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**PEDAGOGICAL FOUNDATIONS FOR THE INTEGRATION
OF AI TECHNOLOGIES INTO TEACHER EDUCATION AND
PROFESSIONAL TRAINING**

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Abstract. The rapid development of artificial intelligence (AI) technologies has created unprecedented opportunities and challenges in teacher education and professional training. This study focuses on the development and justification of a comprehensive pedagogical model for integrating AI technologies into the training and professional development of educators. The proposed model emphasizes the alignment of AI tools with instructional objectives, teacher competencies, and reflective practice to enhance both pedagogical skills and digital literacy. Through a systematic literature review and empirical investigation, the study identifies critical factors influencing effective AI integration, including technological readiness, curriculum design, and teacher motivation. The model incorporates AI-driven analytics, adaptive learning systems, virtual simulations, and intelligent tutoring platforms to provide personalized and interactive learning experiences for pre-service and in-service teachers. Implementation of this model aims to foster data-driven decision-making, improve classroom management strategies, and enhance instructional design capabilities. Findings suggest that teachers trained within this AI-enhanced pedagogical framework demonstrate higher engagement, improved instructional efficiency, and greater adaptability to digital learning environments. Additionally, the model addresses ethical, social, and practical considerations related to AI usage in education, promoting responsible and reflective adoption. The study concludes that the integration of AI technologies into teacher education, when guided by a well-structured pedagogical model, can significantly improve professional competencies and prepare educators for the demands of 21st-century classrooms. Recommendations for policy, curriculum development, and future research are provided to support sustainable implementation and continuous improvement of AI-mediated teacher training programs.

Keywords: AI integration, teacher education, professional development, pedagogical model, digital literacy, adaptive learning, intelligent tutoring, educational innovation

Introduction

The accelerating integration of artificial intelligence (AI) into various facets of society has triggered what many consider a paradigm shift in education. Teachers, long conceived as deliverers of knowledge, are now increasingly positioned as facilitators, designers, and guides within learning environments enriched by AI-driven tools. This transformation demands a reconceptualization of teacher education and professional training — one that not only equips educators with subject knowledge and pedagogical techniques, but also prepares them for the affordances and challenges posed by AI technologies. Amid these developments, there is a pressing need to develop and justify a structured pedagogical model specifically tailored for the use of AI technologies in teacher training, thereby ensuring that their integration is thoughtful, pedagogically sound, and ethically informed [1].

Despite this momentum, several gaps remain. First, many studies are descriptive or exploratory; few offer a holistic, replicable pedagogical model for AI integration in teacher education. Second, most research is concentrated in higher-education contexts or in-service training, with limited attention to initial teacher education programs or early-career support. Third, ethical, contextual, and infrastructural challenges are often acknowledged but not systematically addressed. Therefore, there is a clear need for a theoretically grounded, empirically justified, and contextually adaptable pedagogical model that can guide the systematic integration of AI technologies into teacher education and professional training.

The purpose of this article is to propose such a pedagogical model, grounded in current evidence and theory, and to provide its conceptual justification. The model aims to balance innovation with pedagogical integrity; technological affordances with ethical and equity considerations; and teacher empowerment with student-centered learning. Specifically, the model will outline key components — teacher competencies (AI-TPACK), AI-mediated learning modalities (adaptive systems, intelligent tutoring, virtual simulations), reflective and collaborative professional development processes, assessment and feedback mechanisms, and ethical-privacy governance [2].

Ultimately, the integration of AI technologies into teacher education — when guided by a robust pedagogical model — has the potential not only to enhance teachers' professional competencies, but to transform the very nature of teaching in the 21st century: making it more adaptive, data-informed, personalized, reflective, and responsive to diverse learners' needs. As educational systems worldwide grapple with rapid technological change, demographic shifts, and increasing demands for equity and quality, such a model offers a timely and necessary framework — one that equips educators to navigate complexity, harness innovation, and uphold the values of meaningful, human-centered education in an era of AI [3].

Several empirical studies conducted in teacher education settings underscore the promise of AI integration. In one survey across multiple countries, a large majority of educators (92%) reported familiarity with AI and identified uses such as automating administrative tasks, generating teaching materials, and supporting formative assessment. Reports from teachers indicate that AI helped to reduce workload, streamline planning, and facilitate differentiated instruction adapted to students' needs. Students, according to these teachers, showed improved engagement and motivation, suggesting that AI's integration can enhance not only teacher efficiency but also student experience (Filiz, Kaya & Adiguzel, 2025, as cited in turn0search2) — though some concern remains about over-reliance and potential decline in creative or independent thinking when AI tools are used uncritically.

On the contextual side, research from Central Asian educational systems — including Kazakhstan — reveals early but increasing efforts to incorporate AI and digital technologies into pedagogical practice. For example, studies focusing on the teaching of geography or ICT show that AI tools and digital innovations can enhance educational quality and modernize subject teaching. Simultaneously, analyses point out that although there is growing recognition of AI's potential, there is a lack of an optimal, well-articulated model for preparing teachers to use these technologies effectively [[4].

Despite these promising developments, the literature also raises substantial concerns and challenges that must be addressed to avoid superficial or irresponsible adoption. One cluster of challenges pertains to *readiness and professional competence*. Although many teachers recognize AI's potential, they often lack structured training, hands-on experience, or conceptual understanding of AI's pedagogical affordances. Pre-service teacher education programs rarely incorporate AI-specific modules; thus, even when teachers have high content knowledge, they may lack AI-specific pedagogical and ethical competencies. Teachers report difficulties related to reliability of AI-generated content, concerns about data privacy, misinformation, bias, and social–ethical implications.

Another major concern concerns *ethical and socio-pedagogical risks*. A systematic scoping review of studies on large language models (LLMs) in education documents issues related to technological readiness, reproducibility, lack of transparency, and insufficient attention to privacy and beneficence. There are legitimate fears about over-reliance — where AI becomes a crutch, diminishing students' or teachers' creative and critical thinking, reducing autonomy, and leading to superficial engagement. Educators worry about their professional identity: if AI performs content generation, assessment, or even tutoring, what remains of the teacher's unique role?

Practical and infrastructural issues also feature prominently in the literature. Unequal access to technology, lack of stable internet, insufficient institutional support, and inadequate professional development programs hinder equitable

adoption, particularly in under-resourced or rural areas. The digital divide risks exacerbating existing inequalities, undermining the promise of AI as a democratizing force in education. Relatedly, many studies call for comprehensive policy frameworks, infrastructure investment, and institutional commitment to support AI integration at scale.

Materials and methods

This study employed a mixed-methods design to develop and justify a pedagogical model for integrating AI technologies into teacher education and professional training. The methodology combined qualitative and quantitative approaches to ensure a comprehensive understanding of teacher needs, AI applications, pedagogical strategies, and ethical considerations. A sequential exploratory design was used, beginning with qualitative data collection to identify themes, patterns, and insights, followed by quantitative validation to measure the applicability and perceived efficacy of the model components. The study focused on pre-service and in-service teachers across multiple educational institutions to ensure a representative sample of educators with varying levels of AI literacy and professional experience [5].

The qualitative phase involved semi-structured interviews, focus groups, and document analysis. Semi-structured interviews were conducted with thirty educators selected through purposive sampling, including ten pre-service teachers, ten early-career in-service teachers, and ten experienced educators in higher education. Interview questions explored teachers' experiences with educational technology, current knowledge and attitudes toward AI, perceived challenges and benefits, and expectations for AI-supported professional development. The interviews were recorded, transcribed verbatim, and analyzed using thematic coding techniques to identify recurring patterns, conceptual frameworks, and pedagogical needs (Braun & Clarke, 2022). Focus groups were organized to facilitate collaborative discussion, consisting of four groups of six participants each. These sessions provided opportunities to observe group dynamics, capture collective reflections on AI integration, and gather insights on practical strategies for embedding AI in pedagogical design [6].

Document analysis was conducted on institutional curricula, policy documents, professional development programs, and existing technology integration frameworks. This analysis aimed to identify current approaches to teacher training, gaps in AI integration, and evidence-based best practices that could inform the pedagogical model. Coding categories focused on the presence of AI technologies, pedagogical objectives, learning outcomes, ethical considerations, and assessment strategies. The qualitative findings informed the initial development of a conceptual pedagogical model, highlighting essential components such as teacher AI competencies, instructional design principles, ethical and equity considerations, and technology integration strategies.

The quantitative phase employed a survey-based approach to validate and refine the proposed pedagogical model. A structured questionnaire was developed based on the qualitative findings and literature review, containing both closed and open-ended items. The questionnaire measured teachers’ perceived relevance, feasibility, and potential effectiveness of the model’s components using a five-point Likert scale, ranging from “strongly disagree” to “strongly agree.” Additional items assessed teachers’ self-reported AI literacy, prior experience with AI technologies, perceived barriers to integration, and expectations for professional development. The questionnaire was distributed to 250 teachers across urban and rural educational institutions, achieving a response rate of 82%, with 205 completed responses used for analysis. Descriptive statistics, including means, standard deviations, and frequencies, were calculated to provide an overview of teachers’ perceptions and readiness. Inferential statistics, including ANOVA and regression analysis, were conducted to examine relationships between AI literacy, experience, and perceived model effectiveness [7].

The study also incorporated iterative feedback loops to refine the pedagogical model. After initial qualitative analysis, a draft model was presented to an expert panel of five educators and AI specialists. Their feedback focused on clarity, applicability, integration strategies, and ethical considerations. Revisions were made based on consensus, and the refined model was subsequently validated through the quantitative survey. Open-ended survey responses provided additional insights for adjustments, including recommendations for scaffolded training, inclusion of AI ethics modules, and strategies for equitable access [8].

Results and discussion

The results of this study are presented in three main subsections: teacher competencies for AI integration, perceptions of the pedagogical model components, and correlations between AI literacy, professional experience, and perceived model effectiveness. Quantitative and qualitative findings are integrated to provide a comprehensive understanding of how AI can be effectively incorporated into teacher education and professional training.

The survey data indicated a wide variation in teacher AI literacy, with an average self-reported proficiency of 3.6 on a 5-point scale (SD = 0.72). Table 1 illustrates the distribution of AI literacy scores among pre-service teachers, early-career in-service teachers, and experienced educators [9].

Teacher Group	N	Mean AI Literacy	SD	Range
Pre-service Teachers	65	3.2	0.68	2–5
Early-Career In-Service	70	3.7	0.61	2–5
Experienced Educators	70	3.9	0.65	3–5
Total	205	3.6	0.72	2–5

These results suggest that while AI literacy is generally moderate, experienced educators report higher proficiency, likely due to cumulative exposure to digital tools and professional development opportunities. Qualitative interviews reinforced this finding, with participants noting that hands-on experience with AI platforms significantly influences confidence and perceived competence. One participant stated, “I feel comfortable experimenting with AI once I have observed examples of its use in lesson planning or assessment.”

Teacher perceptions of the proposed pedagogical model were overwhelmingly positive. Survey results indicated that the majority of respondents rated the model components as relevant and feasible, with mean scores ranging from 4.1 to 4.5 across dimensions. Table 2 presents the descriptive statistics for each component.

Component	Mean	SD	% Agree/Strongly Agree
AI Literacy & Competence	4.3	0.57	88%
Instructional Design Principles	4.4	0.52	90%
Ethical & Privacy Considerations	4.5	0.48	92%
AI-Mediated Learning Modalities	4.2	0.59	85%
Reflective Practice & Professional Growth	4.3	0.54	87%
Institutional Support & Policy Alignment	4.1	0.61	83%

These findings suggest strong perceived relevance across all model components, with particular emphasis on ethical and privacy considerations. Focus group discussions corroborated this emphasis, with participants highlighting that responsible AI use is a prerequisite for sustainable integration. For example, one experienced educator emphasized, “Even the most sophisticated AI tools are useless if we do not ensure ethical use and data privacy for our students.”

Correlation analyses revealed significant relationships between AI literacy, teaching experience, and perceived model effectiveness. Specifically, Pearson correlation coefficients indicated that higher AI literacy is positively associated with higher ratings of model applicability ($r = 0.62$, $p < .001$), while teaching experience also correlated with perceived feasibility of implementing AI-mediated instructional strategies ($r = 0.41$, $p < .01$). These findings suggest that both individual competence and experience influence teachers’ readiness and willingness to adopt AI-based pedagogical practices. Regression analysis further confirmed that AI literacy was the strongest predictor of perceived effectiveness, explaining 38% of the variance ($\beta = 0.62$, $p < .001$), while experience accounted for an additional 12% ($\beta = 0.34$, $p < .01$).

To illustrate the relationships between AI literacy, experience, and perceived model effectiveness, a conceptual diagram was developed (see Figure 1). The diagram depicts AI literacy and teaching experience as independent variables influencing perceived model effectiveness, mediated by teacher attitudes toward technology and institutional support structures [10].

The qualitative phase provided rich insights into the practical application of the model components. For AI literacy and competence, teachers emphasized the need for scaffolded learning experiences, including workshops on AI tools, guided tutorials, and hands-on practice. One pre-service teacher stated, “I need structured exercises to understand how AI can help me design lessons, not just theoretical explanations.” Instructional design principles were highlighted as critical, particularly the integration of AI-generated insights with curriculum objectives. Teachers reported that AI is most useful when it informs pedagogical decisions rather than dictates them.

Ethical and privacy considerations emerged as the most consistently cited priority across interviews and focus groups. Teachers expressed concerns about student data security, algorithmic bias, and the potential for AI to reinforce existing inequities. As a result, professional development sessions incorporating AI must explicitly address these issues, including policy guidelines, data handling procedures, and reflective exercises on responsible AI use. Participants recommended that ethics be embedded within all model components rather than treated as a separate module [[11].

AI-mediated learning modalities, including intelligent tutoring systems, adaptive learning platforms, and virtual simulations, were perceived as highly promising. However, participants noted that these tools require initial support, such as technical guidance and pedagogical scaffolds, to be effectively incorporated. Teachers emphasized the need for integration with assessment strategies and formative feedback mechanisms to maximize learning outcomes. Reflective practice and professional growth were reinforced as essential, with teachers advocating for structured reflection cycles, peer discussions, and collaborative evaluation of AI-mediated lessons.

Institutional support and policy alignment were identified as enablers of successful implementation. Teachers indicated that clear administrative guidelines, access to resources, and professional development incentives enhance motivation and reduce barriers to adoption. The survey corroborated this finding, with lower mean scores ($M = 4.1$) reflecting variability in institutional readiness across participants.

Finally, thematic analysis of open-ended responses revealed opportunities for model refinement. Teachers suggested including differentiated training for pre-service versus in-service educators, practical modules for AI tool usage, and integration of case studies illustrating best practices. Recommendations also included ongoing evaluation, feedback loops, and adaptation to emerging AI technologies, underscoring the dynamic nature of AI in education.

In summary, the results demonstrate that the proposed pedagogical model is both relevant and feasible for integrating AI technologies into teacher education and professional training. Quantitative findings highlight positive

perceptions across model components, significant relationships between AI literacy and perceived effectiveness, and variations across teaching experience. Qualitative findings provide contextualized insights into practical application, ethical considerations, and institutional enablers. The integration of these data sets validates the proposed model as a comprehensive framework for preparing educators to use AI responsibly, effectively, and reflectively in contemporary teaching environments [12].

The findings of this study reveal several critical insights into the integration of AI technologies in teacher education and professional training, highlighting the complex interplay between teacher competence, pedagogical design, ethical considerations, and institutional support. The positive perception of the proposed pedagogical model across pre-service, early-career, and experienced educators suggests a broad consensus regarding the relevance and necessity of structured guidance for AI integration. Teachers consistently emphasized the importance of developing AI literacy not only as a technical skill but also as a pedagogical competence, which aligns with the growing literature on AI-augmented teacher preparation (Buta-Baeva, 2025; Zhang et al., 2025). The quantitative results, particularly the significant correlations between AI literacy and perceived model effectiveness, reinforce the central role of teacher knowledge in shaping successful AI adoption. These findings corroborate recent research suggesting that teacher readiness, including confidence and experience with AI tools, strongly predicts both engagement with AI technologies and the quality of pedagogical implementation [13].

The qualitative findings provide a nuanced understanding of the factors influencing AI integration. Participants highlighted scaffolded learning experiences, reflective practice, and hands-on engagement with AI tools as crucial to developing competence. This aligns with prior studies emphasizing that experiential learning, rather than theoretical knowledge alone, is central to cultivating both technical proficiency and pedagogical judgement (Filiz et al., 2025). The interviews also revealed that teachers view AI as a tool for enhancing, rather than replacing, human judgment, which supports frameworks advocating for AI-mediated pedagogy that augments reflective decision-making, differentiated instruction, and personalized feedback (Baker et al., 2022; Alharthi et al., 2024). Such findings underscore the need for models that balance technological innovation with pedagogical integrity, ensuring that AI tools serve as a means of enhancing human-centered education rather than supplanting educators' professional agency.

The integration of AI-mediated learning modalities, including intelligent tutoring systems, adaptive learning platforms, and virtual simulations, was perceived as highly valuable but contingent on proper scaffolding and instructional design. Participants emphasized that AI tools must be embedded within a pedagogically coherent framework, rather than employed as stand-alone

technologies. This finding aligns with recent studies demonstrating that AI tools are most effective when paired with human-led instruction, guided reflection, and alignment with curricular goals (Gupta et al., 2024; McNally et al., 2022). Furthermore, the differential perception of AI-mediated modalities across teaching experience groups highlights the importance of tailoring professional development to teachers' prior knowledge and expertise. Experienced educators may require advanced modules focusing on strategic integration, whereas pre-service teachers benefit from guided exposure and scaffolded interaction with AI systems. This stratified approach ensures that teacher preparation is both efficient and equitable, accommodating the diverse competencies and professional trajectories of participants [14].

The iterative process of model development, involving qualitative analysis, quantitative validation, and expert feedback, ensured that the pedagogical framework is both evidence-based and contextually relevant. Teachers' recommendations for differentiated professional development, hands-on modules, and case-based instruction informed the model's structure, enhancing its practical applicability. Furthermore, the model's design incorporates mechanisms for continuous evaluation and adaptation, acknowledging that AI technologies evolve rapidly and that teacher training programs must remain responsive to emerging tools, pedagogical practices, and ethical standards (Chaudhry et al., 2023; McNally et al., 2022). The dynamic nature of the model reflects contemporary trends in educational research emphasizing adaptive, learner-centered, and technology-mediated professional development [15].

The results also highlight opportunities for future research and policy development. Longitudinal studies are needed to assess the sustained impact of AI integration on teacher practice, student outcomes, and institutional processes. Research should examine the scalability of AI-mediated professional development programs, the transferability of model components across educational contexts, and the effectiveness of specific AI tools in enhancing instructional quality. Policy-level research should explore strategies for equitable access, ethical governance, and alignment with national educational standards, ensuring that AI adoption supports inclusive, high-quality learning experiences for all students.

The study's implications extend beyond immediate teacher training contexts. By demonstrating how AI can be integrated in an ethically informed, pedagogically coherent manner, the research contributes to global discourse on responsible AI in education, offering guidance for curriculum designers, policymakers, and educational technology developers. The validated model provides a replicable framework for institutions seeking to implement AI-enhanced teacher training, highlighting the centrality of teacher competence, reflective practice, and institutional alignment in successful adoption.

The conclusions drawn from this study emphasize the practical and theoretical significance of the proposed model. Teacher preparedness, ethical awareness, scaffolded professional development, and institutional support emerge as essential factors for effective AI integration. The findings provide actionable insights for policymakers, educational leaders, and teacher educators, informing the design of training programs, resource allocation, and curriculum development in the era of AI-enhanced education.

The pedagogical model is designed to remain adaptive, responsive, and sustainable, ensuring that educators can navigate rapid technological changes while maintaining pedagogical integrity and fostering student-centered learning. The integration of AI into teacher education, when guided by this evidence-based framework, has the potential to transform teaching practice, enhance learning outcomes, and prepare educators for the challenges and opportunities of 21st-century education.

Conclusion

The study demonstrates that the integration of AI technologies in teacher education and professional training requires a multi-dimensional, evidence-based approach that accounts for teacher competencies, instructional design, ethical considerations, AI-mediated learning modalities, reflective practice, and institutional support. The proposed pedagogical model synthesizes qualitative and quantitative findings, providing a comprehensive framework that addresses the complex challenges of AI integration while leveraging its potential to enhance educational practice. Teachers across experience levels consistently identified AI literacy, scaffolded engagement, and ethical awareness as central to successful adoption, reinforcing the model's focus on holistic professional development and responsible technology use.

The findings underscore the significance of teacher competence in shaping the effectiveness of AI integration. AI literacy, encompassing technical skills, pedagogical application, and ethical evaluation, emerged as the strongest predictor of perceived model effectiveness. Teachers with higher AI literacy reported greater confidence in using AI tools, more strategic integration into lesson planning, and a stronger sense of agency in the classroom. This highlights the need for teacher education programs to incorporate structured AI-focused training modules that balance theoretical understanding with hands-on application, reflective exercises, and scenario-based learning. Such programs should be differentiated to accommodate varying levels of prior experience and expertise, ensuring equitable access to professional development opportunities [18].

Reflective practice and continuous professional growth were identified as key mechanisms for sustaining AI integration. Teachers valued opportunities to engage in collaborative reflection, evaluate instructional outcomes, and adapt practices based on feedback and emerging technological developments. The

model incorporates structured reflection cycles, peer collaboration, and iterative evaluation as integral components, fostering adaptive expertise and promoting lifelong learning. This approach aligns with constructivist and adult learning theories, emphasizing the co-construction of knowledge, critical reflection, and the dynamic nature of professional practice.

The findings also reveal the importance of addressing differential readiness among educators. Variations in AI literacy, experience, and institutional support necessitate differentiated professional development strategies, ensuring that both novice and experienced teachers can effectively leverage AI technologies. Tailoring training to individual needs enhances engagement, confidence, and the practical application of AI tools, thereby increasing the likelihood of successful integration and long-term sustainability.

Overall, the study validates the proposed pedagogical model as a comprehensive framework for AI integration in teacher education and professional training. The model balances technological innovation with pedagogical integrity, ethical responsibility, and systemic support, providing actionable guidance for educators, institutions, and policymakers. Its adoption has the potential to enhance teacher effectiveness, support personalized and differentiated instruction, and prepare educators for the evolving demands of 21st-century education.

The pedagogical model is positioned to guide the development of AI-mediated professional development programs that are both evidence-based and adaptable to diverse educational contexts. By embedding AI literacy, ethical awareness, reflective practice, and institutional alignment within a cohesive framework, the model promotes responsible and effective AI integration, fostering educators' professional growth and improving learning outcomes. This approach addresses both the opportunities and challenges identified in the literature, providing a robust foundation for future research, policy development, and practical implementation.

Future research should investigate the longitudinal impact of the model on teacher practice, student learning outcomes, and institutional processes. Studies examining scalability, adaptability across educational contexts, and the integration of emerging AI technologies will be critical in refining and sustaining the model. Policy-level investigations should focus on equitable access, ethical governance, and alignment with national and international educational standards, ensuring that AI adoption promotes inclusive, high-quality education.

In conclusion, the integration of AI technologies in teacher education, when guided by a comprehensive pedagogical model, holds significant promise for enhancing professional competencies, supporting differentiated instruction, and fostering reflective, adaptive teaching. The model developed and validated in this study provides a theoretically grounded, empirically supported framework that addresses teacher competence, pedagogical design, ethical considerations,

AI-mediated learning modalities, reflective practice, and institutional support. Its adoption can facilitate responsible and effective AI integration, preparing educators to navigate the complexities of contemporary education while upholding the principles of equity, ethical responsibility, and pedagogical integrity.

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МҰҒАЛІМДЕРДІ ДАЯРЛАУ МЕН КӘСІБИ БІЛІКТІЛІГІН АРТТЫРУ ЖҮЙЕСІНЕ ЖАСАНДЫ ИНТЕЛЛЕКТ ТЕХНОЛОГИЯЛАРЫН ЕНГІЗУДІҢ ПЕДАГОГИКАЛЫҚ НЕГІЗДЕРІ

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Аңдатпа. Жасанды интеллект (ЖИ) технологияларының қарқынды дамуы мұғалімдерді оқыту мен кәсіби даярлауда бұрын-соңды болмаған мүмкіндіктер мен қиындықтар туғызды. Бұл зерттеу ЖИ технологияларын білім берушілердің дайындығы мен кәсіби дамуына интеграциялаудың кешенді педагогикалық моделін әзірлеу мен негіздеуге бағытталған. Ұсынылған модель ЖИ құралдарын оқыту мақсаттарымен, мұғалімдердің құзыреттілігімен және рефлексивті тәжірибесімен үйлестіруге баса назар аударады, бұл педагогикалық дағдылар мен цифрлық сауаттылықты арттырады. Жүйелі әдебиеттерге шолу және эмпирикалық зерттеу арқылы зерттеу технологиялық дайындықты, оқу бағдарламасын жобалауды және мұғалімдердің мотивациясын қоса алғанда, тиімді ЖИ интеграциясына әсер ететін маңызды факторларды анықтайды. Модельге жұмысқа дейінгі және жұмыстағы мұғалімдер үшін жекелендірілген және интерактивті оқу тәжірибесін қамтамасыз ету үшін ЖИ-ге негізделген аналитика, бейімделгіш оқыту жүйелері, виртуалды модельдеу және интеллектуалды репетиторлық платформалар кіреді. Бұл модельді енгізу деректерге негізделген шешім қабылдауды дамытуға, сыныпты басқару стратегияларын жақсартуға және оқытуды жобалау мүмкіндіктерін арттыруға бағытталған. Зерттеу нәтижелері ЖИ-мен күшейтілген осы педагогикалық шеңберде оқытылған мұғалімдердің жоғары белсенділікті, оқыту тиімділігін және цифрлық оқу орталарына бейімделуді көрсететінін көрсетеді. Сонымен қатар, модель білім беруде жасанды интеллектті пайдалануға қатысты этикалық, әлеуметтік және практикалық мәселелерді қарастырады, жауапты және рефлексивті түрде қабылдауды ынталандырады. Зерттеу жақсы құрылымдалған педагогикалық модельді басшылыққа алған кезде, мұғалімдерді оқытуға жасанды интеллект технологияларын интеграциялау кәсіби құзыреттіліктерді айтарлықтай жақсартып алады және педагогтарды 21 ғасырдағы сыныптардың талаптарына дайындай алады деген қорытындыға

келеді. Жасанды интеллект арқылы мұғалімдерді даярлау бағдарламаларын тұрақты енгізуді және үздіксіз жетілдіруді қолдау үшін саясат, оқу бағдарламасын әзірлеу және болашақ зерттеулер бойынша ұсыныстар берілген.

Тірек сөздер: жасанды интеллект интеграциясы, мұғалімдерді оқыту, кәсіби даму, педагогикалық модель, сандық сауаттылық, бейімделгіш оқыту, интеллектуалды репетиторлық, білім беру инновациясы

ПЕДАГОГИЧЕСКИЕ ОСНОВЫ ИНТЕГРАЦИИ ТЕХНОЛОГИЙ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В СИСТЕМУ ПОДГОТОВКИ И ПРОФЕССИОНАЛЬНОГО ОБУЧЕНИЯ ПЕДАГОГОВ

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Аннотация. Быстрое развитие технологий искусственного интеллекта (ИИ) создало беспрецедентные возможности и проблемы в педагогическом образовании и профессиональной подготовке. Данное исследование посвящено разработке и обоснованию комплексной педагогической модели интеграции технологий ИИ в обучение и профессиональное развитие педагогов. Предлагаемая модель делает акцент на согласовании инструментов ИИ с образовательными целями, компетенциями учителей и рефлексивной практикой для повышения как педагогических навыков, так и цифровой грамотности. Благодаря систематическому обзору литературы и эмпирическому исследованию, исследование выявляет критические факторы, влияющие на эффективную интеграцию ИИ, включая технологическую готовность, разработку учебных программ и мотивацию учителей. Модель включает в себя аналитику на основе ИИ, адаптивные системы обучения, виртуальное моделирование и интеллектуальные платформы обучения для обеспечения персонализированного и интерактивного обучения для будущих и работающих учителей. Внедрение этой модели направлено на стимулирование принятия решений на основе данных, совершенствование стратегий управления классом и расширение возможностей педагогического проектирования. Результаты показывают, что учителя, прошедшие обучение в рамках этой педагогической модели, основанной на ИИ, демонстрируют более высокую вовлеченность, более высокую эффективность обучения и лучшую адаптируемость к цифровой среде обучения. Кроме того, модель учитывает этические, социальные и практические аспекты, связанные с использованием ИИ в образовании, способствуя ответственному и осмысленному внедрению. Исследование приходит к выводу, что интеграция технологий ИИ в педагогическое образование, осуществляемая на основе четко структурированной

педагогической модели, может значительно повысить профессиональные компетенции и подготовить педагогов к требованиям школьных классов XXI века. Представлены рекомендации по политике, разработке учебных программ и будущим исследованиям для поддержки устойчивого внедрения и постоянного совершенствования программ подготовки учителей с использованием ИИ.

Ключевые слова: интеграция ИИ, педагогическое образование, профессиональное развитие, педагогическая модель, цифровая грамотность, адаптивное обучение, интеллектуальное обучение, образовательные инновации

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