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DEVELOPING THE METHODOLOGY FOR ENHANCING PRE-SERVICE PRIMARY SCHOOL TEACHERS' METHODICAL TRAINING BASED ON ARTIFICIAL INTELLIGENCE TECHNOLOGIES

Abstract

The integration of artificial intelligence (AI) into education has emerged as a global priority, yet teacher training programs often lack structured methodologies for preparing future educators to effectively utilize AI. This study proposes a conceptual framework for embedding AI technologies into the methodological training of pre-service primary school teachers. Drawing on recent empirical findings and international best practices, the model incorporates four interrelated components: (1) adaptive learning practicum using AI-driven tutoring systems, (2) generative AI for lesson planning and instructional content development, (3) an AI literacy and ethics module to address responsible and equitable AI use, and (4) blended workshops combining traditional pedagogy with AI-enhanced simulations. The framework is designed to strengthen technological pedagogical content knowledge (TPACK) and foster reflective, data-informed teaching practices. Comparative analysis suggests that the AI-enhanced methodology facilitates individualized learning design, improves instructional efficiency, and increases trainee engagement, while maintaining pedagogical integrity. However, challenges related to ethical awareness, algorithmic bias, digital competence, and institutional readiness must be addressed for sustainable implementation. The study contributes to the growing discourse on AI in teacher education by offering a structured

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pathway for integrating AI into pre-service teacher training, with practical implications for curriculum reform and educational policy.

Keywords: artificial intelligence in education, teacher education, methodological training, adaptive learning, generative AI, TPACK, pre-service teachers.

Introduction

The integration of artificial intelligence (AI) into education is rapidly transforming teacher preparation. In Uzbekistan, for example, the government has partnered with OpenAI to launch ChatGPT EDU, a secure platform enabling teachers and students to use powerful AI language models to create educational materials and assistants. This initiative exemplifies a broader trend: AI-driven tools (from adaptive learning systems to generative models like ChatGPT) allow *personalized* instruction tailored to each student's needs. Emerging research underscores AI's potential in teacher training: one study notes that integrating digital AI tools can individualize learning, build methodological competencies, and motivate pedagogical university students. At Navoi State University, for instance, researchers have shown that AI-powered platforms (e.g., intelligent tutors and adaptive technologies) help educators identify individual learning preferences and adapt content delivery to varying student speeds.

Despite these advances, most pre-service teacher programs still follow traditional methods (lectures, fixed curricula, and practicum in real classrooms). National reports warn that technology is often "compartmentalized and inadequately addressed" in such programs. Experts argue it is imperative to deeply integrate AI into teacher education, equipping future educators with the skills to use these advanced tools. The aim of this article is to propose a theoretical methodology for embedding AI technologies into the methodological training of

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future primary school teachers. We compare this AI-enhanced approach with traditional training practices, outlining expected outcomes, benefits, and challenges.

Methods

We develop a conceptual AI-based training framework for pre-service primary teachers. Key components include hands-on modules, reflective seminars, and practice tasks that blend pedagogy with AI tools. The main elements are:

- **Adaptive Learning Practicum:** Teacher trainees use AI-driven adaptive platforms (e.g., intelligent tutoring systems) to design and deliver micro-lessons. For example, using a system like DreamBox in a math mini-lesson, trainees observe how the platform automatically adjusts problem difficulty to each (simulated) student's level. This direct experience shows how machine-learning algorithms can *personalize learning pace and content*. Instructors guide discussions comparing this with teaching a whole class, highlighting how adaptive systems can close knowledge gaps and enhance engagement.
- **Generative AI in Lesson Planning:** Trainees learn to integrate large language models (e.g., ChatGPT) into curriculum design. In structured exercises, they prompt ChatGPT to draft lesson plans or create teaching materials for primary science or language classes. They then *evaluate and refine* the AI-generated output. This builds their technological pedagogical content knowledge (TPACK) by combining AI assistance with their pedagogical judgment. Research shows such tasks help preservice teachers understand the utility and limits of generative AI: ChatGPT can **support** tasks like unit plan design, but the teacher ultimately tailors and contextualizes the content.
- **AI Literacy and Ethics Module:** A seminar covers the theory of AI and its educational implications. Trainees review studies (including Uzbekistan–

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specific cases) on AI in schools. For instance, they examine the Navoi State University findings that AI tools can increase student motivation and success in flipped-classroom settings. They also discuss global guidance (e.g., U.S. Dept. of Education recommendations) emphasizing that educators must balance AI's opportunities with ethical considerations. Topics include data privacy, bias in algorithms, and the importance of equitable access.

- **Blended Workshops:** In collaborative workshops, trainees alternate between **traditional pedagogy exercises** (peer teaching, lesson critique) and **AI-enhanced simulations**. For example, one activity might compare writing a lesson manually versus using an AI co-author; another could involve analyzing student performance reports generated by AI analytics. These side-by-side comparisons (guided by instructors) highlight differences in efficiency, personalization, and required teacher roles.
- **Assessment and Reflection:** Trainees complete projects such as designing an AI-supported lesson. Performance is assessed both by educators and by AI feedback tools. Pre- and post-training surveys (questionnaires, reflective essays) are used to gauge how participants' confidence and competence in using AI tools have changed. Though this paper is theoretical, it anticipates that incorporating iterative feedback (both human and AI) will reinforce learning outcomes.

Results

Implementing the above methodology is expected to yield several improvements over conventional training:

- **Personalized Skill Development:** AI-driven tasks allow each trainee to progress at their own pace. For example, when designing micro-lessons with an adaptive tutor, slower learners receive more scaffolding while advanced trainees encounter deeper challenges. This *individualized instruction* is

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difficult to achieve in large cohorts with traditional lectures. Research shows AI platforms can adapt content to individual needs, enhancing engagement and academic success.

- **Efficiency and Time Savings:** Generative AI and automation reduce routine workload. As Uzbekistan's ChatGPT EDU initiative notes, AI can *automate grading* and paperwork, freeing educators for direct interaction. In our framework, auto-graded quizzes and AI-generated lesson templates will allow trainers to give rapid feedback. Studies confirm that when teachers leverage AI for tasks like grading short answers or creating quizzes, they reclaim time for pedagogical planning.
- **Enhanced Trainee Engagement:** Interactive AI tools (simulations, chatbots) make training more active. Trainees are likely to show higher motivation when they see immediate, AI-driven results of their work. For instance, a math lesson designed in an adaptive system provides instant data on hypothetical student outcomes, making the learning process dynamic. This kind of feedback loop is known to encourage active participation and curiosity.
- **Stronger AI Competence:** By the end of the program, trainees gain both pedagogical skills and AI literacy. They learn to critically assess AI outputs and integrate tools thoughtfully. This dual expertise is crucial: as one study notes, teacher education must consciously build technological knowledge alongside pedagogy. Trainees should emerge with improved TPACK (technological, pedagogical, content knowledge), ready to bring AI into real classrooms.

The comparative advantage over traditional methods is that AI-enhanced training produces future teachers who are not only versed in pedagogical theory but also comfortable with cutting-edge educational technologies. Surveyed educators elsewhere have reported that AI integration improves learning outcomes

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in classrooms, suggesting similar benefits when applied in teacher training. In sum, we hypothesize that AI-based training will produce teachers who can create more flexible, data-informed lesson plans and who feel more confident employing digital tools.

Discussion

A side-by-side comparison of AI-driven training versus traditional approaches highlights clear contrasts:

- **Personalization:** *Traditional* training typically follows a one-size-fits-all schedule (lectures and textbooks). *AI- enhanced* training adapts to the learner: adaptive learning systems continuously tailor content to each trainee's level. This means slower trainees can review material as needed, while others accelerate beyond the standard curriculum.
- **Teacher Workload:** In conventional methods, trainers spend significant time on grading and static lesson prep. In the AI approach, tools handle many routine tasks (auto-grading, content suggestions), reducing manual workload. As one tech writer notes, AI will "take over administrative and repetitive tasks, allowing a teacher to spend more time engaging with students and developing creative lesson plans".
- **Engagement and Interactivity:** Traditional training relies on face-to-face discussion and group work, which builds social skills but limits individual exploration. AI methods introduce simulations and chatbots that provide 24/7 interactivity. This can boost engagement; for instance, trainees using gamified AI tools or VR scenarios often show higher participation than in passive lectures.
- **Role of the Teacher/Educator:** Both approaches value the teacher's human role. Crucially, studies emphasize that AI is *complementary* rather than substitutive. Teachers still "bring the human touch" and interpret AI outputs

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for context. As one source puts it, AI "supports rather than substitutes" educators. Our methodology reinforces this: instructors remain in charge of guiding reflection and ensuring ethical use of AI.

While promising, AI-enhanced training also poses challenges. Key concerns include:

- ✓ **Equity and Bias:** AI algorithms can exhibit biases if not carefully managed. For example, if the underlying data are skewed, certain trainee demographics might receive less accurate feedback. We must ensure diverse, representative datasets when adopting AI tools.
- ✓ **Privacy and Security:** Using AI often involves collecting data on student performance. Robust policies are needed to protect this sensitive information. Trainees and instructors must be made aware of legal and ethical standards.
- ✓ **Over-reliance on Technology:** There is a risk that students and teachers become too dependent on AI. Without critical oversight, automated answers may be accepted uncritically. Our methodology includes critical reflection sessions to combat this, emphasizing that AI is a **tool** not an oracle.
- ✓ **Resource Constraints:** Implementing AI systems requires infrastructure (reliable internet, devices, software) and funding. Not all teacher-training colleges may have these readily. Pilot programs should assess institutional readiness and seek partnerships (e.g., OpenAI's Uzbek collaborations) to share resources.
- ✓ **Teacher Resistance and Training:** Instructors accustomed to traditional methods may resist AI adoption. Professional development must therefore accompany any methodological overhaul. The Uzbekistan "1 Million AI Leaders" initiative (which includes teacher training) is a step in this direction.

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Addressing these issues requires a balanced approach. As education authorities advise, programs must include both opportunities and risks of AI. Our proposed methodology builds in scaffolding: hands-on practice, ethical training, and iterative feedback. Ultimately, the goal is a **blended** pedagogy that leverages AI's personalization and efficiency while preserving the teacher's central role and human judgment.

Conclusion

This study outlines a framework for enriching future primary teacher training with AI technologies. By integrating adaptive platforms, generative models, and data analytics into coursework, we can create a *methodology* that modernizes pedagogical preparation. Early evidence suggests such AI-enhanced training will produce teachers with stronger technological and instructional competencies. Compared to conventional methods, the AI-based approach offers more personalized learning and reduced administrative burden for teachers. Importantly, Uzbekistan's own initiatives (e.g., ChatGPT EDU, Yandex ML School) reflect a national commitment to equipping educators for the digital era.

In practice, successful implementation will require careful planning: ensuring equitable access, robust infrastructure, and ongoing support for instructors. AI should *complement* the irreplaceable skills of teachers, not replace them. Future research and pilot programs (for example, at Navoi State University) will be essential to refine this methodology, compare learning outcomes, and develop best practices. By proactively integrating AI with traditional teacher training, Uzbekistan can prepare primary educators to deliver more effective, personalized instruction, thus advancing educational quality and innovation.

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