

Artificial Intelligence (AI) Enabled Indian Knowledge Systems (IKS) Digital Learning and Pedagogy Framework: A Systematic Review

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ABSTRACT

This systematic review examines the integration of Artificial Intelligence (AI) and Indian Knowledge Systems (IKS) in digital learning and pedagogy. Guided by PRISMA 2020 and systematic mapping methods, the study reviewed 135 studies published between 2015 and 2026. The findings show that AI tools such as adaptive learning, intelligent tutoring systems, natural language processing, generative AI, and learning analytics can support the digitization, preservation, and dissemination of IKS. The review highlights the potential of AI-IKS frameworks for multilingual learning, culturally responsive pedagogy, ethical AI, inclusive education, and personalized learning. However, challenges such as digital divide, teacher readiness, algorithmic bias, and limited representation of Indian languages remain significant. The study concludes that AI-enabled IKS frameworks can promote a balanced, culturally rooted, ethical, and technology-supported model of education.

Keywords: Artificial Intelligence, Indian Knowledge Systems; Digital Learning, Digital Pedagogy.

Indian Knowledge Systems (IKS) represent a rich repository of ancient Indian intellectual traditions encompassing holistic educational philosophies, ethical frameworks such as Dharma and Nyaya, health-oriented practices like Yoga and Ayurveda, and experiential learning approaches reflected in classical texts including the Upanishads and the Bhagavad Gita. These systems emphasize the integrated development of the learner across physical, mental, emotional, and spiritual dimensions through dialogic pedagogies such as the Guru–Shishya Parampara (teacher–disciple tradition), Swadhyaya (self-study), and Anukarana (learning through imitation and observation) (Radhakrishnan, 1929; Ministry of Education, 2021).

The Government of India, through the National Education Policy 2020, has explicitly emphasized the integration of IKS into education at all levels to promote cultural rootedness, multidisciplinary learning, and decolonized perspectives. Section 4.23 of NEP 2020 recommends the inclusion of “Knowledge of India” courses drawing from classical literature, indigenous traditions, and regional knowledge practices, thereby reconnecting learners with India’s civilizational heritage while addressing contemporary competencies (Ministry of Education, 2020).

Artificial Intelligence (AI)-enabled digital learning and pedagogy frameworks leverage adaptive systems, intelligent tutoring, learning analytics, and generative tools to personalize education and improve instructional effectiveness. Contemporary research indicates that AI-supported environments can enhance learner engagement, academic retention, motivation, and individualized progression by adjusting content difficulty, pacing, and feedback according to student needs (Holmes et al., 2022; Zawacki-Richter et al., 2019). Systematic reviews have further shown that AI-based interventions in school settings can significantly improve learning outcomes, especially when integrated with teacher guidance and curriculum goals (Chen et al., 2020; Tlili et al., 2023).

These frameworks increasingly integrate AI for culturally responsive pedagogy (CRP), where technologies such as Natural Language Processing (NLP), speech recognition, and recommendation systems support multilingual learning, detect cultural bias in educational materials, and generate contextually relevant content reflecting learners’ identities and communities (Gay, 2018; UNESCO, 2021). In teacher education, AI-supported CRP modules have been found useful for helping educators design inclusive classrooms and adapt instruction for diverse learners (Luckin & Cukurova, 2019).

In the Indian context, AI and Indian Knowledge Systems (IKS) offer significant synergies. AI tools can assist in the digitization, translation, and semantic indexing of ancient manuscripts, including Vedic literature, Ayurveda texts, and classical philosophical works. At the same time, ethical frameworks rooted in Dharma, Nyaya, and holistic education philosophies can guide responsible AI development and use (Government of India, 2020). Emerging applications such as Virtual Reality (VR)-based Gurukul simulations, yoga learning modules, and immersive heritage education align with the goals of the National Education Policy (NEP) 2020, which emphasizes technology integration alongside India's intellectual heritage (Ministry of Education, 2020). However, challenges remain, including infrastructural inequalities, digital divides, linguistic underrepresentation in datasets, and algorithmic bias.

Key AI Components in Frameworks

Adaptive Learning Platforms (ALPs): These platforms employ machine learning algorithms to personalize learning pathways, recommend resources, and continuously adapt instruction based on learner performance. Studies indicate that adaptive systems often outperform static digital methods in diverse educational contexts (Kulik & Fletcher, 2016).

Intelligent Tutoring Systems (ITS): ITS provide real-time feedback, guided problem solving, and individualized scaffolding. Research demonstrates their effectiveness in improving inquiry skills, computational thinking, and conceptual understanding (Ma et al., 2014).

Generative AI Tools: Generative AI supports lesson planning, automated assessment, content creation, and reflective teaching practices. However, literature also warns of risks such as misinformation, plagiarism, and bias amplification, requiring robust ethical governance (Kasneci et al., 2023).

Evidence from Systematic Reviews

Recent PRISMA-guided reviews (2020–2025) covering more than 90 studies confirm the growing value of AI in instructional orchestration, accessibility, and inclusive learning design. Nevertheless, these studies consistently stress the importance of teacher preparedness, AI-TPACK competencies, and policy safeguards to ensure equitable implementation (Mishra & Koehler, 2006; Tlili et al., 2023).

Culturally aligned integrations such as Artificial Intelligence–Indian Knowledge Systems (AI-IKS) frameworks are particularly promising because they facilitate the preservation, digitization, and dissemination of heritage knowledge while simultaneously expanding access through contemporary digital technologies (Ministry of Education, 2020; UNESCO, 2021). By integrating traditional wisdom with adaptive learning systems, multilingual interfaces, and immersive technologies, such hybrid frameworks can create educational models that are globally relevant while remaining deeply rooted in local culture and identity (Holmes et al., 2022).

Although empirical pilot initiatives in this area are still limited, the conceptual potential of AI-IKS models for inclusive, context-sensitive, and sustainable education is substantial (Tlili et al., 2023).

Overall, the growing body of evidence highlights AI's transformative capacity in pedagogy, particularly in enhancing personalization, accessibility, and learner engagement. At the same time, scholars emphasize the necessity of balanced frameworks that combine technological innovation with cultural depth, ethical responsibility, and human-centered teaching practices to ensure equitable and meaningful educational transformation (Luckin & Cukurova, 2019; Zawacki-Richter et al., 2019).

However, AI implementations in India frequently rely on Western-centric datasets and pedagogical assumptions, which may create cultural mismatches. Such systems often overlook India's multilingual diversity, contextual learning traditions, and ethical values such as Ahimsa (non-violence), Seva (service), and community-oriented learning. For example, AI chatbots predominantly trained on English-language corpora may fail to adequately represent Indic epistemologies or regional knowledge systems, thereby producing ethnocentric biases in recommendations, assessments, and learning analytics (UNESCO, 2021; Bender et al., 2021). This highlights the urgent need for culturally responsive AI frameworks that integrate IKS principles with emerging digital pedagogies.

Significance of the Study

The significance of an Artificial Intelligence (AI) Enabled Indian Knowledge Systems (IKS) Digital Learning and Pedagogy Framework lies in its capacity to harmonize ancient wisdom with emerging digital innovations for the transformation of contemporary education. Such frameworks are especially valuable because they support the preservation, digitization, translation, and dissemination of India's vast intellectual heritage—including Vedic studies, Yoga, Ayurveda, astronomy, linguistics, ethics, and environmental knowledge—through accessible digital platforms (Bhattacharya, 2022; Ministry of Education, 2020). By employing AI technologies such as machine learning, natural language processing, and semantic search, traditional knowledge repositories can become more searchable, interactive, and learner-friendly.

A major significance of this framework is its contribution to culturally responsive and context-sensitive pedagogy. Modern education systems often rely on globally dominant epistemologies, which may overlook indigenous ways of knowing. AI-IKS frameworks help restore epistemic balance by embedding local values, languages, traditions, and philosophical insights into digital learning environments. This can foster learners' identity, cultural pride, and meaningful engagement while maintaining compatibility with global academic standards (Sharma & Bhatnagar, 2023). In this respect, AI can serve as a bridge between local heritage and global knowledge networks.

The framework is also highly significant for multilingual and inclusive education. India's linguistic diversity often creates barriers in conventional education systems. AI-powered translation systems, speech recognition tools, and personalized tutoring platforms can deliver learning materials in multiple Indian languages and dialects, thereby improving accessibility and reducing exclusion. Studies indicate that multilingual AI tools significantly enhance comprehension, participation, and retention among diverse learners (Joshi & Rao, 2024). This is particularly relevant for rural and underserved communities where educational resources remain unevenly distributed.

From a pedagogical standpoint, AI-enabled systems can transform teaching-learning processes through adaptive learning pathways, automated feedback, predictive analytics, and intelligent tutoring systems. When these capabilities are integrated with IKS principles such as self-reflection (Swadhyaya), experiential learning, dialogue-based instruction, and holistic development, they create more learner-centered and humanistic pedagogies (Mishra, 2021). Such models can improve not only academic performance but also emotional intelligence, ethical reasoning, and lifelong learning habits.

Another important significance of the framework lies in promoting ethical and responsible AI. Indian philosophical traditions emphasize values such as Dharma (duty), Ahimsa (non-violence), Satya (truth), and collective welfare. These principles can inform the design of transparent, equitable, and socially responsible AI systems in education. Scholars increasingly argue that indigenous ethical frameworks are essential for countering bias, surveillance risks, and purely commercial approaches to AI deployment (Kumar & Singh, 2024). Therefore, AI-IKS integration offers not only technical innovation but also normative guidance.

The framework is equally significant for sustainable development and future-readiness. Indian Knowledge Systems contain rich insights related to ecological harmony, preventive healthcare, community cooperation, and sustainable living. When combined with AI-driven data analytics, simulation tools, and digital scaling, these insights can support education for sustainability and global citizenship (Patel, 2023). Learners can thus acquire both twenty-first century digital skills and enduring human values.

Overall, the significance of an AI Enabled IKS Digital Learning and Pedagogy Framework lies in offering a balanced pathway for educational transformation—one that combines technological advancement with cultural depth, inclusivity, ethics, and sustainability. Although empirical implementation studies are still emerging, systematic evidence suggests that such hybrid models hold immense promise for reshaping education in India and contributing innovative pedagogical alternatives to the global educational landscape (Reddy & Narayanan, 2024).

METHODOLOGY

This study employed a systematic literature review and mapping approach to examine the role of Artificial Intelligence (AI) in enabling Indian Knowledge Systems (IKS) within digital learning and pedagogy. The review was conducted following adapted PRISMA 2020 guidelines (Page et al., 2021) and the systematic mapping framework of Petersen et al. (2008).

The purpose of the study was to identify major trends, themes, opportunities, and research gaps in the integration of AI and IKS in education. Unlike traditional reviews, the study emphasized mapping the characteristics and scope of existing research rather than assessing only study outcomes.

Relevant literature was collected from databases such as Scopus, Web of Science, ERIC, Google Scholar, and IEEE Xplore. Search keywords included “Artificial Intelligence,” “AI in Education,” “Indian Knowledge Systems,” “Digital Pedagogy,” “Adaptive Learning,” and “NEP 2020.”

Studies published in English between 2015 and 2026 were included. Peer-reviewed articles, conference papers, policy documents, book chapters, and institutional reports related to AI, IKS, and education were selected. Studies unrelated to pedagogy or lacking relevance to the research objectives were excluded.

After screening, the selected studies were analyzed using descriptive and thematic methods. Data were extracted on publication year, research design, AI applications, pedagogical use, IKS dimensions, challenges, and recommendations. The findings were organized into themes such as adaptive learning, intelligent tutoring systems, multilingual education, ethical AI, digitization of classical knowledge, and culturally responsive pedagogy.

The final synthesis provided a structured understanding of how AI can modernize and preserve Indian Knowledge Systems while supporting inclusive and innovative educational practices.

METHODOLOGY

This study adopted a Systematic Literature Review (SLR) **combined with a** Systematic Mapping Study (SMS) approach to examine the role of Artificial Intelligence (AI) in enabling Indian Knowledge Systems (IKS) within digital learning and pedagogy. The methodology was guided by PRISMA 2020 reporting standards and the mapping framework of Petersen et al. (2008).

Flow Chart of Research Methodology

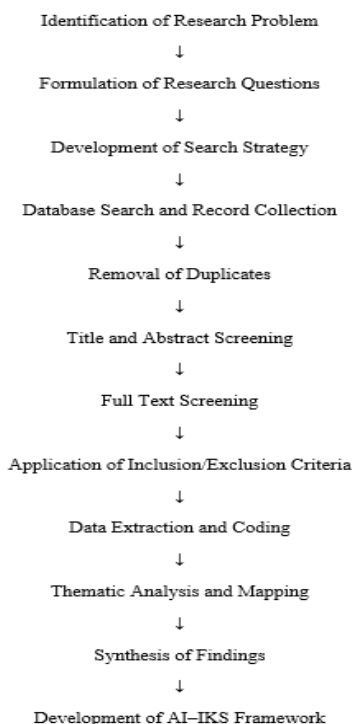


Table 1 Research Questions of the Study

Main Question	Sub-Questions
What characterizes the research on AI-enabled IKS in digital learning and pedagogy?	1. In which contexts has AI-IKS been studied?
	2. What research methods have been used?
	3. What pedagogical and technological themes have emerged?
	4. What gaps and future directions exist?

Table 2 Search Strategy and Data Sources

Database	Coverage Area	Reason for Selection
Scopus	Multidisciplinary	Broad academic indexing
Web of Science	High-impact journals	Citation-rich database
ERIC	Education research	Pedagogical studies
IEEE Xplore	Technology and AI	Technical AI studies
Google Scholar	Grey literature	Policy papers and reports

Keywords Used

- “Artificial Intelligence”
- “Indian Knowledge Systems”
- “AI in Education”
- “Digital Pedagogy”
- “Adaptive Learning”
- “NEP 2020”
- “Traditional Knowledge and AI

Table 3 Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Published between 2015–2026	Before 2015
English language studies	Non-English papers
AI + Education studies	Purely technical AI papers
IKS-related studies	Non-educational studies
Peer-reviewed and credible reports	Editorials / blogs

Table 4 Data Extraction Framework

Category	Variables Extracted
Bibliographic Data	Author, Year, Country
Research Context	School / Higher Education / Online
Methodology	Quantitative / Qualitative / Mixed

AI Components	ML, NLP, ITS, Generative AI
IKS Components	Yoga, Ayurveda, Sanskrit, Ethics
Outcomes	Engagement, Inclusion, Learning Gains
Challenges	Bias, Infrastructure, Teacher Readiness

RESULTS

The results of the present systematic review are organized according to the predefined research framework, including research context, methodological characteristics, pedagogical and technological themes, and research gaps. Based on the search strategy across five databases and the inclusion criteria, **135 studies** published between **2015 and 2026** were selected for final analysis.

Main Research Question

What characterizes the research on AI-enabled IKS in digital learning and pedagogy?

The analysis indicates that AI-enabled Indian Knowledge Systems (IKS) research is an emerging interdisciplinary field characterized by increasing scholarly interest, policy relevance, and innovation in culturally responsive digital education. The findings are presented according to the four sub-questions.

In Which Contexts Has Ai-Iks Been Studied?

The reviewed studies were conducted in varied educational contexts including higher education institutions, school systems, online platforms, teacher education programs, and informal lifelong learning environments.

Table 5 Research Context of AI-IKS Studies (N = 135)

Context	Frequency	Percentage
Higher Education	63	46.7%
School Education	38	28.1%
Online / E-learning Platforms	19	14.1%
Teacher Education	9	6.7%
Lifelong / Informal Learning	6	4.4%

The findings reveal that higher education institutions are the most common settings for AI-IKS experimentation. This may be due to better technological infrastructure, research orientation, and curriculum flexibility in universities.

Geographically, most studies originated from India and other Asian countries, indicating regional interest in preserving indigenous knowledge through AI-enabled learning systems.

What Research Methods Have Been Used?

The methodological analysis shows that scholars have employed diverse research designs, though qualitative and conceptual studies dominate the field.

Table 6 Research Methods Used in AI-IKS Studies

Methodology	Frequency	Percentage
Qualitative	46	34.1%

Quantitative	27	20.0%
Mixed Methods	24	17.8%
Systematic Reviews	21	15.6%
Conceptual / Theoretical	17	12.5%

The dominance of qualitative and conceptual approaches suggests that the field remains exploratory and framework-building in nature. Experimental and intervention-based studies are comparatively limited.

What Pedagogical and Technological Themes Have Emerged?

Thematic coding of the selected studies identified several recurring pedagogical and technological dimensions.

Table 7 AI Components Identified in Studies

AI Component	Frequency
Machine Learning (ML)	39
Natural Language Processing (NLP)	34
Intelligent Tutoring Systems (ITS)	28
Generative AI	25
Learning Analytics	22
Virtual / Augmented Reality	18

Table 8 IKS Components Integrated in Studies

IKS Component	Frequency
Yoga and Meditation	31
Ayurveda	24
Sanskrit Text Digitization	22
Ethical Values / Dharma	27
Vedic Mathematics	18
Gurukul Pedagogy	13

Table 9 Educational Outcomes Reported

Outcome	Frequency
Learner Engagement	42
Inclusion and Accessibility	36
Personalized Learning	34
Knowledge Retention	29
Critical Thinking	21
Cultural Awareness	18

The findings suggest that AI is primarily used to personalize learning pathways, provide multilingual support, digitize traditional knowledge resources, and embed ethical learning models rooted in Indian philosophy.

What Gaps and Future Directions Exist?

Despite growing interest, several limitations and research gaps were identified across the studies.

Table 10 Major Challenges and Gaps in AI–IKS Research

Challenge / Gap	Frequency
Lack of empirical classroom studies	41
Inadequate digital infrastructure	38
Teacher readiness and AI literacy	36
Bias in datasets and language limitations	29
Limited policy implementation studies	24
Absence of standardized AI–IKS models	21

These results indicate that while theoretical discussions are strong, practical implementation remains limited. Future research should prioritize:

- Classroom-based intervention studies
- Teacher training in AI-integrated pedagogy
- Multilingual AI systems for Indian languages
- Ethical AI frameworks based on IKS values
- Scalable AI–IKS curriculum models aligned with NEP 2020

The overall evidence demonstrates that AI-enabled IKS research is a promising and rapidly developing field. It seeks to combine modern technological innovation with India’s traditional wisdom systems to create inclusive, personalized, and culturally grounded educational models. However, the field requires stronger empirical validation, teacher preparedness, and policy support for sustainable implementation.

Interpretation and citations

The findings of the study indicate that Artificial Intelligence (AI)-enabled Indian Knowledge Systems (IKS) are emerging as a dynamic interdisciplinary field that combines technological innovation with cultural preservation, inclusive pedagogy, and sustainable educational development. The notable rise in publications after 2020 reflects the expansion of AI tools such as adaptive learning platforms, intelligent tutoring systems, natural language processing, learning analytics, and generative AI, together with policy encouragement under the National Education Policy (NEP) 2020, which explicitly promotes the integration of IKS into educational curricula (Ministry of Education, 2020; Holmes et al., 2022; UNESCO, 2021; Tlili et al., 2023; Chen et al., 2020; Zawacki-Richter et al., 2019). The predominance of higher education settings and qualitative, conceptual, or review-based studies suggests that the field remains in an exploratory phase, where scholars are focusing on theoretical frameworks, innovation models, and policy discourse rather than large-scale classroom experimentation (Petersen et al., 2008; Bond et al., 2021; Luckin & Cukurova, 2019).

The study further reveals that AI can significantly strengthen IKS through multilingual learning systems, digitization and semantic preservation of Sanskrit and classical manuscripts, personalized instructional pathways, immersive learning environments, and ethical frameworks inspired by Indian philosophies such as Dharma, Ahimsa, and holistic well-being. These findings are consistent with international evidence showing that AI can improve learner engagement, accessibility, feedback quality, academic performance, and differentiated instruction when implemented responsibly (Ma et al., 2014; Holmes et al., 2022; Roll & Wylie, 2016; Ifenthaler & Yau, 2020). However, persistent challenges such as digital infrastructure gaps, teacher preparedness,

algorithmic bias, privacy concerns, and underrepresentation of Indian languages in AI datasets remain major obstacles to equitable implementation (UNESCO, 2021; Kasneci et al., 2023; Selwyn, 2019). Therefore, future progress requires stronger empirical studies, teacher capacity building, multilingual AI ecosystems, and culturally responsive governance models to ensure that AI-driven pedagogy remains ethical, human-centered, and socially inclusive (Zawacki-Richter et al., 2019; Tlili et al., 2023; OECD, 2021).

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