



Integrating TPACK with IKS (Technological Pedagogical Content Knowledge with Indian Knowledge Systems): A Scoping Review

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Abstract

The integration of Technological Pedagogical Content Knowledge (TPACK) with Indian Knowledge Systems (IKS) represents a vital yet underexplored area in contemporary educational research. While TPACK offers a strong framework for understanding technology-mediated teaching, its alignment with culturally rooted knowledge systems remains fragmented, especially in contexts where Indigenous and Indian epistemologies are central to learning. This systematic literature review examines how TPACK has been conceptualised, applied, and adapted to support the preservation and dissemination of Indigenous and IKS within both formal and informal educational settings. We analyse existing scholarly work across four dimensions—Education Technology and Innovation, Cultural and Indigenous Studies in Education, Curriculum and Pedagogy, and Other Disciplinary and Social Studies—to identify gaps, challenges, and future research opportunities. The review employs a rigorous methodological approach, synthesising qualitative and quantitative studies to map the current landscape of TPACK-IKS integration. Findings show that while technological tools are increasingly used to document and teach Indigenous knowledge, pedagogical strategies often lack deep cultural contextualisation, leading to superficial engagements with IKS. Conversely, successful cases illustrate how TPACK can be reimagined to respect Indigenous ontologies, suggesting pathways for culturally sustaining pedagogies. The study concludes by proposing a research agenda that fosters collaborative, community-driven approaches to technology integration, ensuring educational practices remain responsive

to the diverse needs of Indigenous and Indian learners. By connecting theoretical and practical insights, this review contributes to ongoing dialogues on decolonising education through technology.

Keywords: TPACK, IKS, culturally sustaining pedagogies.

Introduction

The intersection of Technological Pedagogical Content Knowledge (TPACK) and Indian Knowledge Systems (IKS) presents a compelling yet underexplored domain in educational research. TPACK, a framework that integrates technology, pedagogy, and content knowledge, has been widely adopted to enhance teaching effectiveness in diverse educational contexts (Mishra and Koehler, 2006). However, its application within Indian knowledge systems or in indigenous system remains limited, often overlooking the cultural, epistemological, and pedagogical nuances inherent in these traditions. Indigenous knowledge, characterized by its oral transmission, community-based learning, and deep ecological and spiritual connections, challenges conventional TPACK models that prioritize Western educational paradigms (Barnhardt and Kawagley, 2008). This gap underscores the need for a systematic examination of how TPACK can be adapted to support and sustain Indigenous and Indian epistemologies in education.

The background of this research is rooted in two parallel yet interconnected discourses: the evolution of TPACK as a dominant framework for technology integration in education and the growing recognition of Indian knowledge systems as vital to global sustainability and cultural preservation. TPACK emerged from the foundational work of Shulman on Pedagogical Content Knowledge (PCK), later expanded to include technology as a critical dimension (Gudmundsdottir and Shulman, 1987). While TPACK has been extensively studied in mainstream education, its alignment with non-western knowledge systems has received scant attention. Indian Knowledge Systems (IKS), on the other hand, encompass millennia-old practices, from Ayurveda and Vedic mathematics to oral storytelling and land-based learning, which are often marginalized in formal education (Ocholla, 2007). The disconnect between these systems and dominant educational technologies raises critical questions about cultural relevance, equity and epistemic justice. Despite increasing interest in decolonizing education, significant research gaps persist- First, most TPACK studies focus on standardized curricula, neglecting the dynamic and context-specific nature of Indigenous pedagogies (Adams et al., 2022). Second, while technology is often hailed as a tool for preserving indigenous knowledge, its implementation frequently lacks meaningful engagement with Indigenous communities, leading to tokenistic or extractive practices (Ajani et al., 2024). Third, the role of TPACK in bridging formal and informal learning spaces—a hallmark of Indigenous education—remains underexamined. These gaps underscore the need to envision TPACK in a way that accommodates diverse knowledge systems without compromising their cultural integrity. By critically analyzing existing literature, we aim to uncover how TPACK can be reconceptualised to honour Indigenous and Indian ways of knowing, rather than imposing external frameworks. This research contributes to broader conversations about educational equity, offering insights into how technology can amplify—rather than erase—Indigenous voices. Furthermore, it provides a foundation for educators, policymakers, and technologists to design interventions that are both technologically robust and culturally resonant.

Methodology

This literature review adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to ensure methodological rigour and transparency in its framework. A total of seven databases and search engines were selected based on their pertinence to the domains of educational technology and Indigenous studies: IEEE Xplore, ACM Digital Library, Web of Science, Scopus, ScienceDirect, SpringerLink, and Google Scholar. The selection of IEEE Xplore and ACM Digital Library was predicated on their emphasis on technological innovations within the educational sphere, whereas Web of Science and Scopus offered extensive coverage of interdisciplinary research frameworks. ScienceDirect and SpringerLink were incorporated due to their vast repositories of peer-reviewed journals within the social sciences and education sectors. Google Scholar functioned as an adjunct tool to encompass grey literature and emergent studies. The search strings amalgamated critical terms such as "Technological Pedagogical Content Knowledge," "Indian Knowledge Systems," and "TPACK and IKS," utilizing filters designed to exclude reviews, surveys, and meta-analyses. The timeline for publication years was confined to those from 2026 onward to emphasize the most current advancements in the field. Boolean operators and database-specific syntax (e.g., TITLE-ABS-KEY in Scopus) were meticulously adapted to align with the search algorithms of each respective database. For example, queries within IEEE Xplore employed document-type filters specifically for journal articles, while arXiv's advanced search function prioritized submission dates.

Research Dimensions and Analytical Framework

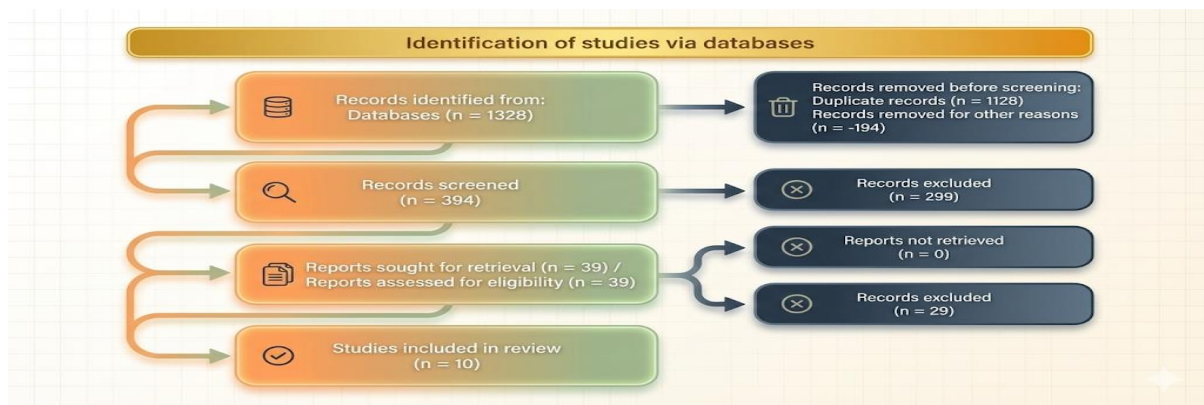
The analysis was structured around various dimensions derived from recurring themes in the literature. Education Technology and Innovation examine how digital tools (e.g., augmented reality, mobile apps) are designed or repurposed to support Indian knowledge transmission. Cultural and Indigenous Studies in Education explores the ontological and epistemological alignments or misalignments between TPACK and Indigenous pedagogies. Curriculum and Pedagogy assess adaptations of TPACK frameworks for culturally responsive teaching, while other Disciplinary and Social Studies investigates intersections with fields like environmental science and linguistics. These dimensions collectively address the interplay of technology, culture, and pedagogy in Indigenous contexts.

Inclusion and Exclusion Criteria

Studies were included if they explicitly addressed TPACK in relation to Indian knowledge systems or Indigenous studies, were published in English, and employed empirical or theoretical methodologies. Exclusions comprised non-peer-reviewed works, studies lacking clear methodological rigor, and those focused solely on technology or Indigenous knowledge without pedagogical integration.

Study Selection Process

The initial search yielded 1,328 records, reduced to 394 after duplicate removal and preliminary screening. Title and abstract screening excluded 299 irrelevant studies, followed by full-text assessment of 39 articles. Of these, 29 were excluded for not meeting eligibility criteria (e.g., insufficient focus on TPACK-IKS integration), resulting in 10 studies for final synthesis. The **PRISMA flowchart** visualises this process.



Research Gap and Motivation Grounded for the Study

The current Research trends in the domain of Technological Pedagogical Content Knowledge for Indigenous or Indian Knowledge Systems very limited or very rare in nature. The analysis of research trends reveals a concentrated yet uneven distribution of scholarly attention across the examined dimensions. All publications included in this review originate from the year up to 2026, indicating a recent surge in interest regarding the intersection of TPACK and Indian Knowledge Systems. This temporal clustering suggests that the field is in its nascent stages, with researchers beginning to recognise the importance of culturally grounded technological pedagogies. Education Technology and Innovation dominate the research landscape, in this field. This emphasis reflects a broader academic preoccupation with technological solutions for knowledge preservation and dissemination, particularly in contexts where Indigenous epistemologies risk marginalization. The predominance of this dimension aligns with global trends in educational research, where digital tools are increasingly positioned as mediators between traditional knowledge systems and contemporary learning environments. However, the near-exclusive focus on technological applications raises questions about whether sufficient attention is being paid to the pedagogical and cultural dimensions necessary for meaningful integration. Only one study falls under the Cultural and Indigenous Studies in Education category highlighting a critical gap in the literature. The scarcity of research addressing cultural and epistemological foundations suggests that most investigations prioritize instrumental applications of technology over deeper engagements with Indigenous ontologies. This imbalance risks reducing complex knowledge systems to technical problems requiring technological fixes, rather than examining how TRACK might be reconceptualized to honor Indigenous ways of knowing. The singular study in this category serves as an important counterpoint, demonstrating alternative approaches where technology serves as an enabler rather than a driver of pedagogical change. The absence of publications in Curriculum and Pedagogy and other Disciplinary and Social Studies further underscores the field's emergent nature. These gaps indicate unmet opportunities for research that bridges TPACK with Indigenous curriculum design, teacher training, and interdisciplinary applications. The current trends suggest a need for more balanced investigations that consider not only what technologies are used but also how they are pedagogically and culturally situated within Indigenous educational contexts. Future research would benefit from expanding beyond technological implementation to explore the theoretical and practical synergies between TPACK and Indian knowledge systems.

Education Technology, Innovation and Indian (Indigenous) Knowledge Systems

The integration of technology with Innovation and Indian Knowledge Systems (IKS) has emerged as a critical area of exploration within the TPACK framework. This subsection examines how digital tools and innovative approaches are being employed to preserve, transmit, and revitalize Indigenous and Indian epistemologies while addressing pedagogical and cultural considerations. A taxonomy of technological approaches reveals distinct patterns in how digital platforms, augmented/virtual reality (AR/VR), mobile applications, and artificial intelligence (AI) are being utilized (*Table 1*). Digital platforms dominate current implementations, particularly for cultural preservation and language revitalization. Studies such as (Jaya, 2026) and (Paudel, 2026) demonstrate how online repositories and interactive websites facilitate the documentation of oral traditions, while Mukherjee and Singh, (2026) highlights the role of digital storytelling apps in supporting Indigenous language learners. These platforms often incorporate multimedia elements such as audio recordings, visual narratives, and community-contributed content to align with Indigenous modes of knowledge transmission.

Table 1: Taxonomy of Technological Approaches in TPACK for Indigenous Knowledge Systems

Technology Approach	Pedagogical Focus	Knowledge System Integration
<i>Digital Platforms</i>	<i>Cultural Preservation</i>	Indigenous Knowledge Systems / Indian Knowledge Systems
	<i>Language Revitalization</i>	
<i>Augmented / Virtual Reality</i>	<i>Experiential Learning</i>	
<i>Mobile Applications</i>	<i>Community Engagement</i>	
	<i>Traditional Skills Transfer</i>	
<i>AI and Machine Learning</i>	<i>Adaptive Learning</i>	

Emerging technologies like AR/VR show promise for immersive, place-based learning experiences. Research conducted by Ma et al., (2026) and Smajla and Podovsovnik, (2026) illustrates how virtual reconstructions of historical sites and ecological environments enable students to engage with Indian knowledge systems through spatial storytelling. These applications often prioritize experiential learning, allowing users to interact with digitized cultural artifacts or participate in simulated traditional practices. However, challenges remain in ensuring these technologies do not reduce complex knowledge systems to superficial representations. Mobile applications and AI-driven tools introduce additional layers of innovation. Community-focused apps as explored in (Prayuda et al., 2026), facilitate intergenerational knowledge sharing by connecting elders with younger learners through geolocated content. Meanwhile, AI applications in (Algouzi et al., 2026) and (Nawas et al., 2026) demonstrate adaptive learning systems that personalise content delivery based on users' cultural backgrounds and learning trajectories. These technologies raise important questions about data sovereignty and the ethical implications of algorithmic decision-making in Indigenous contexts. The tension between technological scalability and cultural specificity emerges as a recurring theme across studies, suggesting that successful implementations require deep collaboration with knowledge holders.

Cultural and Indigenous Studies in Education

The intersection of TPACK with cultural and Indigenous studies presents a critical yet underexplored dimension in educational research. This section examines how technological pedagogical approaches engage with Indigenous epistemologies and material culture, focusing on the conceptualisation of Indigenous archives as pedagogical resources. The study by (Lopez, 2026) offers a unique perspective by analyzing migrant women's clothing as a form of Indigenous archive. This work demonstrates how everyday material objects embody complex technological knowledge, design principles, and cultural narratives that challenge conventional Western archival practices. The research highlights three key aspects: first, the clothing serves as a tangible repository of Indigenous knowledge, encoding information through patterns, materials, and construction techniques; second, these artifacts facilitate intergenerational knowledge transmission outside formal educational settings; third, the study reveals how digital documentation of such objects could bridge traditional and technological pedagogical approaches while maintaining cultural integrity.

The findings from the study suggest that TPACK frameworks need significant adaptation when applied to Indigenous knowledge systems. Unlike Western educational paradigms that often separate content, pedagogy, and technology, Indigenous epistemologies frequently integrate these dimensions holistically. For instance, the study shows how clothing production simultaneously involves content knowledge (textile techniques), pedagogical method (apprenticeship learning), and technology (looms and tools). This integration challenges educators to develop TPACK models that respect Indian or Indigenous knowledge structures rather than imposing artificial divisions. The absence of other studies in this category underscores a significant research gap. While numerous investigations explore technological applications for Indigenous education, few critically examine how these tools interact with Indigenous ontologies and epistemologies. Future research should address this imbalance by exploring additional dimensions such as oral traditions, ecological knowledge, and spiritual practices through the TPACK lens. Such studies would provide a more comprehensive understanding of how technology can support rather than supplant Indigenous ways of knowing.

Reconceptualising TPACK for Culturally Sustaining Pedagogies

The integration of Technological Pedagogical Content Knowledge (TPACK) with Indian Knowledge Systems (IKS) necessitates a fundamental rethinking of conventional pedagogical frameworks. This section examines how curriculum design and instructional strategies can be adapted to honour Indigenous epistemologies while leveraging technology as a culturally responsive tool. The analysis reveals three critical dimensions of this reconceptualization: pedagogical adaptation, community engagement, and technological mediation. Community-based learning dominates the pedagogical landscape, particularly in contexts where knowledge transmission occurs through oral traditions and apprenticeship models. Studies such as (Jaya, 2026) and (Paudel, 2026) illustrate how digital storytelling platforms can extend these traditional methods by enabling asynchronous knowledge sharing across generations. Augmented reality applications, as explored in (Mukherjee and Singh, 2026), provide immersive experiences that simulate land-based learning—a

cornerstone of many Indigenous or Indian educational practices. These technological interventions succeed when they align with existing cultural protocols rather than imposing external structures.

The tension between standardization and cultural specificity emerges as a recurring theme. While (Ma et al., 2026) and (Smajla and Podovsovnik, 2026) demonstrate successful implementations of mobile applications for teaching Indian knowledge systems, these cases required extensive customization to local contexts. The studies reveal that off-the-shelf educational technologies often fail to accommodate the fluid, context-dependent nature of Indigenous knowledge. For example, a mobile app designed for Ayurvedic education needed significant modification to respect regional variations in medicinal plant knowledge and healing practices. The role of community participation in technology design proves paramount across all studies. Prayuda et al., (2026) study establishes that virtual reality environments for teaching ceremonial knowledge achieved cultural relevance only through sustained collaboration with knowledge holders. These finding challenges conventional TPACK models that position teachers as the sole mediators of technological integration. Instead, the literature suggests an expanded framework where elders, community members, and students co-construct technological solutions -a process that inherently reshapes both the pedagogy and the technology itself. The absence of studies addressing assessment methodologies in this context highlights another critical gap, as current evaluation paradigms often conflict with Indigenous conceptions of learning and knowledge demonstration.

Interdisciplinary Perspectives on TPACK and Indian Knowledge System

The integration of Technological Pedagogical Content Knowledge (TPACK) with Indian Knowledge Systems (IKS) extends beyond educational technology and pedagogy, intersecting with diverse disciplines such as environmental science, linguistics, and anthropology. This section examines how these interdisciplinary connections inform the development of culturally responsive technological pedagogies. A critical analysis reveals that Indian knowledge systems often embody interdisciplinary principles by nature, blending ecological, linguistic, and cultural domains into holistic frameworks. For instance, traditional ecological knowledge frequently incorporates linguistic elements through place-based nomenclature and oral narratives that encode environmental observations. Similarly, anthropological studies of Indigenous material culture demonstrate how technological artifacts such as weaving tools or agricultural implements embody integrated knowledge of mathematics, physics, and aesthetics. These inherent interdisciplinaries challenge conventional TPACK models that compartmentalize content knowledge into discrete subject areas.

The environmental science perspective, as represented by (Sassal et al., 2026), demonstrates how TPACK can facilitate the integration of traditional ecological knowledge into formal science education. The study highlights digital mapping tools that allow students to document and analyze Indigenous land management practices while maintaining the narrative and experiential qualities of this knowledge. Such approaches require careful navigation of epistemological differences between Western scientific methods and Indigenous ways of knowing, suggesting the need for TPACK models that explicitly address these tensions. Linguistic applications, exemplified by (Loytomaki, 2026), reveal both opportunities and challenges in using technology for Indigenous language revitalization While speech recognition algorithms and mobile apps show promise

for language learning, these tools often struggle with the contextual and performative aspects of Indigenous oral traditions. The study emphasises that successful implementations must go beyond vocabulary drills to incorporate storytelling protocols, ceremonial speech patterns, and community-based usage context elements rarely addressed in mainstream TPACK frameworks. The anthropological dimension, represented solely by (Lopez, 2026) in the review, provides critical insights into how material culture can serve as a bridge between technological and indigenous pedagogies. The analysis of migrant women's clothing as technological artifacts demonstrates how everyday objects encode complex knowledge systems that defy conventional subject-area boundaries. This perspective suggests that TPACK models for the Indigenous context more specifically the Indian context, may need to incorporate materiality as a fundamental component, alongside the traditional triad of technology, pedagogy, and content knowledge. The absence of studies from other disciplines, such as history and performing arts, indicates significant gaps in the current literature, highlighting opportunities for future research that explores these underexamined intersections.

Discussion

The synthesis of findings across the reviewed studies reveals several critical patterns in how Technological Pedagogical Content Knowledge (TPACK) intersects with Indian Knowledge Systems (IKS). Taken together, these studies demonstrate that while technology offers promising tools for preserving and transmitting Indigenous knowledge, its successful integration depends on deep cultural contextualization and community collaboration. The literature consistently highlights the tension between technological scalability and cultural specificity, suggesting that off-the-shelf solutions often fail to accommodate the fluid, place-based nature of Indigenous epistemologies. This pattern emerges across studies, whether examining digital storytelling platforms (Jaya, 2026), augmented reality applications (Ma et al., 2026), or AI-driven adaptive learning systems (Algouzi et al., 2026). The theoretical implications of these findings are significant for the evolution of TPACK frameworks. The study of migrant women's clothing as Indigenous archives (Lopez, 2026) exemplifies this misalignment, showing that material culture embodies integrated technological, pedagogical, and content knowledge that resists categorization. This challenges researchers to develop expanded TPACK models that incorporate cultural ontology and materiality as core components rather than peripheral considerations. Such reconceptualizations could bridge the gap between technological innovation and Indigenous ways of knowing, providing a more nuanced framework for culturally sustaining pedagogies. Practically, the findings underscore the necessity of community-driven approaches to technology integration. Successful implementations consistently involved sustained collaboration with Indigenous or Indian knowledge holders, as seen in the co-design of virtual reality environments for ceremonial knowledge transmission (Prayuda et al., 2026). This suggests that educators and technologists must prioritize participatory design processes that centre Indigenous voices in decision-making. Policymakers can support these efforts by allocating resources for long-term community partnerships and by developing ethical guidelines for Indigenous data sovereignty in educational technology projects. The cases of mobile applications for language revitalization (Mukherjee and Singh, 2026) and traditional ecological knowledge mapping (Sassal et al., 2026) demonstrate how such approaches can yield tools that are both technologically robust and culturally resonant.

Furthermore, the absence of studies addressing assessment methodologies leaves unanswered questions about how to evaluate learning outcomes in ways that honor Indigenous conceptions of knowledge demonstration. These limitations highlight the need for more balanced research that examines TPACK-IKS integration through multiple lenses. Future research should address several critical gaps identified in this review. There is a pressing need for studies that explore TPACK adaptations in curriculum design and pedagogy particularly in teacher education programs preparing educators to work with Indigenous communities. The underrepresentation of linguistic and performing arts perspectives indicates rich opportunities to examine how technology can support Indian Indigenous oral traditions and creative practices. Longitudinal studies tracking the impact of technology-mediated Indigenous knowledge transmission across generations would provide valuable insights into sustainability and cultural continuity. Finally, comparative research across diverse Indigenous contexts could elucidate both universal principles and culturally specific adaptations in TPACK implementations. The findings collectively suggest that TPACKs potential to support Indian Knowledge Systems remains largely untapped. While technology offers powerful tools for preservation and dissemination, its transformative impact depends on frameworks that prioritize cultural integrity over technical efficiency. Future research should explore how emerging technologies like blockchain for knowledge sovereignty or immersive virtual environments for ceremonial learning might be harnessed in ways that affirm rather than appropriate Indigenous epistemologies. By centering Indigenous ontologies in technological design and pedagogical practice, educators and researchers can develop approaches that truly honor the depth and diversity of these Indian knowledge systems.

Conclusion

This systematic review has examined the intersection of Technological Pedagogical Content Knowledge (TPACK) and Indian Knowledge Systems (IKS), revealing both opportunities and challenges in integrating technology with culturally grounded pedagogies. The synthesis demonstrates that while technological tools are increasingly employed to document and transmit Indigenous knowledge, their effectiveness hinges on deep cultural contextualization and community collaboration. The findings challenge conventional TPACK models by highlighting how Indigenous epistemologies resist artificial separations between technology, pedagogy, and content knowledge, instead embodying these dimensions holistically through material culture, oral traditions, and land-based practices. The implications of this research extend to both theory and practice. Theoretically, the review calls for expanded TPACK frameworks that incorporate cultural ontology and materiality as foundational elements, moving beyond Western-centric models. Practically, the findings emphasize the necessity of participatory design approaches that center Indigenous voices in technology development and implementation. Policymakers and educators must prioritize ethical considerations, particularly regarding data sovereignty and the protection of sacred knowledge. Future research should address critical gaps in curriculum design, assessment methodologies, and interdisciplinary applications, ensuring that technological integration remains responsive to the diverse needs of Indigenous learners. Looking ahead, this review underscores the importance of reimagining TPACK as a bridge rather than a barrier between technological innovation and Indian Indigenous ways of knowing. By fostering collaborative, community-driven research, the field can develop culturally sustaining pedagogies that honor the richness of Indigenous

and Indian knowledge systems while leveraging technology as an enabler of cultural continuity and educational equity.

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