

Artificial Intelligence and the Future of Teacher Education: Pedagogical Innovations, Professional Competence, and Ethical Challenges

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Abstract. Artificial intelligence (AI) is increasingly influencing educational practices, creating new possibilities and challenges for teacher education. Its applications extend beyond automated content generation to lesson planning, instructional design, assessment, personalised learning, reflective practice, and professional development. These developments require teacher education institutions to reconsider how prospective and practising teachers acquire pedagogical knowledge, exercise professional judgement, and prepare learners for an AI-mediated educational environment. This article examines the implications of AI for teacher education through a thematic synthesis of published research and policy frameworks. The discussion is organised around five interconnected themes that examine the role of artificial intelligence in shaping the future of teacher education. These include the use of AI to support pedagogical innovation and improve instructional practices; the development of AI competence among prospective and practising teachers; the changing nature of assessment, feedback, and professional learning; the ethical, epistemological, and institutional challenges associated with AI adoption; and the strategies required to integrate AI responsibly into teacher education programmes. Together, these themes provide a basis for understanding how AI can enhance teaching and learning while addressing the professional, ethical, and institutional considerations necessary for its effective implementation. Research reviews indicate that AI can support instructional planning, feedback, resource development, and professional learning, although the strength and sustainability of these benefits depend on the design of learning activities and the preparation of teachers. Concerns relating to inaccurate outputs, algorithmic bias, privacy, academic integrity, unequal access, and overdependence on automated systems remain important. The article argues that active AI integration requires more than technical familiarity. Teacher education should develop the

capacity to evaluate AI-generated information, design pedagogically appropriate learning experiences, protect learner interests, and retain human responsibility for educational decisions. It proposes a human-centred framework for integrating AI literacy, pedagogical competence, ethical judgement, reflective practice, and institutional support into teacher preparation. The article concludes that AI should strengthen teachers' professional capacity rather than diminish their agency, relationships with learners, or responsibility for educational quality.

keywords: artificial intelligence, teacher education, generative AI, AI literacy, teacher professional development, pedagogical innovation, educational ethics

I. Introduction

Teacher education has always changed according to new ideas in education, the needs of society, and developments in technology. In recent years, digital learning platforms, online study materials, and educational applications have changed the way teachers prepare lessons, interact with students, and evaluate their learning. Artificial intelligence (AI) brings another important change because it can help teachers prepare teaching materials, organise information, give feedback, and complete certain tasks more quickly. In particular, generative AI tools allow users to ask questions and receive responses in simple conversational language, making these tools easier to use even for people with limited technical knowledge. These changes are important for both future teachers who are undergoing training and teachers who are already working in schools and colleges. Future teachers should learn how to use AI tools and check whether the information they provide is correct and suitable for their students. Teacher educators should help them prepare lessons, find reliable information, assess students' learning, and use AI without copying or misusing its content. Therefore, teacher education should encourage the responsible use of AI to improve teaching and learning.

Research on AI in education has identified applications in teaching, learning, assessment, and educational administration, while also documenting concerns about implementation and learning outcomes (Chiu et al., 2023). A systematic review by Celik et al. (2022) identified potential benefits for lesson planning, instructional support, and assessment, while emphasising the importance of teachers' participation in the development and implementation of AI-supported systems. More recent research has examined the relationship between AI integration and teacher professional development, highlighting the need to address teachers' actual learning requirements rather than concentrating exclusively on the availability of technology (Tan et al., 2025).

The main question is not whether AI will influence teacher education, but how educational institutions should use it effectively. Simply introducing AI tools may help teachers learn to use them, but it may not teach them how to use them wisely. Similarly, completely avoiding AI may leave future teachers unprepared for modern classrooms. This article discusses the benefits of AI in teacher education, the skills teachers need, the ethical concerns, and the support required from

educational institutions. It emphasises that AI should be used responsibly to improve teaching and learning, with teachers making informed decisions about when and how to use it.

II. Conceptualising Artificial Intelligence in Teacher Education

Artificial intelligence (AI) refers to computer systems that can perform tasks such as understanding language, recognising patterns, generating content, and supporting decision-making. In education, AI is used for tutoring, assessing students, analysing learning progress, and preparing teaching materials. Since different AI tools have different functions and limitations, teachers need to understand how each tool can be used appropriately (Chiu et al., 2023). Generative AI is particularly useful because it can create lesson plans, explanations, examples, questions, and summaries based on users' instructions. These tools can help future teachers prepare lessons, develop different teaching strategies, and adapt learning materials to students' needs. However, AI may also provide incorrect information or unsuitable examples. Therefore, teachers should check and revise AI-generated content before using it in the classroom. Teacher education involves preparing future teachers and helping practising teachers improve their professional knowledge, teaching skills, subject knowledge, and ethical understanding. In this process, AI should be treated as a tool that supports teachers rather than replaces their professional judgement.

The UNESCO AI Competency Framework for Teachers identifies five important areas: a human-centred approach, AI ethics, basic AI knowledge and applications, the use of AI in teaching, and professional learning through AI. It also describes three stages of development: acquire, deepen, and create (Miao & Cukurova, 2024). This framework highlights that teachers need more than technical skills; they must also know how to use AI effectively in teaching, make responsible decisions, and continue developing their professional competence.

AI-Supported Pedagogical Innovation and Instructional Design

AI can support prospective teachers in preparing lesson plans, developing teaching materials, creating questions, and designing activities for students with different learning needs. For example, a student teacher preparing a lesson on environmental pollution can use AI to develop discussion questions, suggest group activities, and prepare short assessments. However, the student teacher must check whether the materials are accurate, suitable for the learners, and aligned with the curriculum. AI can also help teachers explore different ways of explaining difficult concepts and responding to students' common misunderstandings. Celik et al. (2022) discussed the potential of AI to support lesson planning, teaching, and assessment, while Chiu et al. (2023) examined its different educational applications and the challenges involved in their use. Nevertheless, AI-generated lesson plans may contain errors, unrealistic activities, or materials that do not consider students' language, cultural background, or individual needs. Therefore, AI-generated content should be treated as a starting point rather than a ready-made solution. Teacher educators should encourage prospective teachers to examine, modify, or reject AI suggestions and explain the reasons for their decisions. This helps them develop sound professional judgement and ensures that teachers remain responsible for the quality of their teaching.

III. Developing AI Competence and Redefining Professional Identity

The use of AI in education requires teachers to develop skills beyond subject knowledge, lesson planning, classroom management, and assessment. They also need to understand how AI works, check the accuracy of its responses, recognise possible bias, and decide when it is appropriate to use AI in teaching. The UNESCO AI Competency Framework for Teachers highlights five important areas: human-centred values, AI ethics, basic AI knowledge, the use of AI in teaching, and professional learning. It also explains that teachers can develop these competencies progressively, from gaining basic knowledge to applying and creating new approaches (Miao & Cukurova, 2024). For prospective teachers, AI literacy involves checking AI-generated information against reliable sources, verifying references, and identifying possible errors or unfair representations. These skills also influence teachers' professional identity. If student teachers accept AI responses without questioning them, they may become overly dependent on the technology. However, if they use AI to explore ideas while carefully evaluating its suggestions, they can strengthen their teaching decisions and independent thinking. During teaching practice, they should reflect on how AI has influenced their lesson preparation, which suggestions they have changed, and whether the final lessons have helped students learn effectively. Therefore, AI competence involves not merely knowing how to operate AI tools but also using them thoughtfully, ethically, and with professional judgement while keeping students' learning needs at the centre of teaching.

Transforming Assessment, Feedback, and Professional Learning

AI can support assessment and professional learning in teacher education by helping teachers prepare questions, develop assessment rubrics, provide feedback, and identify students' learning difficulties. It can also help prospective teachers compare AI-generated feedback with that of experienced teachers and understand how to make feedback more accurate and useful. AI-supported systems may help analyse student performance, but their results must be checked carefully because they may overlook valid answers, misunderstand language differences, or assess students unfairly (Celik et al., 2022). Therefore, human supervision is essential, particularly when assessment results influence important educational decisions. AI can also support teachers' professional learning by helping them explore new topics, consider alternative explanations, and reflect on classroom situations. Research on AI in teacher professional development highlights the importance of preparing teachers to integrate AI according to their professional needs (Tan et al., 2025). Such preparation should go beyond demonstrating how AI tools work and provide opportunities for teachers to practise their use, check their outputs, discuss ethical issues, and reflect on classroom experiences. Thus, AI should be used to improve assessment, feedback, and professional development rather than replace teachers' understanding of their students or their responsibility to make fair and informed decisions.

Ethical, Epistemological, and Institutional Challenges

The use of AI in teacher education offers several benefits, but it also raises important concerns about accuracy, fairness, privacy, academic integrity, and professional responsibility. AI tools may provide incorrect information, fabricated references, or outdated explanations; therefore, prospective teachers must learn to verify information using reliable sources. AI-generated materials may also contain bias or fail to consider students' languages, cultural backgrounds, and

individual learning needs. In addition, teachers must protect students' personal information when using AI applications and follow institutional guidelines for data privacy. The growing use of AI also creates challenges for academic integrity, as students may submit AI-generated assignments without demonstrating their own understanding. Teacher education programmes should therefore establish clear rules for AI use and encourage students to explain their ideas, reflect on their learning, and acknowledge AI assistance when required. Teachers must also retain responsibility for decisions about students' learning and progress rather than relying entirely on AI recommendations. Furthermore, differences in internet access, digital devices, training, and institutional resources may create unequal opportunities to use AI effectively. These concerns reflect the wider challenges of introducing AI into education and highlight the need for appropriate guidance and support (Chiu et al., 2023). Similarly, the UNESCO AI Competency Framework for Teachers emphasises human-centred values and ethical responsibility in the use of AI (Miao & Cukurova, 2024). Therefore, the responsible integration of AI into teacher education requires clear institutional policies, adequate teacher training, protection of students' privacy, and equal opportunities to access and use AI tools.

Integrating AI Responsibly into Teacher Education Programmes

AI should be integrated into existing teacher education courses rather than taught only as a separate technology subject. It can be included in educational psychology, teaching methods, assessment, educational technology, research methodology, and teaching practice. Prospective teachers should learn how AI works, identify its limitations, verify information using reliable sources, and use it to prepare lesson plans, learning activities, and assessment materials that meet students' needs. They should also understand ethical issues such as privacy, bias, copyright, academic honesty, and professional responsibility. During teaching practice, student teachers can record how they use AI, evaluate the quality of the materials it produces, and reflect on whether these materials support students' learning. Teacher education institutions should support this process by providing clear guidelines, suitable tools, faculty training, and equal learning opportunities for students with different levels of access and experience. This approach is consistent with the UNESCO AI Competency Framework for Teachers, which emphasises the development of human-centred values, ethical understanding, technical knowledge, pedagogical skills, and professional learning (Miao & Cukurova, 2024). Similarly, Tan et al. (2025) highlight the importance of aligning AI-related professional development with teachers' needs. The main aim is not to encourage teachers to use AI in every teaching activity, but to help them decide when it is useful, recognise its limitations, and choose other approaches when these are more suitable for students' learning.

IV. A Proposed Framework for AI-Integrated Teacher Education

The proposed framework for AI-integrated teacher education brings together five interconnected elements: AI literacy, pedagogical competence, ethical judgement, reflective practice, and institutional support. AI literacy helps teachers understand how AI tools work and recognise their limitations, while pedagogical competence enables them to use these tools to achieve learning objectives and meet students' needs. Ethical judgement guides teachers in protecting privacy, ensuring fairness, and maintaining academic honesty. Reflective practice encourages them to

evaluate the usefulness of AI in their teaching and identify areas for improvement, while institutional support provides clear guidelines, training, and appropriate resources. For example, a student teacher may use AI to prepare a lesson plan, verify the information using reliable sources, adapt the content to students' learning levels, and develop suitable assessment questions. After teaching the lesson, the student teacher can reflect on which AI-generated materials were useful and which required changes. This approach encourages teachers to use AI as a learning resource rather than as a shortcut for completing tasks. It also reinforces the importance of professional judgement and responsibility. The framework is consistent with the UNESCO AI Competency Framework for Teachers, which emphasises human-centred values, ethical understanding, pedagogical application, and professional learning (Miao & Cukurova, 2024). However, the proposed framework is a conceptual model developed from the sources reviewed in this article and has not yet been empirically tested. Further research is therefore needed to examine its usefulness and applicability in teacher education programmes.

Implications for Teacher Educators and Educational Institutions

Teacher educators and educational institutions play an important role in integrating AI into teacher education responsibly. Teacher educators need training to understand how AI can support subject teaching, assessment, classroom interaction, and professional ethics. They should guide prospective teachers in checking AI-generated materials, identifying errors, and making informed teaching decisions. Educational institutions should include AI literacy and ethical practices in existing courses and provide continuous professional development rather than limiting training to occasional sessions. They should also establish clear policies on the use of AI in assignments, lesson preparation, assessment, and research, including guidelines for protecting student data, acknowledging AI assistance, and checking generated content. As AI tools continue to develop, these policies should be reviewed regularly. Institutions must also consider the availability of internet access, affordability, language support, accessibility, and technical assistance to ensure that all student teachers have fair learning opportunities. Alternative approaches should remain available when students cannot access particular AI tools. Finally, the success of AI integration should be assessed through improvements in lesson planning, the ability to evaluate information, the quality of assessment materials, ethical decision-making, and the application of learning during teaching practice. This approach is consistent with the UNESCO AI Competency Framework for Teachers, which emphasises the development of teachers' AI knowledge, pedagogical skills, ethical understanding, and professional learning (Miao & Cukurova, 2024).

V. Research Gaps and Future Directions

Although research on AI in education is growing, more studies are needed to understand its long-term benefits for teacher education. Tan et al. (2025) highlighted limitations in existing research on AI and teacher development, including the limited representation of practising teachers and the small sample sizes of some studies. Future research should examine whether AI training leads to lasting improvements in teachers' knowledge, lesson planning, teaching practices, and professional skills rather than only short-term gains in confidence. Studies should also assess different outcomes, such as AI literacy, assessment skills, ethical decision-making, and student learning, and compare AI-supported training with existing teacher education methods. More re-

search is needed in institutions with limited technological resources and different language requirements to understand how AI can be used effectively in diverse educational settings. Researchers should also investigate its influence on teachers' professional independence, academic honesty, workload, and relationships with students. To strengthen the evidence, future studies should clearly report their participants, research methods, duration, AI tools used, assessment procedures, and limitations. Such research will help educational institutions make informed decisions about AI integration based on demonstrated educational benefits rather than assumptions about technological progress.

VI. Conclusion

Artificial intelligence offers new opportunities to improve lesson planning, teaching, assessment, feedback, and teachers' professional development. However, its effectiveness depends on the accuracy of its outputs, teachers' skills, and responsible implementation. Concerns such as privacy, bias, academic integrity, and unequal access must also be addressed. Teacher education should therefore develop AI literacy, pedagogical competence, ethical judgement, and reflective practice. AI should support teachers' professional decisions and improve educational quality and equity without replacing the human judgement and relationships essential to teaching.

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