



ROLE OF ARTIFICIAL INTELLIGENCE AND EMERGING TECHNOLOGIES IN TEACHER TRAINING IN THE INDIAN CONTEXT

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RESEARCH ARTICLE



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Abstract

The rapid development of Artificial Intelligence (AI), Generative Artificial Intelligence (GenAI), Extended Reality (XR), learning analytics, adaptive learning systems and other emerging digital technologies is transforming the knowledge, skills and professional practices expected of teachers. This transformation presents a fundamental challenge for teacher education in India: teacher preparation programmes can no longer restrict technology education to basic digital literacy or the operational use of conventional information and communication technologies. Teachers increasingly require the capacity to understand, critically evaluate, ethically use and pedagogically integrate AI and immersive technologies into diverse educational contexts. This paper critically examines the role of AI and emerging technologies in pre-service and in-service teacher training in India through a critical narrative review of Indian and international scholarship, policy documents and recent empirical studies. The review paper argues that AI should not be introduced into teacher education merely as an additional technological skill. Rather, it should be conceptualised as a new dimension of professional knowledge that intersects technological, pedagogical, content, ethical and contextual knowledge. This review paper analyzes the potential of AI and XR incorporation into teacher training programmes in India. It explores the benefits as well as hurdles in the implementation of technology-based teacher training programmes. This includes aspects like scope for personalised learning, lesson planning, assessment, teacher reflection, simulation-based practice, classroom-management training, inclusive education, professional development and research. Also, the paper identifies significant challenges, including infrastructural insufficiency, digital divides among teachers with varied demographic backgrounds, data privacy and ethical standards, linguistic limitations, technological dependence etc. This paper puts forth a more human-centred, competency-based framework tailor-made for the Indian TEIs aimed at creating a feasible roadmap for integrating AI and XR across various teacher education programmes. Systematic incorporation of AI and emerging technologies into teacher preparation is not simply desirable but increasingly necessary for maintaining the relevance, quality and social responsiveness of Indian teacher education. Successful implementation of this proposed framework necessitates a shift from technology adoption to pedagogically sound technology integration.

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Introduction

In today's digital age, teacher education is currently undergoing a profound transformation as the influence of artificial intelligence and emerging digital technologies is affecting how knowledge is created, represented, accessed, assessed and communicated. Technologies such as generative AI, intelligent tutoring systems, automated feedback, learning analytics, adaptive learning platforms, virtual reality (VR), augmented reality (AR), mixed reality (MR), immersive simulations and AI-supported content creation are progressively becoming an integral part of everyday teaching, moving from experimental applications towards mainstream educational environments. Consequently, the central question for teacher education is no longer whether teachers will encounter AI and emerging technologies, but whether they will possess the professional know-how required to use them sensibly, creatively and responsibly in classrooms across the spectrum-right from kindergarten to higher education. This issue is particularly significant in India. The National Education Policy (NEP) 2020 lays emphasis on promoting technology-enabled education, digital resources, teacher professional development, experiential learning, innovation and the

development of 21st-century competencies (Ministry of Education, 2020). India's large and diverse education system, comprising government and private institutions, urban and rural schools, multiple languages, boards and socioeconomic contexts, makes the development of contextually appropriate digital competence especially important.

The challenge before the Teacher Education Institutions (TEIs) is not simply to make latest technology available to the teacher trainees but to prepare teachers who can determine when technology adds educational value, when it should be modified and when it should deliberately not be used. The emergence of GenAI has intensified this challenge. Large language models can generate explanations, lesson plans, examples, questions, rubrics, feedback, summaries and multimedia content within seconds which may substantially reduce routine workload and support differentiated instructions but the downfall is that these measures also introduce higher risks linked with fabricated information, data privacy, intellectual property rights infringement, academic integrity and undue dependence on automated outputs (Dwivedi et al., 2023; Tlili et al., 2023). UNESCO (Miao & Holmes, 2023) suggests adopting a more human-centred approach that places ethical, safe, equitable and meaningful use at the centre of educational AI, that seems to balance the pros and cons to a large extent.

The teacher's professional role is therefore changing from that of a primary transmitter of information towards that of a designer of learning environments, facilitator of inquiry, evaluator of information and AI outputs, mentor, ethical decision-maker and human mediator of technology-supported learning. This transformation has direct implications for teacher preparation. The fundamental argument of this paper is that AI and emerging technologies should become an integral component of teacher education in India, but not as a separate technology-oriented add-on. They should be embedded within the pedagogical, disciplinary, ethical and professional foundations of teacher education. In other words, India requires teachers who are not merely "AI users" but AI-literate pedagogues.

Objectives of the Paper: The paper has five major objectives:

1. To examine the emerging role of AI and XR technologies in teacher education.
2. To critically review Indian and international research concerning AI and emerging technologies in teacher training.
3. To identify the pedagogical, professional and institutional benefits of integrating AI and XR into teacher education.
4. To analyze the hurdles and risks linked with their implementation in the Indian context.
5. To propose a context-sensitive framework for incorporating AI and emerging technologies into pre-service and in-service teacher education programmes in India.

Methodological Orientation

This paper adopts a critical narrative review approach. Relevant peer-reviewed research articles, systematic reviews, empirical studies, international frameworks and Indian policy documents were examined to identify recurring themes relating to AI literacy, teacher competence, AI-supported pedagogy, XR-based simulation, professional development, ethics and educational equity.

Particular attention was given to studies published between 2019 and 2026, while seminal theoretical works were retained where necessary. The literature was critically interpreted rather than merely summarised, with emphasis on three questions:

- What capabilities can AI and emerging technologies realistically contribute to teacher education?
- What competencies must teachers develop to use these technologies meaningfully?
- What contextual conditions are necessary for equitable and responsible implementation in India?

This approach is justified because AI in teacher education is a rapidly evolving field in which empirical evidence is developing faster than conventional curriculum-revision cycles. Sperling et al. (2024) in their study reported that AI literacy based research remains comparatively a less explored domain specifically within the teacher education context and identified significant gaps in teachers' practical and ethical knowledge about AI and technology use in classrooms.

Conceptualising AI and Emerging Technologies in Teacher Education

AI in teacher education should be understood broadly. It includes not only GenAI systems such as conversational AI and AI-based content generators but also adaptive learning systems, intelligent tutoring systems, automated assessment, learning analytics, recommendation systems, speech recognition, computer vision and predictive systems.

Emerging technologies extend this ecosystem to include:

- Virtual Reality (VR)
- Augmented Reality (AR)
- Mixed Reality (MR)
- Extended Reality (XR)
- immersive simulations
- learning analytics
- intelligent learning environments
- digital twins
- adaptive learning platforms
- multimodal AI
- AI-supported educational robotics.

The educational value of these technologies lies not in their novelty but in their capacity to address particular pedagogical problems. For example, GenAI may assist a trainee teacher in generating alternative explanations of a mathematical concept, whereas XR may allow that trainee to practise classroom management in a simulated classroom. Learning analytics may help the teacher identify learning gaps, while AR may make an abstract scientific or mathematical concept visually accessible. This distinction is important because *technology-centred teacher education risks producing technically competent teachers who lack pedagogical judgement*. Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework is particularly relevant. The framework conceptualises effective technology integration as an interaction among content, pedagogy and technology rather than knowledge of technology in isolation. Based upon an empirical study pertaining to teachers' professional knowledge, Celik (2023) extended this TPACK framework by incorporating the key component of AI and proposing the Intelligent-TPACK, which ideated that teachers need AI-specific technological and pedagogical knowledge together with knowledge for evaluating AI-related usage and related ethical use. Thus, AI competence needs to be viewed as an extension and transformation of teachers' professional knowledge rather than simply another digital skill to be simply acquired as part of professional development.

International Evidence on AI and Teacher Education

Many international studies provide strong evidence for integrating AI into teacher preparation, while also warning against simplistic technological determinism. Zawacki-Richter et al. (2019), in a key systematic review of AI applications in higher education, identified applications in assessment, prediction, intelligent tutoring and learning support but reported the limited involvement of educators in most of the AI research scenario. This finding has a key implication for teacher education: technological innovation designed without adequate attention to teachers' professional knowledge and crucial inputs at each stage may produce AI learning systems that are technically sophisticated but pedagogically unsuitable for use in actual classrooms. Celik et al. (2022) in their review study found that AI can support teachers in planning, implementation and assessment and can help teachers in clearly identifying student needs, providing immediate customized feedback and analysing learning information. The study also revealed that the benefits of AI usage depend to large extent upon teachers' ability to interpret and critically use AI-generated information and AI tools. Sperling et al. (2024) in their exploratory systematic review on AI based teaching found that AI literacy in teacher education remains insufficiently developed. This study, based on the analysis of 34 relevant publications, indicated that AI literacy must encompass knowledge, competence, practical and ethical dimensions rather than merely technical understanding of AI use in classroom teaching. A teacher who knows how to enter a prompt into an AI system is not necessarily AI literate. It encompasses a wide variety of AI related knowledge and skills. An AI-literate teacher should be able to:

1. formulate meaningful educational problems;
2. select an appropriate AI tool;
3. construct effective prompts;
4. evaluate AI-generated outputs;
5. identify hallucinations and bias;
6. protect learner data;
7. determine when AI should and should not be used;
8. adapt AI outputs to curriculum and learner context;
9. disclose appropriate AI use; and
10. maintain human accountability for educational decisions.

UNESCO's AI Competency Framework for Teachers (Miao & Cukurova, 2024) offers a particularly useful international reference with regards to AI use in education and research. This framework categorizes 15 competencies across five dimensions: human-centred mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning, organised across the progression levels of Acquire, Deepen and Create that can help in providing a useful foundation for designing an Indian competency framework.

Evidence from the Indian Context

The Indian evidence base is much smaller than the international literature but it is rapidly expanding each year. Shankar et al. (2025) in a study integrating technology in classrooms analyzed the perceptions of 67 digitally literate Indian high-school teachers concerning GenAI in technology-enhanced STEM education. In the study, teachers reported personalised learning, content enrichment and interactive learning as key strengths, while differentiated instruction, inclusion and expanded access were acknowledged as opportunities. This study demonstrated that not all Indian teachers are resistant to AI, they recognize its potential when it is connected to meaningful pedagogical purposes and helps them produce tangible quality outcomes. Hesitancy and resistance cannot be clubbed together in the same category. Some studies also highlight issues pertaining to significant teacher preparedness gaps, with various demographic playing a crucial role. Kundu et al. (2025) examined AI literacy among 16 Indian school teachers across varied contexts. Their findings indicate that teachers' understanding of AI is often superficial and tool-centred, particularly in the case of rural and government school contexts. Classroom use is very limited, only used for simple tasks like content delivery and grading rather than the more transformative uses. Concerns relating to privacy, bias, misinformation, cultural alignment, language accessibility and infrastructure add to the reservation among teachers to fully embrace the AI-based classroom concept. This finding is particularly important for teacher education. The problem is not simply

lack of access to AI tools, it is also the lack of professional knowledge and interest required to move from access to meaningful pedagogical integration. Recent Indian evidence on broader digital competence reinforces this conclusion. Sheikh and Nath (2026) adopted a mixed-methods intervention study involving an LMS, AR and data analytics. Findings of this study, based upon data from 244 pre-service teachers in Rajasthan reported significant post-intervention improvements in digital teaching competence, technology attitudes and technology ownership. Qualitative findings revealed that some factors like practical application, peer collaboration and institutional support strengthened teacher confidence. Choudhury et al. (2024) validated an AI-TPACK scale for the Indian context using a sample of 660 Indian higher-education teachers. The scale's seven dimensions and high overall reliability indicate the feasibility of assessing AI-related technological, pedagogical and ethical competencies among Indian educators. These studies broadly suggest that teacher readiness for AI cannot be inferred from general digital proficiency alone but also involves numerous other factors including professional as well as personal factors. Teachers may be comfortable with smartphones, social media, online platforms and conventional ICT but continue to be uncertain about delivering AI-generated content, algorithmic decision-making, prompt design, AI-supported assessment or ethical data use.

Need for AI to be Integrated into Teacher Training Programmes

AI can strengthen personalised and differentiated pedagogy: One of the strongest arguments for AI integration is its potential to support differentiated instruction. Teacher trainees can use AI to generate multiple explanations of the same concept at different levels of complexity, create alternative examples, develop remedial exercises, design enrichment tasks and adapt learning materials for different learner needs. For a mathematics teacher, for example, AI can generate visual explanations, multiple solution strategies and differentiated practice problems. For language teachers, it can provide alternative texts, vocabulary activities and formative feedback. For social science teachers, it can simulate multiple perspectives on historical or social issues. However, the teacher must remain the evaluator and curriculum decision-maker. AI should therefore function as a pedagogical assistant rather than an autonomous teacher.

AI can improve lesson planning and instructional design: Teacher education programmes frequently devote considerable time to lesson planning, but conventional lesson planning can remain highly rigid. AI can support trainees in developing better learning outcomes, create differentiated activities, develop assessment questions, include case studies, discussion prompts, project-based learning tasks, develop rubrics, design remedial activities, create individual need based enrichment activities and promote cross-curricular learning experiences. The educational value lies not in allowing AI to write lesson plans automatically, but in asking trainees to critique and improve AI-generated lesson plans. This represents a significant pedagogical shift: Instead of asking trainee teachers, "Can AI create a lesson plan?", teacher educators should ask, "Can you determine whether an AI-generated lesson plan is educationally sound?" The latter will help develop professional judgement among the teacher trainees.

AI-Supported Assessment and Feedback: Assessment is another area in which AI can contribute substantially to teacher preparation. Trainees can learn to use AI to develop formative assessment items, generate question banks, classify questions according to Bloom's taxonomy, develop rubrics, provide preliminary customized feedback, identify patterns in student responses, analyze learning gaps and design personalised remedial tasks. Automated assessment presents serious ethical and data manipulation related concerns. AI systems could potentially generate inaccurate judgements, reproduce biases based upon inaccurate training data sets or provide apparently sophisticated but pedagogically weak feedback due to weak and generic prompts given by teachers. AI can only assist the teacher, not replace their presence. Human intervention and reasoning remain the key to effective implementation of technology enabled education at the ground level. Therefore, teacher education must explicitly teach human-in-the-loop assessment, with the teacher at the centre of the teaching-learning-evaluation cycle, with AI only in an assisting role. This distinction is particularly important in high-stakes examinations and decisions affecting learner progression.

Artificial Intelligence and Teacher Research: AI also has substantial relevance to the evolving research scenario among teacher educators and research scholars. Teacher training programmes and research (post graduate/doctoral) programmes must introduce AI-assisted research skills such as literature discovery, keyword generation, conceptual mapping, research-question refinement, qualitative coding assistance, statistical interpretation support, reference organisation, academic language improvement and research proposal development. Additionally, teacher education must simultaneously encourage integrating the concept of maintaining research integrity. AI-generated citations may be fabricated, summaries may omit methodological limitations, and generative systems may potentially reproduce bias. AI-supported research training must encourage verification, data source triangulation, transparency and intellectual property ownership. This becomes especially relevant in Indian higher education, where the expansion of doctoral education and research output makes responsible AI literacy an increasingly vital component of research methodology.

Extended Reality and Teacher Training: AI cannot be considered in isolation. XR technologies may provide one of the most powerful complements to AI in teacher preparation. Traditional teacher education frequently suffers from a theory-practice gap. Student teachers may study classroom management, inclusive education, child psychology and assessment theoretically but have limited opportunities to rehearse complex classroom situations before entering schools. XR can address this limitation by creating simulated environments in which trainees can repeatedly practise teaching behaviours. For example, a trainee could enter a virtual classroom containing inattentive learners, highly active learners, students with diverse learning needs, bullying situations, classroom conflicts, large-class environments, multilingual interactions or students requiring differentiated support.

The trainee can then make decisions, observe consequences and repeat the scenario to repeatedly practice and enhance their skills in the virtual world before actually implementing them in classroom situations. Ade-Ojo et al. (2022), in a systematic scoping review of physical and mixed-reality simulations in pre-service teacher education, found evidence that simulation can enhance confidence, self-efficacy, classroom-management skills and communication. Han et al. (2025), in a systematic review and meta-analysis of 52 empirical studies published between 2014 and 2024, reported a moderate overall effect of VR interventions in teacher education (Hedges' $g = 0.524$). These outcomes vary according to immersion, equipment and learning objectives. Seufert et al. (2022) found that VR-supported classroom-management training could potentially produce stronger competency outcomes than video-supported training. Chen (2022) also reported encouraging positive findings concerning immersive VR for preparing pre-service teachers to manage challenging student behaviour. The critical implication of these studies is that XR should not be introduced simply because it is immersive, its real value emerges when it is designed to allow teacher trainees to practise, receive feedback, reflect, retry and thereby refine their various teaching skills in the virtual reality before stepping into real world classroom settings.

AI + XR: Towards Intelligent Simulation-Based Teacher Education: The convergence of AI and XR presents a more effective teacher training scenario. An AI-enhanced virtual classroom could dynamically respond to the trainee teacher's decisions. For example: Trainee action → AI interpretation → virtual student response → feedback → reflection → repeated practice. A trainee managing classroom disruption could receive different responses depending on whether the intervention is authoritarian, restorative, collaborative or pedagogically appropriate. Similarly, AI-powered virtual students could simulate other teaching related challenges faced in real classrooms like issues related to learning difficulties, emotional responses, misconceptions, language barriers, behavioural challenges, diverse cultural contexts and differentiated learning needs. AI based VR environments have the potential to transform teacher education from predominantly observational training to repeated, evidence-informed professional rehearsal with differentiated feedbacks, aimed at creating more professionally trained and better equipped next generation teachers. The development of such AI based practice-classroom environments require careful design and thoughtful, practical implementation. Simulated learners are representations rather than real children and so teacher educators must caution trainees from assuming that AI-generated student behaviour represents the full range of complex student behaviour.

AI and Inclusive Teacher Education: AI and emerging technologies also have the potential to contribute significantly to enhance inclusive education scenario. These days AI-supported tools can provide speech-to-text conversion, text-to-speech, automatic captioning, translation, personalised scaffolding, alternative representations of content, visual supports, adaptive learning activities. All these can be of great help when dealing with children with learning disabilities or those who have some kind of physical impairment. XR can enable students to experience simulations and environments that may otherwise be inaccessible. For teacher education, the implication is considerable- inclusion need not be taught exclusively as a theoretical principle but with the help of AI and XR, the trainees can experience situations involving inclusive learning. Trainees can not only learn how to use AI tools for inclusive learning but also how to design AI- and XR-supported inclusive learning environments. Some of the major impediments are that there is no guarantee that AI tools work smoothly with Indian languages, they require high-speed internet, may depend on expensive hardware and in such situations they may reproduce rather than reduce educational inequality.

Major Challenges in Implementing AI and XR in Teacher Training in the Indian Context

Digital and infrastructural inequality: India's educational ecosystem is highly heterogeneous. While the urban private institutions possess high-speed internet, smart classrooms and advanced devices, most of the rural and government institutions face basic infrastructure constraints. Consequently, a high-cost VR-centred teacher education model cannot simply be imposed uniformly across the board. The appropriate strategy is a technology continuum: Low-cost mobile AI → web-based simulation → AR → desktop VR → immersive XR laboratories. Institutions should adopt the level appropriate to their infrastructure rather than treating high-end hardware as the definition of technological innovation.

Lack of teacher-educator preparedness: One of the most serious obstacles may not be trainee teachers but teacher educators themselves. A teacher educator who lacks confidence in AI may teach AI as a theoretical topic rather than model meaningful AI-supported pedagogy. Teacher educators must be compulsorily encouraged to undergo professional development at fixed time intervals (say, every two years) where they are systematically trained in latest technological developments relevant to the educational settings such as- basics of AI, prompt literacy, AI-TPACK implementation at the institution level, AI ethics, AI-supported assessment, research applications, AI-supported lesson plan designing, XR pedagogy and critical evaluation of AI outputs. This would help in the teacher educator becoming the model of responsible AI use.

Ethical and privacy concerns: There are some underlying concerns whenever AI use is involved, especially in educational settings. AI systems often process sensitive educational information such as student records, assessment data, behavioural information and personally identifiable information and therefore require strict data privacy and careful access. UNESCO (Miao & Holmes, 2023) has emphasized data privacy, human agency and ethical governance as fundamental requirements for educational GenAI. Indian teacher education system, as a whole, must consequently include explicit instructions to teacher trainees on how to maintain and incorporate measures to ensure data protection, informed consent, responsible prompting, anonymity, avoid infringement of intellectual property rights, bypass algorithmic bias, ensure transparency, accountability and responsible, ethical use of AI.

Hallucinations and unreliable information: Generative AI can produce fluent but sometimes factually incorrect responses. This is particularly dangerous in teacher education because trainees might assume that AI use ensures accurate knowledge. AI literacy training at the TEIs must therefore include epistemic vigilance. This would help turn AI use into a critical-thinking exercise rather than passive consumption.

Language and cultural challenges: India's multilingual educational environment creates a particularly important challenge. AI systems may perform unevenly across Indian languages and dialects. Educational content generated in English may also fail to reflect local examples, cultural contexts or indigenous knowledge systems. Teacher education should therefore encourage trainees to critically evaluate AI-generated materials for linguistic accuracy, cultural relevance, inclusivity, incorporation of local examples, balanced gender representation in examples, reference to regional contexts and Indian knowledge traditions. This is an area in which Indian teacher education can make a distinctive contribution to global AI-in-education research.

Risk of Technological Dependency: A major concern is that excessive AI use may weaken teachers' independent thinking. If trainees use AI to generate every lesson plan, question, explanation and assessment, they may gradually lose the capacity to design these independently. The objective of teacher education should not be, "Teach teachers to use AI for everything." Rather, it should be, "Teach teachers to decide when AI adds value—and when human expertise should remain central." This distinction is essential. The teacher's professional identity should remain grounded in human traits and reasoning like empathy, contextual judgement, building warm student-teacher relationships, learning to use AI ethically and responsibly, maintain creative traits, develop greater cultural understanding, focus on real classroom observation and develop better understanding of their individual learners. AI can augment these capacities but cannot replace the relational foundations of teaching.

Proposed AI- and XR-Integrated Teacher Education Framework for India

A practical framework can be organised into six progressive layers.

Layer 1: Digital Foundations

Trainees develop basic digital competence, information literacy, cybersecurity awareness and digital citizenship.

Layer 2: AI Literacy

Trainees learn what AI is, how machine learning works conceptually, what generative AI is, limitations of AI, prompting, verification, bias, privacy and ethical use.

Layer 3: AI-TPACK

Trainees learn to integrate AI with:

Content Knowledge + Pedagogical Knowledge + AI/Technological Knowledge + Ethical Knowledge

This is the level at which AI moves from "tool training" to professional teacher competence.

Layer 4: AI-Supported Pedagogy

Trainees apply AI to lesson planning, differentiated instruction, assessment, feedback, inclusive education, curriculum design, classroom research.

Layer 5: XR and Simulation

Trainees practise classroom management, microteaching, inclusive teaching, parent interaction, conflict resolution, assessment and emergency scenarios.

Layer 6: Critical and Creative AI Practice

Advanced trainees design their own AI-supported learning experiences, critically evaluate emerging tools and conduct small-scale action research on AI-supported teaching.

Proposed Curriculum Structure

AI and emerging technologies should be distributed across teacher education rather than isolated in one optional paper.

Teacher Education Component	Suggested AI/XR Integration
Educational Psychology	AI-supported learner profiling; adaptive learning; cognitive simulations
Pedagogy of School Subjects	AI lesson planning; subject-specific AI tools; simulations
Assessment	AI-generated assessment; automated feedback; assessment ethics
Inclusive Education	Assistive AI; accessibility tools; AR/VR inclusion
Educational Technology	AI literacy; GenAI; XR; learning analytics
Practice Teaching	AI-supported lesson design; video analysis; virtual classrooms
Research Methodology	AI-assisted literature review; coding; research ethics
Internship	AI-supported reflective practice and lesson analysis
Professional Development	AI-enabled CPD and personalised teacher learning

Such integration would prevent AI from becoming another isolated "computer education" component.

Recommended Model for In-Service Teacher Education

For practising teachers, a modular professional-development model would be more feasible.

Level 1 – Awareness

Duration: 6–10 hours

Content:

- AI basics;
- GenAI demonstration;

- opportunities and risks;
- ethical principles.

Level 2 – Application

Duration: 15–20 hours

Content:

- prompt engineering;
- lesson planning;
- assessment;
- content creation;
- differentiated instruction.

Level 3 – Pedagogical Integration

Duration: 30–40 hours

Content:

- AI-TPACK;
- AI-supported classroom strategies;
- data literacy;
- inclusive AI;
- subject-specific applications.

Level 4 – Innovation

Duration: 40+ hours

Content:

- AI-supported action research;
- XR lesson design;
- AI-enabled simulations;
- mentoring peers;
- development of institutional AI practices.

This progression aligns conceptually with UNESCO's Acquire–Deepen–Create approach (Miao & Cukurova, 2024).

Policy Recommendations for Successful Integration of AI and XR in Indian Teacher Training Programmes

A national strategy for AI in teacher education should address five priorities.

Develop an Indian AI Competency Framework for Teachers: India must develop a national AI competency framework aligned with UNESCO guidelines but adapted to Indian languages, NEP 2020 goals, school curricula, demographics of teacher education institutions, Indian ethical traditions, data governance and develop low-resource settings.

Make AI literacy a core component of teacher education: AI literacy should be integrated into B.Ed., M.Ed., integrated teacher education programmes and teacher-educator professional development. It should not be restricted to computer-science teachers but also extend to language teachers and social science teachers.

Establish AI-XR Teacher Education Laboratories: Teacher education institutions (TEIs) should gradually establish laboratories where trainees can experience AI-assisted lesson design, virtual classrooms, AR learning objects, VR simulations, digital assessment, learning analytics. Shared regional laboratories could be considered for institutions with limited resources.

Create multilingual and low-bandwidth AI resources: Indian AI-in-education initiatives should be deliberately designed to support local languages and low-resource environments. This is essential if AI is to contribute to educational equity rather than deepen existing inequalities.

Establish institutional AI ethics policies: Every teacher education institution should have clear guidelines concerning acceptable AI use, AI use disclosure, plagiarism, assessment, data privacy, student/guardian informed consent, intellectual property, AI-generated content, academic integrity.

Critical Discussion

The literature supports neither unconditional technological optimism nor technological pessimism. Three broad positions can be clearly identified. The first is technological optimism, which views AI as a powerful mechanism for personalisation, efficiency, accessibility and innovation. There is credible evidence supporting some of these claims. The second is technological caution, which highlights hallucinations, bias, privacy, academic integrity and teacher dependency. These concerns are also empirically and theoretically justified. The third, and arguably most appropriate position for teacher education, is critical augmentation. Critical augmentation recognises that AI should increase teachers' capacity without diminishing their professional agency. The distinction is important:

Traditional model	AI-augmented model
Teacher creates all resources	Teacher + AI co-create resources
Teacher provides standard explanation	Teacher selects/adapts multiple explanations
Periodic assessment	Continuous formative feedback
Limited simulation	Repeatable XR simulation
Reflection after practice	AI/video-supported reflective analysis

One-size-fits-all CPD	Personalised professional learning
Technology as tool	Technology as professional knowledge

Thus, the objective is not to "replace" traditional teacher education but to *redesign teacher education around augmented professional practice*.

Research Gaps

Despite rapid growth in the literature, several research gaps remain. First, there is insufficient longitudinal research examining whether AI training actually changes teachers' classroom practices over extended periods. Second, Indian research remains disproportionately dependent on perception, attitude and self-reported readiness studies. More experimental and mixed-methods studies are required. Third, there is a need for research comparing AI-integrated teacher education with conventional teacher preparation. Fourth, research on teacher educators themselves remains limited. Fifth, the Indian context requires much more research on multilingual AI, rural teacher education, government teacher education institutions, AI and Indian Knowledge Systems, AI in mathematics teacher education, AI-supported inclusive education, AI ethics among trainee teachers, AI-supported practice teaching, XR-based classroom-management training and AI-TPACK framework implementation among B.Ed. and M.Ed. students. Finally, research should move beyond "intention to use" and examine actual classroom implementation and student-learning outcomes.

Conclusion

Artificial Intelligence and emerging technologies are redefining the professional knowledge required of teachers. For India, this transformation represents both a challenge and an opportunity. The challenge lies in the country's considerable digital, infrastructural, linguistic and institutional diversity. The opportunity lies in the possibility of using AI and XR to make teacher preparation more personalised, experiential, inclusive, reflective and evidence-informed. The literature review clearly indicates that AI can support teachers in planning, assessment, differentiation, content creation and professional learning, while XR can provide realistic, repeatable and safe environments for practising complex teaching behaviours. However, the evidence equally demonstrates that technology alone does not create pedagogical improvement. Effective integration depends on teachers' technological, pedagogical, content, ethical and contextual knowledge. The Indian evidence is particularly revealing. Teachers and trainee teachers demonstrate interest in AI and emerging technologies, but significant gaps remain in AI literacy, practical experience, infrastructure and institutional support. Recent Indian researches also show that hands-on technology integration can improve digital competence and confidence, while AR research reveals persistent barriers involving awareness, training, infrastructure and institutional support. Therefore, India's response should not be to add a superficial "AI module" to existing teacher education curricula. Instead, AI and emerging technologies should become a cross-cutting dimension of teacher professional preparation. The future-ready Indian teacher should be able to work *with* AI without becoming dependent on it, use technology without surrendering professional judgement, exploit automation without compromising human relationships, and employ immersive technologies without confusing simulation with authentic human experience. The ultimate objective should consequently be not AI replacing teachers, but teachers becoming more capable because they know how, when, why and when not to use AI. In this sense, AI literacy should become as fundamental to twenty-first-century teacher education as pedagogical knowledge itself.

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