that researchers recognize the importance of tailoring the framework to diverse curricular requirements and pedagogical traditions prevalent in Asian schools.

TPACK Scale Development and Validation in Asian Contexts

The development and validation of TPACK measurement instruments in Asian educational settings have followed distinct trajectories, reflecting the need to adapt Western-originated frameworks to local pedagogical and cultural contexts. Asian researchers have predominantly employed quantitative validation approaches, with confirmatory factor analysis (CFA) being the most common method for testing the structural validity of TPACK scales (Choudhury et al., 2024). Studies such as (Li et al., 2023) and (Li et al., 2024) applied rigorous CFA procedures to examine the seven-factor TPACK model, consistently finding that technological knowledge (TK) and technological pedagogical knowledge (TPK) dimensions required cultural adaptation to maintain construct validity in Confucian-heritage classrooms.

A second validation approach combines exploratory factor analysis (EFA) with CFA, particularly for discipline-specific TPACK scales. Research by (Onal, 2016) on science teachers in Japan and (Gozali and Cahyono, 2022) on mathematics educators in South Korea demonstrated that subject-area nuances necessitated modifications to standard TPACK survey items. These studies revealed that Asian teachers' content knowledge structures, deeply rooted in regional curriculum standards, influenced their technological integration patterns differently than Western models predicted. The mixed-methods validation strand, exemplified by (Greene and Jones, 2020) and (Jang and Tsai, 2013), incorporated qualitative interviews with quantitative validation, uncovering how language-specific pedagogical terms and local teaching norms affected scale reliability.

First, general TPACK scales required significant modification for Asian contexts, particularly in technological knowledge items that assumed universal digital literacy levels. Second, discipline-specific validations revealed that mathematics and science teachers in Asia demonstrated stronger integration of

technology with pedagogical content knowledge than humanities educators, possibly due to STEM education priorities in regional policies. Third, cultural adaptation studies emphasized the need to translate not just language but pedagogical concepts, as direct translations of Westem teaching approaches often misaligned with Asian classroom dynamics. The Delphi study by Hu and Lei (2024) further established that pre-service teacher education programs in Asia needed context-specific TPACK benchmarks, differing from Western competency expectations. These validation efforts collectively demonstrate that while the core TPACK framework maintains theoretical coherence across cultures, its operationalization in Asia requires careful consideration of local educational philosophies, curriculum structures, and technological infrastructures. The studies also underscore the importance of developing validation protocols that account for regional differences in teaching norms and technology access, rather than relying on direct translations of Western-developed instruments.

Subject-Specific Manifestations of TPACK

The application of TPACK across different subject areas in Asian educational contexts reveals distinct patterns of technology integration shaped by disciplinary epistemologies and regional curricular priorities. Two primary subject domains emerge from the analyzed studies: language education and science teaching, each demonstrating unique adaptations of the TPACK framework to address subject-specific pedagogical challenges.

In language education, (Le and Song, 2018) examined Vietnamese pre-service EFL teachers' TPACK development within a Computer-Assisted Language Learning (CALL) course. The study found that contextual factors such as institutional technology policies and sociocultural perceptions of language teaching significantly influenced how teachers integrated technological tools. Specifically, communicative language teaching approaches combined with technology created tensions with traditional grammar-translation methods prevalent in Vietnamese classrooms. This necessitated modifications to standard TPACK models to account for local language pedagogy traditions. The research highlighted how Asian language teachers often prioritize pedagogical content knowledge (PCK) over technological knowledge (TK) when these domains conflict with cultural expectations about language acquisition. Science education presents a contrasting TPACK implementation pattern, as demonstrated by Sothayapetch and Lavonen, (2022)’s comparative study of Thai and Finnish primary school teachers during COVID-19. While both groups utilized TPACK for remote science instruction, Thai teachers exhibited stronger integration of technology with concrete, curriculum-aligned content examples compared to their Finnish counterparts' more exploratory approaches. This difference stemmed from Thailand's centralized science curriculum and examination system, which constrained teachers' flexibility in technology use but enhanced alignment with specific learning objectives. The study also revealed how Asian science teachers frequently employed technology to simulate laboratory experiments when physical resources were limited, creating a distinctive TPACK configuration that blended virtual and practical science pedagogies.

The comparative analysis underscores how Asian educational systems mediate subject-specific TPACK implementations through structural and cultural filters. Language teaching adaptations prioritize pedagogical

continuity, while science education modifications emphasize curriculum fidelity and resource pragmatism. These findings challenge universal TPACK application assumptions and highlight the need for discipline-specific framework adaptations that account for regional educational philosophies and systemic constraints.

Factors Influencing TPACK Development in Asian Contexts

The development of Technological Pedagogical Content Knowledge (TPACK) among educators in Asian settings is shaped by a complex interplay of demographic, personal, and organizational factors- Studies examining these influences reveal distinct patterns that differentiate Asian contexts from Westem models, particularly in how cultural norms and institutional structures mediate technology integration. Chua and Jamil, (2012) investigated TPACK development among Technical and Vocational Education and Training (TVET) instructors in Malaysia, identifying three primary categories of influencing factors. Demographic characteristics such as age and educational background created baseline disparities in technological familiarity, with younger instructors demonstrating greater initial TPACK competence. Personal factors, including self-efficacy and motivation, emerged as critical mediators, determining how instructors translated technological access into pedagogical innovation. Organizational support structures, particularly institutional policies and professional development opportunities, either facilitated or constrained sustained TPACK growth. The study highlighted how Malaysia's centralized education system created both standardized opportunities and systemic barriers for technology integration, a pattern observed across several Asian contexts.

The two critical insights about Asian TPACK development. First, cultural values emphasising hierarchical relationships and examination-oriented curricula frequently override technological considerations in pedagogical decision-making. Second, while infrastructure limitations persist in some regions, the primary barriers to TPACK integration are often pedagogical rather than technological, requiring professional development programs that address both technical skills and cultural-institutional constraints. These findings suggest that TPACK growth strategies in Asia must account for the region's unique educational ecosystem, where systemic factors frequently mediate individual capability development.

TPACK Development and Application in Asian Contexts

The development and application of TPACK in Asian educational settings demonstrate distinctive patterns shaped by regional pedagogical traditions and systemic constraints. Studies reveal that pre-service teacher training programs serve as primary incubators for TPACK development, with (Li et al., 2023) demonstrating how structured technology integration courses in Chinese universities significantly enhanced pedagogical technology competencies. These programs typically combine theoretical TPACK frameworks with practical micro-teaching sessions, allowing trainees to experiment with technology-enhanced lesson designs within controlled environments. However, the effectiveness of such programs varies according to institutional resources and the degree of alignment between training content and local curriculum requirements.

In-service teachers in Asia often develop TPACK through professional learning communities and school-based mentoring systems, as evidenced by Hu and Lei, (2024)'s study of Japanese STEM educators.

Collaborative lesson planning sessions, where experienced teachers model technology integration strategies, emerged as particularly effective for contextualizing TPACK to specific subject areas and grade levels. This approach capitalizes on Asia's strong professional learning culture while addressing the challenge of transferring abstract TPACK concepts into daily classroom practice. Nevertheless, the hierarchical nature of many Asian school systems sometimes inhibits open sharing of technological experimentation, particularly among junior teachers reluctant to challenge traditional pedagogies.

The application of TPACK in classroom settings reveals further regional particularities. Greene and Jones, (2020)'s investigation of Vietnamese language teachers showed how TPACK implementation often follows a "pedagogy-first" approach, where technological tools are selected based on their alignment with existing teaching methods rather than driving pedagogical innovation. This contrasts with Western models that frequently position technology as a catalyst for instructional transformation. In STEM subjects, Gozum and Demir (2021), observed that South Korean science teachers developed unique TPACK configurations combining simulation software with intensive problem-solving exercises, reflecting the country's emphasis on competitive academic performance. These application patterns underscore how Asian educators adapt TPACK principles to maintain cultural and curricular continuity while gradually incorporating digital tools.

The studies collectively demonstrate that TPACK development in Asia cannot be divorced from its application contexts, as the region's educational systems prioritize seamless integration of new technologies with established pedagogical traditions. This results in distinctive TPACK manifestations that balance innovation with cultural-educational continuity, challenging assumptions about universal technology integration pathways while offering valuable insights into contextually grounded professional development models.

TPACK and Technological Integration in Asian Classrooms

The integration of TPACK frameworks within Asian educational systems reveals distinctive patterns of technology adoption that reflect regional pedagogical traditions and infrastructural realities. Studies consistently demonstrate that Asian educators approach technological integration through a lens of pedagogical continuity rather than disruptive innovation, prioritizing alignment with existing curricular goals and examination systems. This contrasts with Western models that often position technology as a catalyst for pedagogical transformation, highlighting fundamental differences in how TPACK principles are operationalized across cultural contexts.

A critical factor shaping TPACK implementation in Asia is the region's diverse technological infrastructure landscape. Research by (Alotumi, 2020) on Indonesian schools identified three tiers of technology integration corresponding to institutional resource levels. High-resource urban schools demonstrated sophisticated TPACK applications incorporating learning management systems and AI-based adaptive learning tools, while rural institutions with limited connectivity focused on basic mobile technologies and offline digital resources. This infrastructure-mediated TPACK stratification creates unequal professional development needs across educational settings, necessitating differentiated support strategies. The study also found that even in well-resourced schools, teachers frequently underutilized available technologies due to

gaps in pedagogical integration knowledge rather than technical skills, suggesting that Asian TPACK development programs must emphasize the "P" (pedagogical) component more strongly than in Western contexts.

It also explains how Asian educators navigate the complex interplay between technological possibilities and contextual constraints- Curriculum-aligned adoption dominates in high-stakes examination systems, where teachers prioritize technologies that directly support content mastery. Resource-adaptive implementation reflects the pragmatic realities of uneven technological development across the region, with educators creatively repurposing limited tools to achieve pedagogical goals. Culturally-grounded innovation demonstrates how Confucian-heritage values influence technology choices, often favouring tools that maintain teacher authority while gradually introducing collaborative elements.

These integration patterns collectively suggest that TPACK frameworks in Asia require substantial contextual adaptation to address regional infrastructural disparities, cultural pedagogies, and systemic educational priorities. The studies challenge universalist assumptions about technology integration by demonstrating how Asian educators reconstruct TPACK principles within localized teaching ecosystems, blending global technological trends with deeply rooted educational values. This reconstruction process offers valuable insights for developing context-sensitive TPACK models that respect regional diversities while advancing technology-enhanced learning.

Discussion

The synthesis of findings across Asian educational contexts reveals both consistencies and contradictions in how TPACK frameworks are conceptualized and implemented. Taken together, the studies demonstrate that while the core TPACK model maintains theoretical coherence across cultures, its practical manifestations are profoundly shaped by contextual factors unique to Asian educational systems. A consistent pattern emerges across studies: the prioritization of pedagogical and content knowledge over technological innovation when these domains come into tension with cultural or institutional norms. This contrasts with Western implementations where technology often drives pedagogical change, suggesting that Asian educators approach TPACK as a means to enhance rather than transform existing practices.

Theoretical implications of this synthesis challenge universalist assumptions about technology integration in education. The findings collectively suggest that TPACK frameworks must incorporate contextual knowledge as a distinct dimension rather than treating it as peripheral background. Studies such as (Le and Song, 2018) and (Alotumi, 2020) demonstrate how regional curricular priorities, infrastructural realities, and cultural pedagogies actively reshape TPACK configurations, necessitating models that account for these mediating factors. This aligns with recent critiques of TPACKs cultural neutrality (Gatete, 2025), supporting arguments for contextually-grounded theoretical extensions that better reflect non-Western educational realities. The persistent finding that Asian teachers adapt technologies to fit existing pedagogical structures rather than allowing technologies to redefine teaching approaches suggests that TPACK models may need to incorporate "contextual flexibility" as a core construct.

Practical implications for teacher education and professional development are substantial. The consistent evidence that Asian educators benefit most from TPACK training that respects local pedagogical traditions while gradually introducing technological innovations points to the need for differentiated professional learning models. Programs that successfully developed TPACK, such as those described in (Li et al., 2023) and (Hu and Lei, 2024), shared three key characteristics: they situated technology integration within familiar teaching scenarios, provided sustained mentoring rather than one-time workshops, and aligned with institutional expectations about classroom practice. Policymakers should note the infrastructure-mediated disparities identified in (Alotumi, 2020), which suggest that equitable TPACK development requires concurrent investments in both technological resources and pedagogical support, particularly for rural and under-resourced schools.

Several methodological limitations in this review warrant consideration. The exclusive focus on English-language publications may have omitted valuable insights from studies published in Asian languages, potentially skewing findings toward more internationally connected research institutions. Database selection bias, despite comprehensive search strategies, might have underrepresented certain national contexts where research is disseminated through local platforms. The predominance of small-scale qualitative studies and convenience-sampled surveys in the literature limits the generalizability of some findings, as does the uneven geographic distribution of studies across Asian subregions- These limitations suggest that while the review provides robust evidence about TPACK in several Asian educational systems, caution is needed when extrapolating to the entire region's diverse contexts.

Future research directions should address several gaps identified in this synthesis. There is a pressing need for longitudinal studies tracking TPACK development across career stages in Asian contexts, as current research predominantly captures snapshot assessments. Comparative investigations across Asian subregions could illuminate how varying cultural, economic, and policy environments mediate TPACK implementation, building on foundational work like (Sothayapetch and Lavonen, 2022)'s Thailand-Finland comparison. Understudied areas include the role of school leadership in fostering TPACK-supportive cultures and the impact of national digital education policies on classroom-level technology integration. Research should also explore indigenous technological tools and pedagogies, moving beyond Western-originated technologies to examine how locally-developed educational technologies might enable more culturally congruent TPACK configurations.

The contradictions in findings about subject-specific TPACK applications point to another critical research frontier. While STEM subjects dominate current studies, the humanities and vocational education sectors remain underexplored, despite their centrality in many Asian curricula. Future research should investigate whether the "pedagogy-first" pattern observed in language education holds across other non-STEM disciplines, and how vocational educators reconcile TPACK with competency-based training models. Additionally, the emergence of generative AI tools presents new challenges and opportunities for TPACK in Asian classrooms, particularly in contexts where teacher authority and knowledge transmission are highly

valued. Research exploring how Asian educators negotiate these technologies within existing pedagogical frameworks could yield valuable insights for global TPACK scholarship.

The forward-looking implications of these findings extend beyond academic circles. Educational technology developers working in Asian markets should consider how the region's distinctive TPACK patterns inform product design, moving beyond direct translations of Western-edtech models to create tools that align with local pedagogical values and infrastructural realities. Teacher certification bodies might reevaluate competency frameworks to better reflect the contextualized nature of effective technology integration, as standardized TPACK assessments often fail to capture the nuanced adaptations Asian educators make. These practical applications, grounded in the empirical evidence synthesized here, could significantly enhance the relevance and effectiveness of technology integration initiatives across Asia's diverse educational landscape.

Conclusion

This systematic review has synthesized empirical evidence on TPACK and contextual knowledge (C-TPACK) in Asian educational settings, addressing how the framework is adapted, validated, and applied across diverse regional contexts. The findings collectively demonstrate that while TPACK retains its core theoretical structure, its implementation is profoundly mediated by cultural, institutional, and infrastructural factors unique to Asia. Key insights reveal that Asian educators prioritize pedagogical continuity over technological disruption, resulting in distinctive TPACK configurations that balance innovation with established teaching traditions. The development of context-sensitive assessment tools and localized professional leaming models emerges as critical for effective technology integration. The theoretical contribution of this review lies in its challenge to universalist assumptions about TPACK, highlighting the necessity of incorporating contextual knowledge as a central dimension rather than a peripheral consideration. Practically, the findings underscore the need for policy frameworks that support infrastructure development alongside pedagogical training, particularly in under-resourced regions. Future research should explore longitudinal TPACK development trajectories, indigenous technological tools, and subject-specific adaptations in understudied disciplines. By centering Asian perspectives, this review advances a more nuanced, globally inclusive understanding of technology integration in education.

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Cite this Article

*Joy Prakash Deb, "Exploring C-TPACK (TPACK with Contextual Knowledge) in Asian Educational Perspectives: A Review Study", **International Journal of Multidisciplinary Research in Arts, Science and Technology (IJMRAST)**, ISSN: 2584-0231, Volume 4, Issue 1, pp. 42-54, January 2026.*

***Journal URL:** https://ijmrast.com/*

***DOI:** https://doi.org/10.61778/ijmrast.v4i1.221*