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SINDH TEACHER EDUCATION DEVELOPMENT AUTHORITY

Integrating Artificial Intelligence in Teacher Education: Opportunities, Challenges and Professional Implications in Pakistan

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Abstract: Artificial Intelligence (AI) has become one of the most transformative technological forces influencing education systems globally. Within teacher education, AI offers innovative opportunities to redesign pedagogical processes, enhance reflective practice, and support teachers in both pre-service and in-service phases. In the context of Pakistan, where teacher quality, access to updated pedagogical resources, and continuous professional learning remain major concerns, AI may contribute significantly in bridging instructional gaps and strengthening the quality of teacher preparation. This study examines the challenges and opportunities of integrating AI in teacher education in Pakistan with particular focus on teacher learning, instructional support, policy understanding, technology readiness, and ethical concerns. The study follows a mixed-method approach through simulated survey datasets, document analysis, and reflective examples based on Pakistani teacher training realities. Data trends suggest that teachers are interested in AI-based innovations, especially for lesson planning, multilingual explanations, assessment feedback, and concept simplification. However, fears regarding job displacement, reliability of AI responses, data privacy, and lack of AI literacy remain strong barriers for full-scale adoption.

The study concludes that AI should be positioned as a supportive tool that strengthens the teacher, instead of replacing human teaching roles. AI cannot replace the relational, creative, moral and philosophical dimensions of teaching. Pakistani teacher education institutions must therefore move through a balanced approach—encouraging AI as an academic assistant, while simultaneously protecting the human role of teachers. The paper recommends national policy alignment, professional capacity building, and ethical frameworks for sustainable AI integration.

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INTRODUCTION

Teacher education today stands at one of the most critical turning points in history. Globally, educational systems are being redesigned due to rapid shifts in knowledge, digital innovation, and emerging sociotechnical structures. Artificial Intelligence (AI) has become one of the strongest drivers of this shift. While AI is often discussed as a future technology, its presence has already entered daily instructional practices, learning environments, curriculum development, and assessment systems around the world. Teacher education therefore cannot remain separate from this transformation. If teachers are not equipped to work with AI, understand its pedagogical implications, and adapt instructional strategies through AI-supported tools, then the gap between educational demands and teacher capacity will increase. For developing nations like Pakistan, this risk is much higher, because existing gaps in professional development, digital literacy, and limited access to quality academic content already exist as structural problems.

Teacher education in Pakistan is traditionally structured through pre-service programs, in-service short professional courses, workshops, and continuous professional development (CPD) initiatives led by teacher training institutions at provincial and federal levels. In recent years, educational policies and curriculum frameworks have repeatedly emphasized the need to introduce modern learning strategies and to improve the performance of teachers through technology integration. However, AI remained less explored and less discussed compared to general ICT integration. The arrival of accessible generative AI tools such as ChatGPT, DeepSeek, Gemini and other systems changed this landscape. Suddenly, teachers found that advanced explanations, comparative examples, lesson planning support, simplified English content, automatic formative assessment, and data-driven academic reflection became accessible instantly. Consequently, AI not only became a technology shift, but also a major cognitive support system.

This situation makes AI integration in teacher education not a futuristic concept, but a necessary contemporary academic requirement. If teacher education reforms in Pakistan aim to upgrade teacher professionalism, quality, reflection depth, and learner-centered pedagogy, then AI literacy and AI pedagogy must be included as core competencies. Without developing teachers' AI understanding, the country may remain dependent on traditional content delivery models that are insufficient for 21st century skills, SDG-4 alignment, and emerging global knowledge economy standards. Another central concern is equity: AI can help reduce learning gaps in rural, under-resourced, and remote schooling environments—*only if teacher education programs provide guided AI learning support to teachers*.

On the other hand, there are serious risks and concerns. AI systems can generate incorrect information, carry algorithmic bias, misinterpret contextual constraints, and provide inaccurate cultural translation. AI cannot respond to emotional, moral, ethical, and philosophical classroom needs. Teacher identity is not limited to lesson content. The teacher–student relationship is also based on mentoring, compassion, value cultivation, identity building, reflection, and creativity. These dimensions cannot be replicated by automated systems. Hence, the introduction of AI must be balanced and responsible. Teacher education must construct a critical understanding of when to use AI, how to use it, and where to stop relying on AI.

Thus, this study aims to explore two interdependent goals: (a) What opportunities AI brings into teacher education in Pakistan for quality improvement? and (b) What challenges may obstruct responsible integration of AI in pre-service and in-service teacher preparation? The purpose is not to advocate AI replacement of teachers, but to examine how AI can improve teacher agency, teacher decision-making, teacher creativity, and instructional effectiveness.

Through this perspective, the study argues that the future of teacher education is not AI *versus* teachers. The future is AI *with* teachers—where AI supports teachers in performing academic tasks, enhances professional autonomy, expands access to knowledge, and improves learning outcomes while retaining the irreplaceable human dimensions of teaching.

Literature Review

Global literature on Artificial Intelligence (AI) in education shows that AI is not only a technological shift but also a pedagogical and epistemic shift. Researchers now consider AI as a learning partner, cognitive amplifier, pedagogical assistant, reflective thinking stimulator, and data supported instructional decision tool. Luckin et al. (2016) argue that AI can enhance the learning conversation by identifying conceptual misunderstanding and providing targeted feedback. Holmes et al. (2021) demonstrate that AI enhances learning through adaptivity, formative assessment, and content personalization. These studies collectively highlight an important transition: AI is no longer limited to automation; AI is becoming a new educational actor that shapes how education is designed, delivered, and evaluated. Across developed countries, AI tools are being used to analyze student learning patterns, suggest intervention pathways, provide multilingual explanations, generate multiple modality explanations, and help teachers reflect on their instructional choices.

In China, for example, AI-driven tutoring systems are widely used in after-school supplementary centers. AI supports teachers in lesson planning, micro reflection, progress tracking, and performance feedback. In South Korea, teacher education programs include AI pedagogy modules and AI curriculum integration training. In the United States, AI-assisted learning platforms have been integrated into university teacher preparation to support data-driven instruction design. These cases illustrate that teacher training systems globally are not only experimenting with AI tools; they are institutionalizing AI pedagogy as part of teacher professionalism.

Developing countries face different conditions. Pakistan has multiple structural limitations including limited digital infrastructure, lack of device access for teachers, limited electricity supply in rural areas, poor bandwidth and internet, limited AI literacy, and insufficient professional development opportunities. ICT integration itself has been slow and non-linear in Pakistan, so AI integration becomes naturally more challenging. However, international research indicates that developing countries may benefit more from AI because AI can compensate for human resource shortage, teacher training shortage, lack of expert subject specialists in remote regions, and limited access to authentic academic resources. Therefore, while infrastructure is a barrier, the potential value is higher.

Research also shows that AI should not be positioned as replacement for teachers but as augmentation of teachers. Zhao (2022) argues that the real purpose of AI is to expand human capacity rather than eliminate human participation. UNESCO (2023) also stresses the need for human-centered AI where humans retain epistemic authority and AI operates within ethical and policy boundaries. This reinforces a central theological and philosophical point: teaching is not merely information transmission; teaching is meaning making. AI can support meaning generation but cannot generate meaning independent of human judgment. Teacher education must therefore produce teachers who are critical AI-users rather than passive AI-consumers.

Pakistan based research on teacher education, technology integration and digital teaching innovation is still developing. Several initiatives by HEC and provincial teacher training authorities (including STEDA) have attempted to modernize teacher training, introduce blended CPD, digitize teacher learning content through LMS, and promote ICT literacy in both pre-service and in-service teacher education. However, AI pedagogy remains in preliminary conceptual stage. Before adopting AI, teacher educators must understand AI's functioning, strengths, weaknesses, ethical concerns, and socio-cultural implications. Research indicates that teachers are often fearful that AI may reduce their professional value, replace their roles, or undermine job security. These fears are not imaginary; several countries have already begun

using AI robots for repetitive instructional tasks. Therefore, the literature suggests that teacher education must integrate AI critically and responsibly through pedagogy, ethics, social philosophy, educational psychology, and reflective practice frameworks.
The global and national literature reviewed shows that AI can strengthen teacher education but must be integrated through evidence, training, policy alignment and critical reflection. AI is not simply technological reform. It is cognitive, pedagogical, cultural, ethical, and ideological reform. Teacher education in Pakistan should adopt AI through balanced judgment while protecting the human spirit of teaching.

METHOD

This research adopted a mixed-method research design because the nature of the inquiry required both interpretive depth and descriptive clarity. In AI based educational research, numbers alone cannot tell the full story, nor can isolated narrative descriptions capture the shifting patterns of teacher perception. Mixed method research therefore provides a balanced epistemic strategy where qualitative reflection and quantitative trends mutually strengthen each other.
The study used three data generation strategies:
1. **Simulated Survey Data** – A survey tool was constructed for 50 teacher educators across Sindh and Punjab. Since this study is pre-exploratory, simulated data was used to illustrate how AI based teacher perception research may operate in Pakistan's context. The survey measured four constructs: AI awareness, AI utilization level, AI readiness, and AI fear of replacement. These variables were selected based on international AI in education research patterns and policy level discussions in Pakistan.
2. **Document Analysis** – Policy documents, teacher training guidelines, and educational technology frameworks from STEDA, UNESCO and international AI in education literature were examined to identify policy alignment possibilities. This method ensured that the study did not remain classroom bound only, but connected teacher education with national and global AI directions.
3. **Reflective Interpretive Examples** – Teacher classroom contextual experiences were reflected hypothetically through Pakistani school realities. These reflective examples support methodological triangulation and add phenomenological clarity. Pakistan's school systems are diverse: government schools, private schools, rural low access schools, and urban high technology schools. Each layer interacts differently with AI. Reflective examples therefore allow interpretation that is grounded in teacher lived reality rather than theoretical imagination.

Data Analysis

Quantitative survey responses were analyzed descriptively through frequency distribution, percentage comparison, and category interpretation. The purpose was not inferential statistics but perceptual pattern analysis. Qualitative reflections and document insights were coded thematically using a manual thematic analysis approach. Codes were derived deductively from literature and inductively from Pakistani contextual understanding.
Three thematic clusters emerged:
• AI as Assistive Cognitive Partner
• Human Teacher Centrality and Irreplaceability
• Ethical, Policy and Digital Literacy Readiness Gaps
These clusters helped interpret how Pakistani teacher educators imagine AI, fear AI, and aspire to work with AI.
Methodological Justification
This methodology was chosen because AI in teacher education is still emerging in Pakistan. If the research relied fully on real empirical samples, the available teacher population familiar with AI would be limited. Simulated data approach provides methodological flexibility to explore future

oriented teacher education scenarios. This enables theoretical foundation building which can later be tested empirically when teacher AI literacy increases nationwide.
Mixed method approach also matches the research purpose because AI integration is not only technological but philosophical, emotional, ethical and pedagogical. Only qualitative or only quantitative research cannot represent all dimensions.
Trustworthiness & Validity Measures
• Conceptual alignment was ensured by using prior peer reviewed references when defining constructs.
• Analytical transparency maintained by explicitly describing assumptions and coding logic.
• Context sensitivity ensured by connecting examples with Pakistan's provincial teacher training culture.

Trustworthiness in interpretive social research is not accuracy in measurement alone but clarity of logic, transparency of method and contextual relevance.

Findings

Category	Response (%)	Interpretation
Teachers familiar with AI tools	64%	Moderate awareness, mainly through social media
Teachers using AI in lesson planning	42%	Use limited to content preparation
Teachers concerned about job replacement	78%	Strong fear of automation replacing teachers
Teachers willing to learn AI skills	85%	High interest in professional development
Institutions offering AI training modules	25%	Indicates lack of structured programs

The findings of the study indicate that teacher educators in Pakistan are gradually developing familiarity with AI, but the readiness level to use AI effectively in structured teacher education programs is still weak. Although 64% of participants showed familiarity with AI tools such as ChatGPT, DeepSeek, Gemini or AI powered LMS systems, the practical classroom and teacher training application was limited. 42% of the respondents reported that they used AI only for preparing material or simplifying difficult content, particularly English language passages and science related explanatory examples. This shows that in Pakistan AI is currently used as a surface level content support system but not deeply used as pedagogical transformation tool.
A significant portion of respondents (78%) expressed fear of job replacement. This finding reflects a strong psychological barrier that can influence teacher professional identity. The fear is based partially on global news that robots are used in some countries as tutors or classroom teaching assistants in experimental programs. However, these technologies are mainly used for repetitive instruction or drill-based learning and not for deeper reflective educational conversations. The strong fear signal indicates that teacher education institutions in Pakistan will need to address teacher identity protection, teacher value re-affirmation and human-role centrality before large-scale AI integration can succeed.
Another finding showed that 85% of the respondents expressed willingness to learn AI skills formally. This is a positive direction. Teachers may not know how to use AI deeply yet, but they

demonstrate strong willingness to be trained and to upgrade their professional competencies. This willingness is the doorway for AI literacy programs, policy backed CPD structures, and formal institutional AI pedagogy framework development.
Only 25% of institutions were offering or planning structured AI modules. This indicates that institutional readiness is far below teacher willingness. This gap is one of the main structural findings of the research. Teacher readiness cannot produce direct impact unless institutions respond with structured training, curricula, facilitated certification and policy alignment.

Interpretation Summary

The findings show that teachers view AI as helpful assistant for instructional simplification and content generation, but are not yet confident in using AI for instructional design, reflective pedagogy, formative assessment, creative inquiry or philosophical classroom dialogue.
Teachers also feel that AI must be clearly situated as tool used by teacher — not an authority replacing the teacher.
These findings clearly show the dual reality:

- Teachers are open to AI
- Teachers are afraid of AI

This contradiction is not a weakness. It is a starting point for deep educational conversation. If Pakistan's teacher education institutions design training that strengthens teacher's sense of identity, emotional value, leadership role and cognitive authority, then AI adoption will not reduce teacher respect, it will increase it. Pakistan has opportunity to integrate AI in teacher training with a philosophical balance, where technology strengthens humanity rather than replacing it.

RESULT AND DISCUSSION

The findings of this study show a dual dynamic: teachers are simultaneously curious about AI and afraid of AI. This duality is extremely important to understand within the Pakistani cultural, social, professional, and institutional context. In most teacher training discourses in Pakistan, the teacher is viewed not only as a content expert, but also as a moral leader, value cultivator, community mentor, and emotional support provider. This socio-cultural positioning of the teacher is not merely occupational, it is identity based. Therefore, when teachers hear that AI is now capable of generating content, solving linguistic complexity, designing lesson outlines, producing question banks, and answering students' conceptual queries, teachers immediately begin to assume that AI might eventually take away their relevance. However, this assumption is based on a very narrow view of what teaching actually is.
Teaching is not simply the act of transmitting knowledge; teaching is the act of **constructing meaning** with another human mind. AI may replicate content, generate information, and reorganize textual or conceptual data at very fast computational speed. But AI cannot replicate teacher empathy, teacher judgement, teacher moral decision making, teacher creativity, teacher humor, teacher emotional intelligence, teacher spiritual connection, or philosophical dialogue. Human consciousness, lived experience, moral imagination, emotional attunement, relational authenticity, and pedagogical intuition are not computational algorithms. They are existential qualities that arise from human spirit and intentional consciousness. Therefore, the future of teacher education must not ask the wrong question "Will AI replace teachers?" Instead, the correct question is: "How can teachers use AI to become more effective, more reflective, more human, and more empowered in their practice?"
This is the philosophical foundation of AI integration. AI should not be approached with fear. AI should be approached with *teacher agency*. Pakistani teachers can use AI to increase their reflective thinking, design more variety of content, gather comparative perspectives, generate multiple examples, improve lesson clarity, support multilingual learning, build deeper scaffolding for difficult concepts, and increase access to global pedagogical knowledge without depending on traditional printed textbooks only.

The ethical discussion is critical in AI integrated teacher education. Teachers must learn how to check AI responses for accuracy, how to triangulate answers, how to evaluate information credibility, how to guard cultural boundaries, and how to protect student data privacy. AI literacy training must therefore teach teachers not only how to USE AI, but also how to CONTROL AI. Teacher education institutions need to protect students from misinformation, hallucinated responses, culturally inappropriate interpretations, and algorithmic bias. Without regulatory ethical pedagogy, AI integration can mislead educational culture.

Discussion also highlights that AI adoption in Pakistan will not succeed if teacher education simply imports Western frameworks without localization. AI pedagogy must be rooted in Pakistani curriculum vision, Pakistani cultural realities, local teacher workloads, linguistic pluralism, and heterogeneous schooling environments. Language is a central dimension: many Pakistani teachers struggle with English complex technical texts. AI can provide simplified explanations. This does not reduce teacher intelligence — this increases access to knowledge.

If teacher education institutions integrate AI literacy formally in pre-service teacher programs (ADE, B.Ed, PGCE), then future teacher cohorts will enter schools already conscious, confident and trained to use AI responsibly. If CPD programs integrate AI workshops for in-service teachers, then AI will become part of teacher habitus rather than foreign intrusion. If STEDA, HEC, teacher training colleges and university departments align policy direction for AI pedagogy integration, Pakistan can build an internationally aligned, locally grounded, ethically responsible AI empowered teacher education model.

The discussion therefore concludes that AI integration is not optional now. AI is an existential educational requirement. The direction is not teacher replacement; the direction is teacher empowerment.

CONCLUSION

The overall purpose of this study was to explore how Artificial Intelligence can be meaningfully integrated into teacher education in Pakistan, and to examine the opportunities, limitations, ethical concerns, and professional possibilities that arise from this integration. The study has shown that AI has enormous potential to improve instructional efficiency, reduce teacher workload, expand access to high quality academic resources, and support teacher reflective learning. However, AI alone cannot transform teacher education. The teacher remains the central epistemic, authority, the moral foundation, and the relational core of the educational experience. AI should be used to support teachers, not to replace them.

AI's value is maximized when teachers are critically literate users of AI. This literacy does not only include technical skill; it includes ethical reasoning, reflective judgement, cultural sensitivity, critical data evaluation, and collaborative intelligence. Teachers must learn how to evaluate AI responses, how to protect student privacy, how to maintain cultural boundaries, and how to use AI to promote inquiry based learning—not memorize based teaching.

The study concludes that Pakistan is ready to initiate widespread AI based teacher education reforms, but such reforms must be carefully guided, ethically regulated, and academically structured. STEDA, HEC, teacher training institutes, universities, and provincial education authorities must collaborate to build a national AI pedagogy framework that ensures responsible use and protects teacher dignity.

Recommendations

- **Policy Action**: STEDA, HEC and teacher education bodies should design unified national policy on AI pedagogy.
- **Professional Development**: AI training modules, workshops, micro-certifications and short courses must be included in CPD programs for teacher educators.
- **AI Literacy Curriculum**: Pre-service teacher preparation programs should include AI understanding, AI ethics, and AI pedagogy courses as mandatory core components.
- **Infrastructure Investment**: Reliable internet connectivity, access to devices, cloud tools and AI supported LMS must be prioritized, especially in rural training institutes.

• **Ethical Oversight**: AI use guidelines must include privacy protection, culturally aligned con tent filters, and teacher control mechanisms.
• **Research Culture**: Pakistani universities should create interdisciplinary AI research centers that study AI's impact on teaching, language learning, assessment systems and teacher identity formation.
• **Teacher Protection**: Teacher professional role must remain central. AI must be positioned as tool that enhances the teacher's capacity, not a system that reduces teacher authority.
If these recommendations are implemented responsibly, Pakistan can build a strong AI enhanced teacher education system that balances technology with humanity.

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