

Pedagogical and Psychological Foundations of AI-Based Methodological Training for Future Primary School Teachers

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Abstract

The rapid integration of artificial intelligence (AI) into education has intensified the need to reconsider the pedagogical and psychological foundations of teacher preparation, particularly in primary education. This study aims to synthesize contemporary theoretical perspectives on AI-based methodological training for future primary school teachers, with a focus on pedagogical principles and psychological mechanisms that enhance professional readiness. Using a thematic literature review of international studies published between 2018 and 2025, the research analyzes scholarly works addressing AI-supported scaffolding, adaptive learning, feedback systems, and competency-based teacher education frameworks. The findings indicate that AI technologies function as effective cognitive and motivational scaffolds by personalizing instruction, managing cognitive load, enhancing self-efficacy, and reducing performance-related anxiety among pre-service teachers. From a pedagogical perspective, AI-enhanced methodological training aligns with constructivist, student-centered, and reflective learning approaches, particularly through the integration of intelligent tutoring systems, simulations, and AI-extended TPACK models. The study also emphasizes the importance of ethical, human-centered AI use to preserve empathy, professional judgment, and pedagogical responsibility. The article concludes that AI-based methodological training, when grounded in sound pedagogical and psychological theory, represents a sustainable and innovative pathway for improving the quality of future primary teacher education in Uzbekistan and comparable educational contexts.

Keywords: artificial intelligence; teacher education; methodological training; pedagogical foundations; psychological foundations; pre-service primary teachers.

Introduction

Education reforms worldwide emphasize preparing teachers with 21st-century digital skills. In Uzbekistan, for example, modernizing the education system has been a policy priority, casting teachers as “educator[s], leader[s], innovator[s]” who must master modern pedagogies and digital tools. Recent UNESCO initiatives in Uzbekistan specifically promote AI-based solutions in teacher training. In 2025, UNESCO launched ICT competency frameworks for educators that explicitly include AI tools, and experts have introduced AI-driven modules and training programs for teacher training centers. Against this backdrop, future primary-school teachers – whose **methodological training** teaches them how to design and deliver instruction – are a key focus. Integrating artificial intelligence (AI) into methodological training holds promise for personalizing instruction, providing real-time feedback, and scaffolding complex pedagogical tasks. For example, adaptive AI systems can tailor learning materials to individual needs and simplify complex concepts, while freeing instructors’ time for direct student engagement. However, successful integration requires grounding in sound pedagogical and psychological theory. This review synthesizes recent scholarship (primarily post-2018) on the **pedagogical and psychological principles** underlying AI-enhanced training for pre-service primary teachers, with an eye to implications for teacher readiness in both Uzbekistan and comparable contexts.

Methods

A thematic literature review was conducted. We searched academic databases and recent conference proceedings (2018–2025) using combinations of keywords such as “AI in teacher education,” “pedagogical principles,” “psychological foundations,” “TPACK and AI,” and “scaffolding AI learning.” We included theoretical and review articles as well as empirical studies of AI applications in teacher training (with a focus on primary/general education). Sources were screened for relevance to pre-service teacher “methodological training” (courses on teaching

methods) and for discussion of underlying educational or psychological theories. We especially considered frameworks like **TPACK (Technological Pedagogical Content Knowledge)** adapted for AI, UNESCO competency guidelines, and studies on AI-based feedback and scaffolding. Key themes and recommendations from the literature were synthesized into pedagogical and psychological dimensions.

Results

AI as Scaffold and Cognitive Support. A dominant theme is that AI can function as a *scaffolding mechanism*, consistent with Vygotsky's theory of guided learning. For instance, a quasi-experimental study grounded in scaffolding theory found that AI tools (like ChatGPT and an AI speaking coach) significantly reduced pre-service teachers' public-speaking anxiety and provided "scaffolded, learner-centered support" for skill development. The authors highlight that such AI tutoring offers personalized feedback and motivation, aligning with constructivist ideas of learner-centered engagement. Similarly, adaptive AI learning systems can **manage cognitive load** by breaking complex teaching tasks into simpler steps. A systematic review found that AI-driven adaptive instruction "optimizes cognitive load management by automatically adjusting instructional materials, scaffolding complex concepts, and providing immediate feedback," leading to greater engagement and reduced overload. In practice, this means AI tutors or simulation tools can guide novices through lesson planning or classroom scenarios in incremental stages, reducing extraneous load and promoting germane processing.

Personalization and Feedback. Relatedly, AI's ability to personalize and automate feedback is highlighted. AI-driven feedback systems (such as automated lesson analysis tools) can deliver data-driven critiques of a trainee's micro-teaching. One study comparing AI vs. instructor feedback found that both improved teaching self-efficacy, with AI feedback showing promise as a scalable tool (though trainees rated human feedback more credible). Importantly, this research notes that the *design* of AI feedback must be cognitively manageable and pedagogically meaningful so as not to overwhelm learners. In sum, AI can offer continuous,

individualized guidance (e.g. via chatbots, simulations, or analytics), which aligns with psychological needs for timely feedback and supports self-regulated learning.

Teacher Cognition and Motivation. Psychological theory underscores that confidence and motivation are critical for adopting new teaching methods. Studies link AI training to enhanced teacher self-efficacy: for example, both human and AI feedback in simulated teaching significantly boosted pre-service teachers' confidence in classroom management and instruction. AI tools also notably reduced anxiety in performance tasks. These effects can be framed in Bandura's terms: as trainees receive success experience and mastery feedback (even from AI), their belief in their teaching capabilities grows. Moreover, research suggests AI environments may heighten engagement through immediate rewards and autonomy. The novel, interactive nature of AI tools can spark intrinsic interest and a sense of competence – both key factors in motivation.

Pedagogical Frameworks. On the pedagogical side, several principles emerge. First, are recurrent ideals. The reviewed literature suggests that AI tools should be used to promote inquiry and reflection rather than rote instruction. For instance, AI-powered research assistants and concept-mapping tools can help pre-service teachers explore pedagogical literature and teaching strategies (as when instructors use AI search engines to find evidence-based methods). Educause commentary emphasizes that AI should *augment* human teaching (not replace it), freeing instructors to foster critical thinking and collaboration. In methodological training, this means AI can help analyze content or simulate practice, while mentors focus on higher-order pedagogical guidance.

Second, the **TPACK framework** is extended to include AI. Recent models (e.g. “Intelligent-TPACK”) integrate AI knowledge with pedagogical content knowledge. Professional-development studies show that focusing on AI-technology-pedagogy interplay (AITPK) significantly raises educators' AI competencies. Likewise, researchers have proposed instruments to measure pre-service teachers' “AI-enhanced TPACK,” underscoring that digital, pedagogical, and content knowledge must co-develop with AI literacy. Thus, methodological training should embed AI

both as a subject (e.g. understanding how AI algorithms work) and as a tool (e.g. designing lessons with AI tutors), to build this combined competence.

Third, aligning with active learning and feedback principles is crucial. AI-based modules often use simulation, role-play, or problem-solving tasks. For example, virtual classroom simulations with AI-driven student avatars can give trainees a safe space to practice. These methods fit activity-based approaches emphasized in Uzbek reforms. They also support reflection: AI systems can record and analyze trainee performance, prompting metacognitive reflection (e.g. reviewing a lesson plan critique generated by an AI mentor). Research suggests such technology supports adult learners' needs for mastery and relevance, as they see how AI insights apply to real teaching.

Ethical and Human-Centered Considerations. Finally, psychological literature warns that reliance on AI must not erode human elements of teaching. One analysis (in an inclusive-education context) notes that while AI can individualize learning, “concerns remain about the potential reduction of human interaction and empathy in the classroom”. Applied to teacher training, this implies we must design AI pedagogies that preserve relational skills. Trainee teachers need to learn not only *how* to use AI, but *when* human judgment is needed. Teacher training programs must thus include discussions of ethics and empathy: for example, using AI feedback alongside peer review, or reflecting on how AI recommendations align with educational values. Training modules should explicitly cover responsible AI use (e.g. data privacy, bias). UNESCO’s competency framework underscores this, stressing a “human-centered approach” and AI ethics as core elements. In sum, psychological readiness involves trusting AI tools while remaining sensitive to student emotions and inclusion.

Discussion

The reviewed literature portrays AI-based methodological training as a powerful adjunct to traditional teacher education, grounded in well-established educational theories. Psychologically, AI tools function as cognitive and motivational supports: they scaffold novice teachers’ learning (per Vygotsky),

manage cognitive load through adaptivity, and boost self-efficacy by providing evidence of mastery. Pedagogically, AI integration aligns with student-centered, constructivist principles. Intelligent tutoring and simulation offer “personalized instruction” and rich formative feedback, enabling trainees to experiment safely and reflect on practice. Importantly, models like intelligent-TPACK highlight that building AI competence in teachers requires merging technical, pedagogical, and content knowledge.

For Uzbekistan (and similar contexts), these findings suggest concrete actions. Teacher education curricula should include AI literacy components – not as standalone tech courses, but embedded in methodology classes. For instance, a lesson on “teaching reading” might incorporate an AI tool that analyzes reading fluency, allowing trainees to interpret AI-generated feedback. Mentor-led seminars could discuss case studies where AI aided inclusive practices or how to balance AI use with interpersonal care. In-service master-trainer programs (as UNESCO has begun) can prepare teacher educators to guide this integration. Practically, education departments can pilot AI-supported teaching simulations and gather trainee feedback to refine the approach.

At the system level, policy support is crucial. Uzbekistan’s emphasis on ICT frameworks and teacher competency standards is an auspicious start. Authorities should ensure that teacher trainers have access to AI resources and professional development. Evaluation of AI training impact on teacher readiness – via surveys or classroom studies – will help fine-tune programs. Globally, the principles identified here are transferable: any primary teacher training should ground AI use in sound pedagogy (e.g. active learning, feedback loops) and psychology (motivation, confidence-building).

Conclusion

In conclusion, AI-enriched methodological training holds great promise for preparing future primary teachers. The pedagogical and psychological foundations reviewed here – scaffolding, personalization, feedback, self-efficacy, and technology-pedagogy integration – provide a roadmap for effective design. By

leveraging AI undergirded by educational theory, teacher educators can create learning experiences that enhance trainees' skills and readiness, ultimately leading to more innovative and inclusive primary education.

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