Future-Proofing Teacher Education: Essential Competencies for Teachers in the Age of Artificial Intelligence

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ABSTRACT

Artificial Intelligence (AI) is rapidly transforming educational systems by reshaping curriculum design, teaching practices, assessment, learner engagement, and institutional decision-making. While AI offers significant opportunities to enhance educational quality, personalization, and accessibility, it also demands a fundamental rethinking of the competencies required of future teachers. Contemporary teacher education can no longer focus solely on pedagogical knowledge and subject expertise; it must prepare teachers to integrate AI into teaching and learning in ways that are pedagogically sound, ethically responsible, and learner-centred. This paper critically examines the essential competencies that teacher education programmes should cultivate to prepare future educators for AI-enabled classrooms. Drawing upon recent scholarly literature (2022–2026), UNESCO's AI Competency Framework for Teachers (2024), the UNESCO Guidance for Generative AI in Education and Research (2023), and the vision of the National Education Policy (NEP) 2020, the paper synthesizes key domains of teacher competence, including AI literacy, digital pedagogical competence, assessment literacy, ethical decision-making, data literacy, critical thinking, inclusive instructional design, collaboration, and lifelong professional learning. The paper argues that preparing future teachers requires moving beyond technological proficiency towards a human-centred approach in which AI enhances, rather than replaces, professional judgement, reflective practice, and meaningful teacher–student interaction. It further discusses institutional and policy challenges associated with AI integration in teacher education, including curriculum redesign, faculty preparedness, digital infrastructure, and continuous professional development. Based on the reviewed literature, the paper offers recommendations for strengthening teacher education curricula and institutional practices to prepare future-ready educators capable of using AI responsibly, ethically, and effectively. The study contributes to the growing discourse on AI and teacher education by providing a comprehensive synthesis of emerging competency requirements and practical implications for teacher educators, policymakers, and curriculum developers in an evolving educational landscape.

Keywords: Teacher Education; Artificial Intelligence; AI Literacy; Teacher Competencies; Future-Ready Teachers; NEP 2020

INTRODUCTION

Artificial Intelligence (AI) is transforming education by reshaping teaching, learning, assessment, and educational management. Technologies such as generative AI, adaptive learning systems, learning analytics, and automated feedback are increasingly being integrated into educational practice, creating new opportunities for personalized learning, improved efficiency, and data-informed decision-making (Garzón et al., 2025; Holmes et al., 2022; Miao & Holmes, 2023).

At the same time, these developments raise important pedagogical and ethical questions regarding the role of teachers, the quality of learning, and the responsible use of AI in education (Miao & Cukurova, 2024; Selwyn, 2022). As AI becomes an integral part of educational ecosystems, the role of teachers is evolving from knowledge transmitters to facilitators, instructional designers, mentors, and ethical decision-makers (Holmes et

al., 2022; Miao & Cukurova, 2024). This transformation requires teacher education programmes to prepare future educators who can critically evaluate AI technologies, integrate them into teaching responsibly, and maintain meaningful human interaction within increasingly technology-enabled classrooms (Miao & Cukurova, 2024; Ministry of Education, Government of India, 2020).

International and national policy frameworks have recognized the need to strengthen teachers' AI-related competencies. According to UNESCO's Guidance for Generative AI in Education and Research (Miao & Holmes, 2023) and the AI Competency Framework for Teachers (Miao & Cukurova, 2024), teachers require competencies related to AI literacy, ethical responsibility, and continuous professional learning. Likewise, the National Education Policy 2020 emphasizes technology-enabled teaching, innovation, digital literacy, and continuous professional development while reaffirming the central role of teachers in educational transformation (Ministry of Education, Government of India, 2020).

Despite increasing research on AI in education, relatively limited attention has been devoted to systematically examining the competencies that future teachers require to effectively work in AI-enabled learning environments (Garzón et al., 2025; Miao & Cukurova, 2024). Addressing this gap, the present paper critically examines the essential competencies needed by future teachers and discusses the institutional challenges associated with integrating AI into teacher education. The paper is organized into four sections: the transformation of teacher education in the AI era, essential competencies for future teachers, major implementation challenges and recommendations, and concluding observations for strengthening future-ready teacher education.

AI and the Transformation of Teacher Education

The changing educational landscape requires teacher education programmes to reconsider how future teachers are prepared for professional practice (Holmes et al., 2022; Miao & Holmes, 2023). Traditional teacher preparation has largely emphasized subject knowledge, pedagogical skills, classroom management, and assessment practices (Ministry of Education, Government of India, 2020). While these competencies remain essential, they are no longer sufficient for teaching in AI-enabled learning environments, where educators are expected to make informed decisions about the pedagogical, ethical, and responsible use of emerging technologies (Miao & Cukurova, 2024).

Preparing teachers for the AI era involves more than familiarising them with digital tools (Crompton & Burke, 2023). Future teachers must understand how AI influences teaching, learning, assessment, and educational decision-making while recognising its limitations and potential risks (Tlili et al., 2025). They should be able to evaluate AI-generated content critically, protect learner privacy, address algorithmic bias, and ensure that technology supports rather than replaces meaningful human interaction in education (Crompton & Burke, 2023; Miao & Holmes, 2023; Selwyn, 2022).

This shift requires teacher education institutions to redesign curricula, strengthen professional learning opportunities, and systematically integrate AI-related competencies across teacher preparation programmes (Miao & Holmes, 2023; Miao & Cukurova, 2024). International policy frameworks, including UNESCO's AI Competency Framework for Teachers (Miao & Cukurova, 2024) and the National Education Policy 2020 (Ministry of Education, Government of India, 2020), emphasize that future teachers should possess not only technological competence but also ethical awareness, reflective practice, inclusive pedagogical approaches, and a commitment to lifelong professional learning.

Viewed from this perspective, the transformation of teacher education is not simply about adopting new technologies but about preparing professionals who can combine pedagogical expertise with responsible AI integration. The following section discusses the essential competencies that future teachers require to effectively teach and learn in AI-supported educational environments.

Essential Competencies for Future Teachers in the Age of Artificial Intelligence

Preparing teachers for AI-enabled education requires a broader conception of professional competence than

traditional teacher education has offered (Holmes et al., 2022; Miao & Cukurova, 2024). Beyond subject knowledge and pedagogical skills, future teachers must possess competencies that enable them to use AI critically, responsibly, and effectively while maintaining meaningful human interaction in the learning process (Miao & Cukurova, 2024; Miao & Holmes, 2023). The following competency domains are particularly important for preparing teachers to respond to emerging educational needs.

AI Literacy and Digital Pedagogical Competence

AI literacy enables teachers to understand the capabilities, limitations, and educational applications of AI systems (Ng et al., 2024; Miao & Cukurova, 2024). Rather than simply using AI tools, teachers should be able to evaluate the accuracy, reliability, and appropriateness of AI-generated content before incorporating it into teaching and learning (Miao & Cukurova, 2024). Alongside AI literacy, digital pedagogical competence enables teachers to integrate AI into curriculum planning, instructional design, formative assessment, and personalized learning in ways that enhance learner engagement and educational quality (Holmes et al., 2022; Miao & Holmes, 2023).

Assessment and Data Literacy

AI-supported assessment systems provide opportunities for timely feedback, adaptive assessment, and learning analytics (Garzón et al., 2025; Tlili et al., 2025). However, teachers require assessment literacy to interpret AI-generated evidence critically and avoid relying solely on automated decisions (Miao & Cukurova, 2024; Miao & Holmes, 2023). Data literacy is equally important, as educators must understand how learner data are collected, analysed, and used while ensuring privacy, transparency, and responsible data management (Miao & Holmes, 2023). Professional judgement should remain central to educational assessment despite increasing technological support (Miao & Cukurova, 2024; Selwyn, 2022).

Ethical and Human-Centred Professional Practice

The integration of AI raises important concerns relating to algorithmic bias, academic integrity, privacy, accountability, and equity (Ali et al., 2024). Consequently, teachers require ethical competence to make informed decisions regarding the appropriate use of AI in different educational contexts (Ali et al., 2024; Miao & Cukurova, 2024). Human-centred professional practice recognises that although AI can support instructional processes, essential educational responsibilities—including mentoring, empathy, value education, and professional judgement—must remain under human guidance (Holmes et al., 2022; Miao & Cukurova, 2024; Miao & Holmes, 2023). Teachers should therefore employ AI as a pedagogical resource rather than a substitute for professional expertise (Miao & Holmes, 2023).

Critical Thinking and Reflective Practice

As AI increasingly generates educational content and instructional recommendations, teachers must critically evaluate AI-generated outputs rather than relying on them uncritically (Miao & Holmes, 2023; Selwyn, 2022).

Critical thinking enables educators to assess the credibility, relevance, and pedagogical value of AI-generated information before integrating it into classroom practice (Holmes et al., 2022; Miao & Cukurova, 2024). Reflective practice further supports continuous professional improvement by encouraging teachers to evaluate their experiences, adapt instructional strategies, and respond effectively to emerging technological developments (Miao & Cukurova, 2024; Ministry of Education, Government of India, 2020).

Inclusive Teaching and Lifelong Professional Learning

AI has the potential to support inclusive education through personalised instruction, multilingual learning resources, and assistive technologies (Tlili et al., 2025). Teachers therefore require the competence to design equitable learning experiences that address diverse learner needs while reducing digital inequalities (Miao & Cukurova, 2024; Ministry of Education, Government of India, 2020). Given the rapid pace of AI innovation, continuous professional learning is essential for ensuring that teachers remain responsive to emerging

educational needs (Miao & Cukurova, 2024; Miao & Holmes, 2023). Ongoing engagement with professional development programmes, educational research, and policy initiatives enables teachers to update their competencies and sustain effective practice throughout their careers (Holmes et al., 2022; Ministry of Education, Government of India, 2020). Drawing upon the literature reviewed in this paper, the essential competency domains required for future teachers in the age of Artificial Intelligence are presented in Table 1.

Table 1. Essential Competencies for Future Teachers in the AI Era

Competency Domain	Professional Focus
AI Literacy and Digital Pedagogy	Responsible integration of AI into teaching and learning
Assessment and Data Literacy	Evidence-informed assessment and ethical use of learner data
Ethical and Human-Centred Practice	Responsible AI use, professional judgement, and learner well-being
Critical Thinking and Reflective Practice	Evaluation of AI outputs and continuous professional improvement
Inclusive Teaching and Lifelong Learning	Equitable learning opportunities and continuous competency development

Strengthening Teacher Education for the AI Era

Despite growing recognition of AI in education, several institutional and policy challenges continue to influence its effective integration within teacher education programmes (Ali et al., 2024; Miao & Cukurova, 2024; Miao & Holmes, 2023). Developing future-ready teachers requires systematic changes in curriculum design, faculty development, institutional policies, and learning infrastructure rather than isolated training programmes (Ali et al., 2024). AI-related competencies should therefore be integrated across teacher education courses and practicum experiences instead of being taught as stand-alone technology modules (Miao & Cukurova, 2024).

Curriculum revision should be accompanied by continuous professional development for teacher educators (Miao & Cukurova, 2024; Miao & Holmes, 2023). Teacher educators require opportunities to strengthen their own AI literacy, pedagogical understanding, and ethical awareness in order to effectively prepare future teachers for AI-enabled classrooms (Miao & Holmes, 2023).

Institutional collaboration with technology experts, researchers, and schools can further support the development of authentic learning experiences that connect theoretical knowledge with classroom practice (Ali et al., 2024).

Equally important is the establishment of institutional policies that promote responsible AI use (Ali et al., 2024). Teacher education institutions should provide clear guidance on academic integrity, learner privacy, transparency, and the ethical use of AI-supported educational tools (Ali et al., 2024; Miao & Cukurova, 2024; Miao & Holmes, 2023). Such policies help ensure that technological innovation remains aligned with educational values while protecting the rights and interests of learners (Selwyn, 2022).

Finally, preparing future-ready teachers should be viewed as an ongoing process rather than a one-time curricular reform (Holmes et al., 2022; Miao & Cukurova, 2024). Regular curriculum review, continuous professional learning, and evidence-informed policy development will enable teacher education programmes to

respond to emerging technological changes while maintaining the central role of teachers in promoting inclusive, ethical, and learner-centred education (Miao & Cukurova, 2024; Ministry of Education, Government of India, 2020). Drawing upon the literature reviewed in this paper, the key institutional strategies for strengthening teacher education in the age of Artificial Intelligence are presented in Table 2.

Table 2. Strategies for Strengthening Teacher Education in the AI Era

Area	**Priority Action**
Curriculum	Embed AI competencies across teacher education courses
Faculty Development	Continuous AI-related professional learning
Institutional Policy	Ethical AI guidelines, privacy, and academic integrity
Partnerships	Collaboration with schools, researchers, and technology experts
Quality Improvement	Periodic curriculum review and evidence-informed practice

CONCLUSION

Artificial Intelligence is reshaping education by creating new possibilities for teaching, learning, assessment, and educational innovation. These developments require teacher education to move beyond traditional models of professional preparation and equip future teachers with competencies that enable them to engage with AI critically, ethically, and effectively. Preparing teachers for AI-enabled classrooms is not simply a technological challenge but an educational responsibility that requires balancing innovation with sound pedagogical practice and human values. This paper has argued that future-ready teachers require a combination of AI literacy, digital pedagogical competence, assessment and data literacy, ethical responsibility, critical thinking, reflective practice, and a commitment to continuous professional learning. Developing these competencies depends not only on individual teachers but also on teacher education institutions that are capable of redesigning curricula, strengthening faculty capacity, and establishing supportive institutional policies for responsible AI integration. As AI technologies continue to evolve, teacher education must adopt a proactive rather than reactive approach to professional preparation. Continuous curriculum renewal, evidence-informed policy development, and sustained professional learning will be essential to ensure that teachers remain capable of responding to emerging educational challenges. Ultimately, the future of AI in education will depend less on technological advancement itself and more on the ability of well-prepared teachers to employ AI responsibly while preserving the human relationships, ethical judgement, and inclusive values that remain central to quality education.

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