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Use of artificial intelligence in teacher education: Opportunities, challenges and ethical concerns

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Abstract
Artificial Intelligence (AI) is gradually becoming an important part of teacher education and is changing the way future teachers learn, teach, assess, and develop professional skills. The use of AI tools can provide several benefits to teacher education by making learning more flexible, personalised, and accessible. AI can help student teachers prepare lesson plans, create teaching materials, understand learners' needs, receive feedback, and improve their digital and teaching skills. Generative AI has further expanded these possibilities by supporting content creation, classroom activities, reflective learning, and access to a wide range of educational resources. However, the growing use of AI also raises several challenges. These include limited digital infrastructure, unequal access to technology, lack of AI knowledge among teacher educators and student teachers, concerns about data privacy, biased AI-generated information, academic dishonesty, and overdependence on technology. Ethical issues are equally important, particularly when AI is used to support educational decisions without adequate transparency or human judgement. Therefore, teacher education programmes should focus on developing the ability of future teachers to use AI responsibly and critically. This paper examines the major opportunities, challenges, and ethical concerns related to the use of AI in teacher education. It emphasises that effective and responsible use of AI requires human supervision, clear institutional guidelines, teacher training, and protection of personal data, transparency, and respect for professional judgement. AI should be viewed as a supportive tool rather than a replacement for teachers. When used carefully and responsibly, it can strengthen teacher education and help prepare teachers for the changing needs of modern education.

Keywords: Artificial Intelligence, Teacher Education, Generative AI, Educational Technology, Ethical Concerns

Introduction

Artificial Intelligence (AI) is becoming an increasingly important part of modern society and is influencing different areas of life, including education. Its growing presence is changing the way teacher's plan lessons, students learn, assessments are conducted, and educational materials are prepared. The emergence of generative AI has expanded these possibilities further by enabling users to create text, questions, lesson ideas, summaries, and other learning resources within a short time.[1] These developments have made it necessary to prepare future teachers not only to use AI tools but also to understand their limitations and use them responsibly.

In India, the role of technology and AI in education has received attention through the *National Education Policy (NEP) 2020*. The policy recognises Artificial Intelligence as an important contemporary area and encourages the use of technology to improve teaching, learning, assessment, and educational management. It also proposed *the National Educational Technology Forum (NETF)* as a platform for sharing ideas and practices related to educational technology. In addition, NEP 2020 introduced *the four-year Integrated Teacher Education Programme (ITEP)* to strengthen teacher preparation through a multidisciplinary approach.[2] These developments reflect the need to prepare teachers for the changing technological and educational environment.

India has also introduced several initiatives to promote AI awareness and digital education. The NITI Aayog National Strategy for Artificial Intelligence, released in 2018, identified education as one of the important areas in which AI could be applied. The Central Board of Secondary Education (CBSE) has introduced AI as a skill subject and has undertaken various activities related to AI learning and teacher training. Another notable initiative is AI for All, launched in 2021 by CBSE in collaboration with Intel India. The programme was designed to provide basic knowledge and awareness about AI to the wider public.[3] Such initiatives show that AI literacy is becoming relevant not only for students but also for teachers and teacher educators.

Teacher professional development is also being supported through programmes such as NISHTHA and DIKSHA. These initiatives have encouraged the use of digital platforms and technology-supported approaches for teacher learning and professional development. More recently, IIT Madras has expanded AI-related learning opportunities through SWAYAM Plus, including an AI for Educators course aimed at school teachers.[4] Such efforts indicate that teachers increasingly need opportunities to develop the knowledge and skills required to work effectively in an AI-supported educational environment.

At the national level, the India AI Mission, approved by the Union Cabinet in March 2024, has an outlay of ₹10,371.92 crore over five years. The mission focuses on areas such as computing infrastructure, datasets, AI applications, future skills, support for start-ups, and the development of safe and trusted AI. Although the mission extends beyond education, its emphasis on skills and responsible AI has significant implications for teacher education.[5] Teachers will play an important role in helping learners develop the knowledge and abilities needed to participate responsibly in an increasingly AI-driven society.

The importance of teacher preparation for AI is also recognised internationally. In 2024, UNESCO introduced the AI Competency Framework for Teachers, which identifies 15 competencies under five areas: human-centred mindset, ethics of AI, AI foundations and applications, AI pedagogy, and AI for professional learning. The framework describes three levels of development—Acquire, Deepen, and Create—and highlights human agency, ethical responsibility, and continuous professional learning.[6] It provides useful guidance for developing teachers who can use AI effectively while maintaining professional and ethical standards.

AI can offer several benefits to teacher education. It can assist student teachers in preparing lesson plans, developing teaching materials, designing assessment activities, analysing learner responses, and obtaining feedback. AI tools can also support personalised learning by providing resources and explanations according to individual needs. Generative AI may encourage creativity and help future teachers explore different classroom activities and teaching approaches. When used appropriately, AI can reduce some routine tasks and provide teachers with more time for interaction, reflection, creativity, and meaningful learning.[7]

Despite these opportunities, the integration of AI into teacher education also presents several challenges. Unequal access to digital devices, reliable internet services, and technological infrastructure can create a digital divide among learners and institutions. In addition, many teacher educators and student teachers may not yet have sufficient knowledge or training to use AI effectively. AI-generated information may also include errors, biased content, or misleading responses.[8] Therefore, future teachers need strong critical-thinking skills to check and evaluate AI-generated material before using it in educational settings.

The ethical dimension of AI is another major concern. AI systems may collect and process personal and educational data, raising questions about privacy and data protection. Algorithmic bias can also reinforce existing inequalities if AI systems are not carefully designed and monitored. The use of generative AI in assignments creates further concerns about academic integrity, originality, and independent learning. Excessive dependence on AI may reduce opportunities for students to develop creativity, critical thinking, problem-solving skills, and professional judgement.[9] These concerns make human supervision and responsible use essential.

Teacher education institutions therefore have an important responsibility to prepare future teachers for an AI-supported educational environment. Teacher preparation programmes should provide opportunities to develop AI literacy, digital competence, critical thinking, ethical awareness, data protection knowledge, and responsible technology use. Continuous professional development is equally important because AI technologies are developing rapidly. Teachers should learn not simply how to operate AI tools but how to select appropriate tools, verify their outputs, protect learners' information, and make informed professional decisions.[10]

AI should therefore be understood as a supportive technology rather than a replacement for teachers. Teaching involves empathy, communication, relationships, cultural understanding, classroom interaction, motivation, and professional judgement.[11] These human aspects remain central to effective education. The most meaningful use of AI will come from combining technological capabilities with teachers' knowledge, experience, creativity, and ethical responsibility.

Against this background, the present paper examines the opportunities, challenges, and ethical concerns associated with the use of Artificial Intelligence in teacher education. It explores how AI can contribute to teacher preparation while also considering the risks that may arise from its inappropriate or excessive use. The paper argues that responsible integration of AI can strengthen teacher education when technology is combined with sound pedagogy, adequate training, ethical safeguards, human oversight, and professional judgement.

Conceptual Framework

Artificial Intelligence (AI) in teacher education can be understood as the use of intelligent digital tools to support teacher preparation, learning, teaching, assessment, and professional development. In this study, AI is viewed mainly as a supporting resource rather than a substitute for teachers. It can help student teachers and teacher educators with different academic and professional activities, while important educational decisions remain guided by human judgement and professional experience.

The conceptual framework focuses on the connection between AI integration, teacher competencies, opportunities, challenges, ethical concerns, and responsible use. AI can support personalised learning, lesson planning, and preparation of teaching materials, assessment, feedback, and professional learning. However, its effective use may be affected by limited infrastructure, unequal access to technology, inadequate AI knowledge, inaccurate information, and excessive dependence on digital tools. It also raises ethical issues such as data privacy, algorithmic bias, transparency, accountability, academic integrity, and the responsible use of AI-generated content.[12]

The framework suggests that the success of AI in teacher education depends largely on how well teachers and teacher educators understand and use AI. AI literacy, digital competence, critical thinking, pedagogical knowledge, ethical awareness, institutional support, and human oversight are therefore essential. When these elements are properly addressed, AI can strengthen teachers' professional abilities, improve the quality of teacher preparation, and contribute to a more flexible, effective, and future-ready teacher education system

Artificial Intelligence in Teacher Education: Applications and Opportunities

The growing use of Artificial Intelligence (AI) in teacher education represents more than a technological change; it signals a shift in how future teachers can be prepared for increasingly complex educational environments. AI can support lesson planning, learning, assessment, feedback, resource development, and professional learning. However, its educational value should not be judged simply by the availability of AI tools. The real benefit depends on whether these technologies strengthen teachers' pedagogical knowledge, critical thinking, creativity, and professional judgement.[13] Therefore, AI should be integrated into teacher education as a complementary resource rather than treated as a substitute for teachers or teacher educators.

One of the most significant applications of AI is in lesson planning and development of teaching-learning materials.

Student teachers can use AI to generate lesson ideas, classroom activities, examples, questions, and alternative explanations. This can reduce the time spent on routine preparation and allow greater attention to classroom interaction and instructional planning. However, AI-generated material may contain factual errors or may not reflect the social and cultural context of a particular classroom. For this reason, the use of AI should involve teacher review and adaptation. The opportunity is therefore not simply to automate lesson planning but to help future teachers develop the ability to evaluate and improve AI-supported resources.[14]

AI also offers considerable potential for personalised learning. Teacher education programmes include learners with different levels of academic preparation, learning styles, and professional interests. AI-based systems can provide individualised explanations, practice activities, learning resources, and feedback. This can help student teachers identify their strengths and areas requiring improvement. Nevertheless, personalisation through technology cannot fully replace the understanding that teacher educators develop through direct interaction with learners. AI can identify patterns in learning, but teachers remain essential for interpreting those patterns and responding to the wider educational and emotional needs of students.[15]

Another important application is assessment and feedback. AI can assist in preparing questions, organising assessment activities, analysing responses, and providing preliminary feedback. Such applications may make assessment processes more efficient and provide learners with quicker responses to their work. From a teacher-education perspective, however, efficiency should not become the primary goal of assessment. Human judgement remains necessary because learning involves qualities such as creativity, reasoning, communication, and contextual understanding that cannot always be measured accurately through automated systems. AI is therefore most useful when it supports teachers' assessment decisions rather than making those decisions independently.[16]

The emergence of generative AI has created additional opportunities for teacher preparation. Future teachers can use generative AI to develop case studies, discussion questions, quizzes, classroom scenarios, and alternative explanations of difficult concepts. It can also support reflective practice by allowing student teachers to examine different approaches to classroom problems.[17] These possibilities can encourage experimentation and creativity. At the same time, uncritical dependence on generated responses may weaken independent thinking. The educational value of generative AI consequently depends on whether teacher education programmes teach students to question, verify, modify, and critically evaluate AI-generated content.

AI can further contribute to professional development and reflective learning. Teachers need to continue updating their knowledge as curricula, technologies, and learner needs change. AI-supported tools can provide access to educational resources, assist in exploring new teaching strategies, and support reflection on classroom practices. This can make professional learning more continuous and accessible. However, professional development should not become dependent on automated recommendations. Teacher educators and professional communities remain important for providing contextual knowledge, discussion, mentoring, and ethical guidance.[18]

Another promising area is inclusive and accessible education. AI-supported technologies can assist with translation, speech recognition, text generation, simplified explanations, and adaptation of learning materials. These applications may help teachers respond to learners with different linguistic abilities and educational needs. However, technology does not automatically create inclusion. If AI systems are trained on biased or limited data, they may reproduce existing inequalities.[19] Thus, AI can support inclusion only when teachers understand its limitations and carefully monitor its outcomes.

The opportunities offered by AI therefore need to be considered alongside the professional role of teachers. Teaching is fundamentally a human activity involving empathy, communication, motivation, relationships, cultural understanding, and ethical decision-making. These dimensions cannot simply be transferred to automated systems. The argument, therefore, is not whether AI can replace aspects of teachers' work, but whether it can strengthen teachers' capacity to perform their work more effectively. A teacher who understands AI critically can use it to generate possibilities while retaining responsibility for selecting, adapting, and evaluating them.[20]

Overall, AI has the potential to improve teacher education through personalised learning, lesson planning, resource development, assessment, feedback, generative content creation, professional development, and inclusive education. Yet these opportunities are not automatic. They depend on adequate digital infrastructure, teacher training, AI literacy, critical thinking, ethical awareness, and institutional support. The most appropriate approach is therefore a human-centred model in which AI extends teachers' capabilities without weakening their professional autonomy. In this sense, the successful integration of AI into teacher education should be measured not by how much technology is used, but by how effectively it contributes to better teaching, deeper learning, and stronger professional competence.

Challenges and Ethical Concerns in the Use of Artificial Intelligence

Although Artificial Intelligence (AI) has considerable potential to improve teacher education, its growing use also brings several practical and ethical concerns. The success of AI cannot be measured simply by whether the technology is available. It also depends on adequate infrastructure, teachers' knowledge and skills, institutional support, and responsible implementation. If these factors are overlooked, AI may increase existing inequalities rather than provide equal educational opportunities. A balanced approach is therefore necessary to ensure that technological progress remains aligned with educational values.

One of the most important challenges is unequal access to technology. Students and institutions do not always have the same access to reliable internet, digital devices, software, and technical facilities. Differences between rural and urban areas and between institutions with different levels of resources can influence the extent to which learners benefit from AI.[21] This unequal access may further widen the digital divide. Educational institutions therefore need to strengthen digital infrastructure and make AI-supported learning opportunities more accessible to different groups of learners.

Another concern is the limited level of AI literacy among teachers and teacher educators. Access to an AI tool does not automatically mean that it can be used effectively. Student teachers need to understand the basic functioning of AI, develop appropriate instructions, evaluate its responses, and identify possible errors or bias. Teacher educators also need adequate training to guide students in responsible AI use. Without such preparation, AI may become a shortcut for completing academic tasks instead of a tool that supports meaningful learning and professional development.[22]

The accuracy and reliability of AI-generated information also require careful consideration. AI systems can sometimes produce responses that sound convincing but contain incorrect, incomplete, or misleading information. In teacher education, such errors may enter lesson plans, teaching materials, assignments, or assessment activities. Future teachers must therefore learn to verify AI-generated information using reliable academic and educational sources. Critical evaluation should be treated as an essential skill when working with AI.[23]

Over dependence on AI is another significant concern. If student teachers regularly rely on AI to prepare lessons, write assignments, solve problems, or generate ideas, they may have fewer opportunities to develop independent thinking and creativity. Excessive dependence may also weaken problem-solving, reflection, and professional decision-making skills. AI should therefore be used to extend learners' thinking and capabilities, not to take over tasks that are important for developing professional competence.

The protection of privacy and personal data is a further ethical issue. AI-supported educational platforms may collect information about learners, including their academic performance, learning behaviour, interactions, and other personal details. This raises questions about how such information is collected, stored, shared, and used. Teacher education institutions need clear data-protection practices and should ensure that teachers and students understand the risks of entering personal or confidential information into AI systems.[24]

Algorithmic bias and fairness are also important concerns. AI systems are developed using large amounts of existing data, which may reflect social, cultural, linguistic, or other forms of bias. Consequently, AI-generated recommendations, content, or assessments may not always produce fair outcomes for all learners. Future teachers need to recognise that AI is not necessarily neutral and should be prepared to examine its outputs critically.[25] This awareness is particularly important when AI is used in educational decisions that may affect learners' opportunities.

The growing use of generative AI has also raised questions about academic integrity and originality. Students can use AI to produce assignments, reports, and other academic work with limited personal involvement. This can make it difficult to determine whether submitted work reflects the student's actual knowledge and understanding. Rather than depending entirely on restrictions, teacher education institutions should establish clear expectations regarding acceptable AI use. Students should be encouraged to use AI transparently while maintaining originality, acknowledging assistance where appropriate, and demonstrating their own understanding.[26]

Transparency and accountability present another challenge. Many AI systems rely on complex processes that users may not fully understand. When an AI tool contributes to an assessment, recommendation, or educational decision, it may be difficult to explain why a particular result was produced.[27] This creates an important question of responsibility when an AI-supported outcome is inaccurate or unfair. Educational decisions should therefore remain under human responsibility, with teachers and teacher educators retaining the authority to review and question AI-generated results.

The human dimension of teaching must also remain central. Education is not simply the delivery of information; it involves empathy, communication, relationships, motivation, cultural understanding, and professional judgement. These qualities are difficult to reproduce through automated systems. If teacher education becomes overly focused on technology, important human aspects of teaching may receive less attention. AI should consequently be used in ways that strengthen teacher-student relationships and support, rather than reduce meaningful human interaction.[28]

Overall, the challenges associated with AI demonstrate that technology alone cannot guarantee improvements in teacher education. Unequal access, limited AI literacy, unreliable information, overdependence, privacy concerns, algorithmic bias, academic integrity, lack of transparency, and the possible loss of human interaction require careful attention. Addressing these concerns calls for teacher training, institutional policies, ethical guidelines, data-protection measures, regular monitoring, and meaningful human oversight. The responsible integration of AI should ultimately be guided by the principle that technology must serve educational and human needs. AI can contribute positively to teacher education when its capabilities are combined with professional knowledge, ethical responsibility, critical thinking, and sound human judgement.

Future Directions and Policy Implications

The future use of Artificial Intelligence (AI) in teacher education will depend on how well technology is combined with professional knowledge and ethical responsibility. AI is expected to become more common in areas such as lesson planning, assessment, learning support, teacher training, and professional development. However, simply introducing AI tools into teacher education will not automatically improve its quality. Policies should focus on preparing teachers who can use AI thoughtfully, critically, creatively, and responsibly.

One of the most important priorities is to improve AI literacy and professional skills among teachers and teacher educators. Teacher education programmes should provide basic knowledge of AI along with practical opportunities to use AI tools, evaluate their outputs, identify errors, understand data-related issues, and make ethical decisions. Both pre-service and in-service teacher training should be updated regularly to keep pace with technological changes. Teacher educators also need continuous professional development so that they can effectively support student teachers.[29]

Another important area is digital infrastructure and equal access to technology. Differences in internet connectivity, availability of devices, digital resources, and institutional facilities can limit the benefits of AI for some learners. Future policies should therefore give particular attention to

institutions and communities with fewer technological resources. AI-supported teacher education should not become an advantage available only to well-equipped institutions. Wider and equitable access is necessary to ensure that AI contributes to educational inclusion rather than increasing the digital divide.

Institutional guidelines for responsible AI use are also necessary. Teacher education institutions should clearly explain how generative AI can be used in assignments, lesson planning, assessment, and research. Guidelines should address academic integrity, acknowledgement of AI assistance, verification of AI-generated information, and responsible use of digital resources. Rather than completely restricting AI, institutions should help student teachers understand how to use it appropriately while maintaining originality, independent thinking, and professional responsibility.

Privacy and data security should also receive greater attention in future policies. AI-based educational systems may collect and process information about learners and their academic activities. Institutions should therefore consider what data is collected, how it is stored, who can access it, and for what purposes it can be used. Teachers and student teachers should also be made aware of the risks of sharing personal or confidential information with AI systems. Strong data-protection practices will be important for building confidence and trust in AI-supported education.

Future policies must also consider fairness, algorithmic bias, transparency, and accountability. AI systems should be carefully evaluated before being used for important educational purposes, particularly assessment and learner-related decisions. Teachers should have the ability to question AI-generated recommendations and correct outcomes that appear inaccurate or unfair. Responsibility for educational decisions should remain with people rather than being transferred to automated systems.

India already has several policy and programme-level foundations that can support these developments. NEP 2020, the National Educational Technology Forum (NETF), Integrated Teacher Education Programme (ITEP), the India AI Mission, and teacher-development initiatives such as NISHTHA and DIKSHA provide important directions for strengthening technology and AI-related capacities. These initiatives need continued investment, effective coordination, teacher training, and regular evaluation. The focus should be on achieving meaningful educational outcomes rather than simply increasing the use of technology.

Further research and evidence-based evaluation are also necessary. More research should examine how AI influences student teachers' learning, creativity, critical thinking, professional judgement, teaching competence, and classroom practices. Studies should also consider differences in access and use across regions, institutions, and learner groups. Such evidence can help policymakers identify effective approaches and avoid implementing AI-based solutions without sufficient educational evidence.

A human-centred approach should remain at the heart of future AI policies. Teachers contribute far more than information delivery; they provide guidance, encouragement, empathy, communication, mentoring, and professional judgement. These human qualities remain essential to effective education. AI can assist with routine and information-based activities, but it should not replace the teacher's central role. Future teacher education should therefore develop professionals who are technologically capable while remaining committed to human and educational values.

Overall, the central policy question is not whether AI should be included in teacher education, but how it can be introduced in a fair, safe, effective, and responsible manner. A balanced approach based on AI literacy, equal access, professional development, data protection, ethical standards, institutional accountability, and human oversight can help India gain the benefits of AI while limiting its risks. Such an approach can prepare teachers for technological change without weakening the professional, ethical, and human foundations of teaching.

Conclusion

Artificial Intelligence (AI) is gradually becoming an important part of teacher education and has the potential to influence how future teachers learn, teach, assess students, and develop professionally. AI-based tools can support student teachers in preparing lesson plans, developing learning materials, obtaining feedback, and exploring different teaching strategies. Generative AI has added further possibilities by helping users create questions, classroom activities, examples, case studies, and other educational content. At the same time, the usefulness of these technologies depends on the ability of teachers and teacher educators to use them with proper understanding and professional judgement.

The integration of AI also raises several challenges that cannot be overlooked. Differences in access to digital devices, internet connectivity, and technological facilities may prevent some institutions and learners from benefiting equally. In addition, many teachers and student teachers may not yet have sufficient knowledge to evaluate AI-generated information or recognise errors and bias in its outputs. Concerns related to privacy, data security, algorithmic bias, academic integrity, and excessive dependence on technology further highlight the need for careful implementation. These concerns suggest that the introduction of AI should be supported by appropriate training, institutional policies, ethical standards, and mechanisms for regular monitoring and evaluation.

An important consideration emerging from this discussion is the continuing importance of the teacher's role. AI can assist with many routine and information-based tasks, but teaching is not limited to the delivery of information. Effective teachers understand learners, provide encouragement, communicate with sensitivity, manage classroom relationships, and make decisions according to particular educational and social contexts. These responsibilities require human understanding and professional judgement. AI should therefore be regarded as a supportive resource that strengthens teachers' capabilities rather than as a substitute for them.

In the Indian context, initiatives such as NEP 2020, ITEP, NETF, NISHTHA, DIKSHA, and the India AI Mission provide opportunities to integrate emerging technologies into education and teacher preparation. However, policy initiatives alone cannot ensure meaningful change. Their effectiveness will depend on adequate infrastructure, continuous professional development, institutional preparedness, and clear guidelines for responsible AI use. Teacher education programmes should therefore give

attention not only to technical skills but also to critical thinking, ethical awareness, digital competence, and the ability to make informed decisions about the use of AI.

Future development should also be supported by research that examines the actual effects of AI on teacher preparation and classroom practice. Evidence is needed to understand whether AI improves learning, teaching competence, creativity, critical thinking, and professional decision-making. Such research can help educational institutions and policymakers identify useful applications while avoiding approaches that introduce technology without clear educational benefits.

Conclusively, AI presents meaningful opportunities for improving teacher education, but its successful use requires a balanced approach. Technology should be introduced in ways that are equitable, responsible, transparent, and centred on educational and human needs. When combined with sound pedagogy, teacher expertise, ethical safeguards, and human oversight, AI can contribute to more flexible and effective teacher preparation. The future of AI in teacher education should therefore focus not on replacing teachers, but on using technology thoughtfully to strengthen their knowledge, skills, professional practice, and ability to respond to the changing needs of learners.

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