International Journal of Leading Research Publication (IJLRP)

E-ISSN: 2582-8010 ● Website: www.ijlrp.com ● Email: editor@ijlrp.com

# Integration of Artificial Intelligence in Teacher Education: Challenges and Opportunities

**Chinmayee Behera[1], Debadatta Behera[2]**

[1]Ph.D scholar, Hemchand Yadav Vishwavidyalaya Durg

[2] Independent Researcher, Master of Education, Hemchand Yadav Vishwavidyalaya, Durg, C.G

[1]ORCID: 0009-0001-3021-8516

**Abstract**

This paper investigates the systematic integration of **Artificial Intelligence (AI)** and Generative AI (GenAI) in teacher education, analyzing the complex balance between innovative pedagogical opportunities and systemic implementation challenges. Employing a qualitative systematic review design that synthesizes empirical literature published between 2018 and 2026, the study examines how AI-driven tools reshape pre-service and in-service teacher preparation. The findings reveal a significant disparity between theoretical enthusiasm for AI and its practical adoption in higher education. While generative tools offer substantial benefits such as reducing administrative burdens, facilitating differentiated instruction and enabling simulation-based practice their sustainable integration is hindered by persistent barriers. These obstacles include structural digital inequalities, a lack of institutional policy frameworks and a pronounced gap in educators' **Technological Pedagogical Content Knowledge (TPACK).** Crucially, this study unpacks the "ethical-practical tension" wherein educators demonstrate high moral awareness of **algorithmic bias** and data privacy concerns yet fail to implement practical classroom mitigation strategies. Disciplinary backgrounds further influence how teachers perceive AI, with STEM cohorts focusing on methodologies and educational technology cohorts emphasizing technical functionalities. To address these gaps, the study proposes a holistic, four-stage AI integration framework grounded in Critical Digital Pedagogy, AI **Digital Literacy** and Constructivist Learning Theory, moving from ethical-technical orientation to reflexive redesign. Finally, the paper provides evidence-based policy recommendations to guide policymakers and teacher training institutions toward equitable, human-centered AI adoption.

**Keywords:** Artificial Intelligence, Teacher Education, Algorithmic Bias, Digital Literacy, Pedagogical Competence, Educational Policy.

## Conceptualizing Artificial Intelligence in Modern Pedagogy

The global educational landscape is experiencing a profound paradigm shift driven by the rapid evolution of *Artificial Intelligence*. Broadly defined, AI refers to advanced computing systems or solutions capable of emulating human cognitive functions such as learning, adapting, synthesizing, reasoning, self-correction and utilizing massive datasets for complex processing tasks. Historically, the conceptual origin of technology-mediated instruction traces back to early experiments with *computer-assisted instruction (CAI)* during the 1960s and 1970s, which emerged from the foundational algorithms

of the mid-century. However, contemporary AI has transcended these early rule-based structures. Today, educational technology is characterized by a sophisticated confluence of machine learning, natural language processing (NLP), predictive algorithms and data analytics.

The release of consumer-facing Generative AI (GenAI) tools has accelerated this transformation, transitioning AI from a backend diagnostic asset into an active, collaborative conversational partner within higher learning environments. This technological evolution challenges traditional pedagogical models, pushing institutions to move beyond simple digitization toward automated, adaptive and highly customized learning ecosystems. In teacher training contexts, this shift demands that pre-service and in-service educators cultivate advanced digital fluencies, enabling them to navigate systems that autonomously generate content, analyze student performance in real time and simulate complex classroom dynamics.

**Research Objectives**

The rapid deployment of automated systems in classrooms has outpaced the development of structured training frameworks, creating a critical gap in teacher preparation. While global frameworks such as the European Commission's Digital Education Action Plan (2021–2027) mandate systematic professional development to foster AI-related skills among educators , empirical studies indicate a substantial lag in teacher readiness. For example, international assessments reveal that while approximately 39% of teachers across surveyed countries felt adequately prepared to utilize basic digital tools, a staggering 61% remained unprepared for technology-mediated instruction. This gap is even more pronounced for generative technologies.

Consequently, this qualitative inquiry is designed to address this preparation gap through several key research objectives:

- To systematically analyze the pedagogical utility and technical affordances of AI tools within pre-service and in-service teacher training contexts.
- To identify, categorize and propose solutions for current technological, pedagogical and ethical challenges associated with AI integration.
- To critique the systemic implications of algorithmic bias, fairness and data privacy in human-centered educational applications.
- To synthesize these qualitative findings into a holistic, process-oriented AI integration framework that balances automated efficiency with core humanistic teaching values.

**Research Design**

This study employs an qualitative systematic review and exploratory case design to synthesize empirical evidence on AI integration in teacher education. Grounded in Critical Digital Pedagogy, the investigation prioritizes qualitative content analysis, supplemented by descriptive quantitative metrics (such as term frequencies and thematic codes) to contextualize academic discourse trends. Literature was systematically retrieved from major global databases including Scopus, Web of Science, ERIC, SpringerLink, ScienceDirect, MDPI, IEEE Xplore and preprint repositories like arXiv.

The inclusion criteria restricted the corpus to peer-reviewed empirical studies, systematic reviews and theoretical frameworks published between 2018 and 2026, focusing explicitly on pre-service or in-

service teacher education. Studies focusing solely on general K-12 or higher education student outcomes without a dedicated teacher training or professional development component were excluded. To ensure a highly rigorous qualitative synthesis, the analysis utilized a thematic synthesis approach. This involved identifying raw codes, clustering them into sub-themes (such as technological barriers, pedagogical affordance and ethical concerns) and performing a comparative cross-regional analysis of institutional readiness, with a focus on contrasting highly resourced Western settings with developing contexts.
Additionally, the analysis incorporated findings from documented dialogic reflection workshops and educational case studies, such as the qualitative investigations conducted at the Nigerian Army College of Education (NACE) and collaborative teacher training cohorts. This multi-layered methodological design ensures that the proposed framework is grounded in diverse, real-world educational practices.

**Deciphering Current Challenges and Targeted Algorithmic Solutions**

To successfully integrate AI into teacher training, institutions must systematically address a range of technological, pedagogical and ethical hurdles. Table 1 identifies ten prominent challenges documented in contemporary literature, paired with targeted technological and instructional solutions.

Table 1: Current Challenges and AI-Enabled/Pedagogical Solutions

| No. | Challenge Category | Specific Empirical Barrier | Targeted AI or Pedagogical Solution |
|---|---|---|---|
| 1 | Digital Inequality & Infrastructure Gaps | Unequal access to high-speed internet, hardware and premium software licenses, particularly in rural or under-resourced schools. | Deployment of mobile compatible, low-bandwidth AI applications and offline capable edge computing models. |
| 2 | Inadequate Educator AI Literacy & TPACK | Teachers lack the Technological Pedagogical Content Knowledge (TPACK) required to effectively integrate AI into classroom activities. | Integrating mandatory, multi-dimensional AI competency modules (technical, ethical, pedagogical) into teacher training. |
| 3 | Algorithmic Bias & Discriminatory Outputs | Machine learning models trained on non-representative datasets, leading to biased grading, profiling, or cultural erasure. | Training educators in "inclusive prompt engineering," intersectional analysis, and collective dialogic reflection. |
| 4 | Data Privacy Risks & Regulatory Compliance | AI platforms collect student data, behavioral patterns and biometrics, risking compliance issues with FERPA or LGPD. | Implementing localized data collection protocols, strict administrative safeguards and private, self-hosted LLM |

| No. | Challenge Category | Specific Empirical Barrier | Targeted AI or Pedagogical Solution |
|---|---|---|---|
| | | | instances. |
| 5 | Academic Integrity & Unreliable Detection | Student over-reliance on generative texts, paired with ineffective, biased AI-detection tools that unfairly flag non-native English speakers. | Replacing detection tools with constructivist, process-oriented assessments and student-led "AI-humanizer" analyses. |
| 6 | Information Hallucinations & Inaccuracy | AI systems confidently generating factually incorrect, fabricated or misleading pedagogical content. | Teaching critical evaluation, mandatory cross referencing and verification protocols within lesson planning exercises. |
| 7 | Teacher Resistance & Low Self-Efficacy | Educators resisting AI integration due to job security concerns, high workload anxiety or lack of psychological safety. | Implementing scaffolded, low-stakes micro-integration pilots and supportive peer-mentoring networks. |
| 8 | Dehumanization & Relational Atrophy | Over reliance on automated tutoring systems, displacing the social relational core of teacher-student interactions. | Adopting the TRIC model (Technology, Relationships, Interactions, Context) to maintain human centric classroom practices. |
| 9 | Rigid Curriculum & Outmoded Assessments | Traditional, exam-heavy institutional curricula that penalize the collaborative, iterative workflows enabled by generative AI. | Redesigning curricula to support process based, portfolio driven evaluations and collaborative human AI project designs. |
| 10 | Cognitive Overdependence & Skill Atrophy | Students and teachers relying excessively on AI for writing and analysis, undermining critical thinking and research skills. | Designing scaffolded learning pathways where AI handles baseline brainstorming, reserving higher-order evaluation for human intellect. |

Unpacking these challenges reveals deeper, second order implications for teacher education programs. For instance, the rise of academic integrity concerns has led to a counter productive reliance on commercial AI detection software. Empirical evidence indicates that these detection tools are not only inconsistent but systematically biased against non native English speakers, frequently misclassifying

their structured lexical patterns as automated text. This creates a climate of distrust that disproportionately penalizes international and minority students.

Similarly, the issue of "cognitive overdependence" is not merely about student cheating; it threatens to atrophy the fundamental critical thinking and research skills that teacher candidates must develop to become effective practitioners. If pre-service teachers rely entirely on automated systems to generate lesson plans, analyze student data and draft reflections, they bypass the essential cognitive struggles that build pedagogical expertise and professional intuition.

**Empowering Educators: Pedagogical and Administrative Benefits**

The thoughtful integration of AI into teacher preparation programs yields significant, measurable advantages. These systems help educators streamline administrative duties, refine their instructional strategies and access tailored professional growth opportunities.

**Administrative Workload Reduction and Instructional Design Support**

One of the most immediate benefits of AI tools in teacher education is their ability to reduce heavy workloads. Educators spend a substantial portion of their time on administrative tasks, including drafting rubrics, creating differentiated worksheets, organizing lesson plans and managing parent communications. By automating these repetitive processes, AI assistants allow teachers to focus more on instructional decision-making and direct student interaction.

Additionally, AI systems support instructional design by generating custom lesson plans, interactive warm-ups and targeted vocabulary exercises. This administrative relief reduces teacher burnout and provides educators with more time to build meaningful classroom relationships.

**Differentiated Instruction and Adaptive Personalization**

In modern classrooms, teachers are tasked with supporting students with a wide range of learning styles, speeds and language backgrounds. AI-driven personalization helps meet these needs by analyzing performance data in real time.

With these resources, educators can easily generate multiple versions of a reading passage, customize language complexity for English Language Learners (ELL) and design specific scaffolds for students with Individualized Education Programs (IEPs). This shift from a one-size-fits-all model to an adaptive approach ensures that personalized support is a core component of daily instruction.

**Data-Driven Continuous Professional Development (CPD)**

AI analytics are also transforming continuous professional development (CPD). Rather than relying on generic, school wide workshops, educators can use adaptive systems to identify their specific instructional needs.

These platforms analyze classroom data to recommend customized training modules, peer-collaboration groups and micro credential pathways. This diagnostic capability ensures that professional development remains relevant, targeted and aligned with each teacher's professional growth.

Furthermore, grounding teacher upskilling in humanist educational philosophy emphasizes learner autonomy and professional agency. Under this paradigm, AI-driven learning analytics do not merely evaluate compliance; they function as reflective mirrors, offering personalized performance insights that encourage teachers to take ownership of their advancing professional trajectories.

**Taxonomy and Real-World Applications of AI in Teacher Education**

The rapidly growing market of educational technology has produced a wide range of specialized tools. Table 2 categorizes these applications and outlines their primary pedagogical functions within teacher education.

Table 2: Comparative Matrix of AI-Powered Educational Platforms

| Platform Category | Representative Tools | Core Pedagogical Functionality | Specific Teacher Training Utility |
|---|---|---|---|
| Lesson Design & Resource Generation | MagicSchool, Eduaide, Brisk Teaching, SchoolAI, Diffit TeachMatic, | Automates lesson planning, generates customized rubrics, creates scaffolded worksheets and adapts text complexity. | Enables student-teachers to quickly generate diverse, standards-aligned classroom materials. |
| Gamified & Interactive Assessment | Quizizz AI, Curipod, Slidesgo, Canva | Generates adaptive, interactive presentations, gamified formative assessments and live polling elements. | Teaches educators how to design engaging, high interest activities that capture real-time student data. |
| Intelligent Tutoring & Virtual Guidance | Khanmigo, Quipper | Provides personalized, conversational academic support and adaptive instructional guidance. | Simulates one-on-one student coaching, helping teachers practice clear, structured explanations. |
| Immersive Simulation Environments | Virtual Reality (VR) Classrooms | Recreates real world classroom environments populated by AI-driven student avatars. | Allows pre-service teachers to practice classroom management and lesson delivery in a low risk environment. |
| Multimodal | Synthesia AI, | Translates text into realistic | Supports the creation of |

| Platform Category | Representative Tools | Core Pedagogical Functionality | Specific Teacher Training Utility |
|---|---|---|---|
| Content Creation | ElevenLabs, FigJam, Napkin AI | audio voices, creates AI-avatar videos and builds clean flowcharts or visual mind maps. | multimodal learning assets, improving accessibility for diverse student groups. |

A key application within this taxonomy is the use of virtual simulation environments. Virtual reality (VR) classrooms populated by interactive AI student avatars allow pre-service teachers to practice classroom management, instructional delivery and behavior intervention in a safe, low-stakes setting. Research indicates that these immersive simulations significantly boost teacher candidates' confidence and self-efficacy before they enter real physical classrooms.

However, studies also highlight critical limitations: these virtual systems struggle to replicate the complex, unpredictable and highly relational dynamics of real world classrooms. Consequently, while simulation tools are valuable for practicing fundamental teaching routines, they must complement, rather than replace, hands-on field experience and mentoring.

**Structural Trends and Policy Alliances Transforming Teacher Education**

Several notable trends are shaping the future of teacher preparation, driven by emerging technologies, public-private investments and regional workforce initiatives.

**The Rise of Large-Scale Public-Private Partnerships**

A major driver of modern AI integration is the growth of large-scale public-private partnerships. A key example is the establishment of the National Academy for AI Instruction in the United States, backed by a twenty-three million dollar private investment from leading developers, including OpenAI, Microsoft and Anthropic. This initiative aims to equip educators with the technical skills needed to prepare the next generation for an AI-dominant workforce.

Additionally, the White House's Pledge to America's Youth, supported by sixty-eight major technology organizations (such as Microsoft, Amazon, OpenAI, NVIDIA and Meta) has committed significant resources to expand digital training and curriculum support for teachers across the country.

**Workforce-Aligned and Regionally Specific Strategies**

States are increasingly using AI training to align K-12 classrooms with future workforce opportunities. For instance, Mississippi partnered with NVIDIA to integrate AI and cybersecurity education directly into both K-12 schools and local job training programs. This workforce-first approach focuses heavily on rural and historically underserved communities, allowing students to build future-ready skills locally.

Similarly, collaborations with platforms like Stemuli have led to gamified AI curricula across twenty heartland states in the US, aiming to close regional technology gaps and prepare students for projected automation impacts.

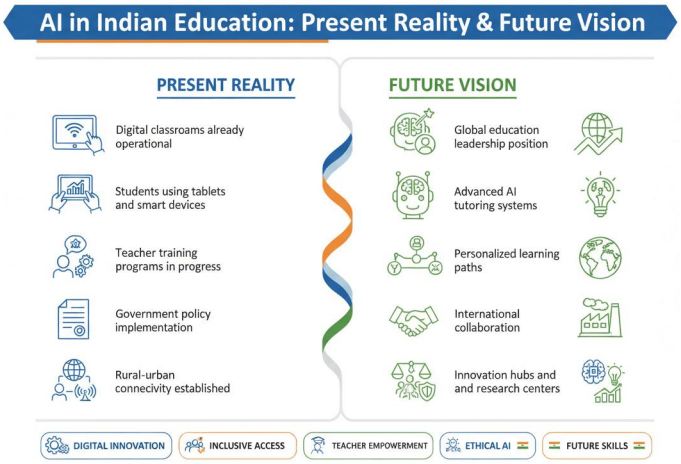


Image credit- Only Education https://www.onlyeducation.in/articles/how-ai-is-transforming-education-in-india-opportunities-and-challenges

**Transitioning to Integrated, School-Wide Frameworks**

Teacher training is shifting away from isolated workshops toward comprehensive, district-wide implementation. Organizations such as Michigan Virtual provide detailed AI Integration Frameworks and Planning Guides that help school districts assess their needs, engage community stakeholders, and build sustainable implementation roadmaps.

By offering flexible, self-paced professional development, specialized micro-credentials for school administrators and curated guides for students and teachers, these initiatives keep human relationships at the center of the educational experience. Through these structured programs, AI is treated not just as an isolated software tool, but as a central component of digital literacy.

**National Education Frameworks and Systemic Implementations**

On a global scale, national education policies are playing a crucial role in directing AI integration. In India, the National Education Policy (NEP 2020) explicitly promotes the adoption of emerging technologies including AI and smart tutoring systems to redefine teacher training and drive data informed classroom decisions. Under this policy mandate, the Ministry of Education introduced the DIKSHA (Digital Infrastructure for Knowledge Sharing) platform, which uses content recommendation engines and modular adaptive learning to support continuous teacher upskilling.

Furthermore, research by Singh and Rajput (2021) demonstrated that mobile compatible, low bandwidth AI learning analytics could track teacher performance and deliver local language upskilling on mobile devices. These targeted interventions help reduce regional inequalities in teacher preparedness and address classroom communication needs in highly multilingual settings.

## Algorithmic Bias, Fairness, and the Sociotechnical Dimensions of Education

An essential part of preparing teachers to use AI is helping them understand that these technologies are not neutral tools. Instead, AI systems are sociotechnical products deeply influenced by human values, power dynamics and historical contexts. When deployed in educational settings, algorithms can easily replicate, reinforce and worsen existing social inequalities.

## Forms of Bias and Their Impact in Education

To protect student equity, educators must learn to recognize three primary forms of bias:

- **Data-Related Bias:** Occurs when algorithms are trained on non representative, skewed or culturally narrow datasets. For instance, automated essay grading platforms have demonstrated biased grading patterns, scoring essays written by minority students lower than highly similar work produced by dominant demographic groups.
- **Algorithmic Bias:** Arises when the underlying code prioritizes metrics that favor privileged groups. A clear example of this occurred in the United Kingdom, where a national grading algorithm used during the pandemic assigned grades that disproportionately favored students in private schools over those in public institutions.
- **User-Interaction Bias:** Occurs when educators or students interact with AI systems in ways that reinforce stereotypes. Additionally, popular AI-detection tools (like Turnitin and ZeroGPT) have shown systematic bias against non native English speakers, frequently misclassifying their writing as AI-generated due to less varied sentence structures. This often leads to unfair academic penalties for multilingual students.

## Frameworks for Fairness: Algorithmic Justice and the TRIC Model

To address these inequities, teacher preparation programs are turning to critical frameworks like Algorithmic Justice and the TRIC (Technology, Relationships, Interactions and Context) model. Algorithmic justice applies an intersectional lens to educational technology, examining how factors like race, gender, socioeconomic status and linguistic background interact with automated decisions.

The TRIC model emphasizes that educational technology cannot be evaluated in isolation; it must be analyzed through the relationships it alters, the classroom interactions it shapes and the local context in which it is used. By applying these frameworks, educators learn to treat AI as a system requiring continuous, critical oversight.

## Cultivating Critical Agency through Dialogic Reflection

To turn ethical awareness into concrete classroom practice, training institutions are using dialogic reflection based workshops. These programs focus on "inclusive prompting" teaching educators how to write, refine and test prompt structures to minimize bias and counter stereotypes in AI outputs.

By analyzing real world case studies, engaging in collaborative discussions and working through bias checklists, teachers build the confidence to advocate for fairness in their schools. This training helps educators move from passive users to active defenders of equity in technology supported classrooms.

**Constructivist Opportunities in Teaching and Learning**

Despite these serious ethical risks, the strategic integration of AI opens up major opportunities to improve teaching and learning. When used responsibly, these tools support a shift toward student-centered, active and collaborative education.

**Shifting to Student-Centered, Constructivist Learning**

AI has the potential to transform classrooms by supporting a student-centered, constructivist approach to education. Rather than serving as the sole source of knowledge, the educator acts as a facilitator, guiding students as they interact with technology.

In this model, AI tools serve as resources for inquiry, helping students explore complex ideas, test hypotheses and analyze information. This approach encourages active learning, curiosity and deep conceptual understanding.

**Reducing Cognitive Load for High-Level Processing**

From a cognitive perspective, AI's ability to adapt task difficulty to each learner helps manage cognitive load. By handling foundational tasks such as translating texts, summarizing long documents or formatting references AI allows students to focus their mental energy on higher order tasks.

This redistribution of effort allows learners to spend more time on critical evaluation, synthesis, creative problem-solving and original research.

**Fostering Collaborative Learning Communities**

AI can also support collaboration by helping teachers build active communities of practice. Collaborative AI platforms allow educators to share successful prompt designs, compare lesson plans and exchange feedback on student work.

Furthermore, within classrooms, AI-driven collaborative tools help students co-create projects, brainstorm ideas in real time and map out concepts together. These interactive experiences prepare students for modern, collaborative workplaces where teamwork and technology go hand in hand.

**Findings and Discussion**

Synthesizing qualitative evidence across diverse institutional environments reveals a clear "ethical-practical tension" in modern teacher training. While there is strong support for the theoretical benefits of AI, actual classroom implementation is often limited by structural, professional and cultural barriers.

**The Disconnect Between Perceptions and Practice**

Studies of pre-service teachers (PSTs) consistently show a gap between how they view AI and how they actually use it. On one hand, student teachers appreciate generative AI as a "learning buddy" or personal assistant that helps with information searches, text editing and exam preparation. On the other hand, a study at the University of Patras found that undergraduate teaching students expressed serious concerns

about using AI, particularly regarding plagiarism, technological dependence and a potential loss of critical research skills.

As a result, actual classroom adoption remains low. Many future teachers remain ambivalent and very few have used AI during their actual student teaching placements.

This hesitation is often driven by a lack of confidence and low self-efficacy. This dynamic was highlighted in a Sri Lankan study of over 1,300 ICT educators, which found that teachers' readiness to use AI was heavily influenced by emotional anxiety and a lack of support, rather than their objective technical ability.

Similarly, a Portuguese study of 72 basic education and master's students found that while future teachers recognized the importance of AI, they felt held back by poor school infrastructure, insufficient digital training and a fear of dehumanizing the classroom experience.

**Disciplinary Influences and Thematic Focus Areas**

Data comparing different teacher training cohorts shows that an educator's academic background can shape how they approach AI. For example, in collaborative training workshops:

- **Biology and Science Cohorts:** Focused heavily on classroom methodology, with 6.49% of their discussion centered on how to integrate AI tools into specific science lessons.
- **Innovation and Educational Technology Cohorts:** Placed a higher emphasis on the technical features of the software, with teaching methodology representing 5.17% of their comments.

Despite these different perspectives, both groups spent very little time discussing access issues or classroom diversity (2% to 3%). This consistent focus on technology over equity highlights the urgent need for training programs to intentionally connect technical training with ethical literacy.

**Towards a Holistic AI Integration Framework: The Scaffolded Model**

To resolve this ethical-practical tension and build educator self-efficacy, teacher training institutions need a structured, step-by-step approach to AI integration. Grounded in the NACE (Nigerian Army College of Education) model, this framework provides a contextually customizable pathway for teacher preparation.

Table 3 outlines the key objectives, targeted actions and supporting research for each stage of this integration framework.

Table 3: Process-Oriented AI Integration Model for Teacher Education

| Stage | Core Objective | Targeted Pedagogical Actions | Core Theoretical Framework |
|---|---|---|---|
| Stage 1: Ethical & Technical Orientation | Establish baseline technical skills and build awareness of algorithmic bias, | Mandatory workshops on prompt design, data protection rules and "unplugged" pattern- | Critical Digital Pedagogy, UNESCO AI Competency |

| Stage | Core Objective | Targeted Pedagogical Actions | Core Theoretical Framework |
|---|---|---|---|
| | hallucinations and privacy risks. | recognition activities. | Framework |
| Stage 2: Scaffolded Practical Integration | Build confidence by using AI for low-stakes, routine administrative and lesson-design tasks. | Draft simple warm-up activities, generate practice questions and design basic grading rubrics. | Constructivist Learning Theory, TPACK |
| Stage 3: Critical Evaluation & Redesign | Develop evaluation skills by critically analyzing and refining AI-generated content. | Have teachers work in groups to review AI lesson plans for accuracy, bia and cultural relevance. | Critical Digital Pedagogy, Algorithmic Justice |
| Stage 4: Reflexive Dialogic Practice | Ensure technology supports, rather than replaces, human relationships by using student-centered, relational models. | Apply the TRIC model to evaluate how AI tools affect classroom relationships and support collaboration. | TRIC Model, Humanist Education Philosophy |

This four-stage model helps future teachers move from passive technology users to active, critical developers of digital learning experiences. By starting with ethical principles, the framework ensures that teachers learn to identify and mitigate bias before using these systems in their classrooms.
This structured progression builds both practical skill and critical judgment, helping educators use AI in ways that support equity, transparency and student-centered learning.

**Conclusion and Strategic Policy Recommendations**

The integration of Artificial Intelligence into teacher education presents a historic opportunity to modernize instructional design, reduce administrative burdens and personalize professional development. However, realizing this potential requires addressing significant challenges, including digital divides, data privacy risks and algorithmic biases that can reinforce educational inequalities.

To ensure that AI integration is equitable, effective and human-centered, education systems should prioritize the following five policy recommendations:

1. **Integrate Multi-Dimensional AI Literacy into Teacher Education Curricula:** Institutions must update their programs to include training that covers the technical, pedagogical and ethical aspects of AI. This training should focus on practical skills such as prompt design and bias mitigation to ensure teachers can use these tools effectively and responsibly.

2. **Develop Long-Term, Coached Professional Development Systems:** School systems should transition away from short-term workshops. Instead, they should invest in ongoing mentoring, peer-collaboration groups and professional learning communities that support teachers as they adapt to new technologies.
3. **Formulate Clear Institutional Policies and Ethical Governance Frameworks:** Universities and school districts must develop clear, formal guidelines governing AI use. These policies should establish high standards for data privacy, protect student work under regulations like FERPA and LGPD, and clarify expectations for academic integrity.
4. **Bridge the Rural and Underserved Digital Divides:** Policymakers and private partners must collaborate to close digital divides. Funding should target high-speed connectivity and accessible, mobile-friendly educational tools, particularly in rural and historically under resourced communities.
5. **Adopt a Socio-Technical and Human-Centered Integration Perspective**: Policy decisions should treat AI not as a quick software fix, but as part of a complex educational ecosystem. Future initiatives should keep human relationships at the center of education, ensuring technology is used to support, not replace, the essential work of teachers.

## References

1. Bowdoin College. *AI in high school education: Trends, challenges, and opportunities*. https://www.bowdoin.edu
2. Frontiers in Education. (2024). *Artificial intelligence for higher education: Benefits and challenges for pre-service teachers*. *Frontiers in Education, 9*, Article 1501819. https://doi.org/10.3389/feduc.2024.1501819
3. Frontiers in Education. *Challenges and best practices in training teachers to use artificial intelligence*. https://www.frontiersin.org
4. Heartland Forward. *Investing in AI education: How Heartland states are leading the charge*. https://www.heartlandforward.org
5. International Journal of Future Modern Research. *Transforming teacher education: Integration of artificial intelligence in continuous professional development*. https://www.ijfmr.com
6. International Review of Research in Open and Distributed Learning. *AI and the future of teaching: Preservice teachers' reflections on the use of artificial intelligence in open and distributed learning*. https://www.irrodl.org
7. IntechOpen. *Challenges of artificial intelligence in teacher training: Perceptions of future teachers*. https://www.intechopen.com
8. Michigan Virtual. *AI Lab*. https://www.michiganvirtual.org/ai-lab
9. MDPI. *Dialogic reflection and algorithmic bias: Pathways toward ethical artificial intelligence in teacher education*. https://www.mdpi.com
10. MDPI. *Sustainable AI integration in teacher education: From personalised learning to professional practice*. https://www.mdpi.com
11. MDPI. *Systematic review of artificial intelligence in education: Trends, benefits and challenges*. https://www.mdpi.com

12. Preprints.org. *A systematic review on artificial intelligence in education: Opportunities, challenges, and ethical implications*. https://www.preprints.org
13. Quest Journals. *Reimagining teacher education through artificial intelligence-enhanced pedagogy: A study of digital instructional innovation*. https://www.questjournals.org
14. ResearchGate. *Challenges of artificial intelligence in teacher training: Perceptions of future teachers*. https://www.researchgate.net
15. ResearchGate. *Integrating artificial intelligence in teacher education*. https://www.researchgate.net
16. SchoolAI. *Teaching students to advocate for ethical AI use*. https://www.schoolai.com
17. Scribd. *AI integration in education guide*. https://www.scribd.com
18. Taylor & Francis Online. *AI-driven innovations in higher learning institutions: A review of pre-service teacher education*. https://www.tandfonline.com
19. Teachers College, ERIC. *Ethical issues of using AI in language education: A critical perspective*. https://files.eric.ed.gov
20. The Association for the Advancement of Artificial Intelligence. *Integrating AI competencies into teacher education programs*. *Proceedings of the AAAI Conference on Artificial Intelligence*. https://ojs.aaai.org