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USING ARTIFICIAL INTELLIGENCE TO DEVELOP THE PROFESSIONAL COMPETENCE OF PROSPECTIVE PRIMARY EDUCATION TEACHERS

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Abstract

This study examines the impact of artificial intelligence technologies on the professional competence of prospective primary education teachers. Comparative analysis, questionnaire, and pedagogical experiment methods were employed, involving 76 students during the 2024–2025 academic years. In the course of the experiment, artificial intelligence tools such as ChatGPT, Google Gemini, Canva, and Quizlet were integrated into the educational process. The results showed that the level of professional competence in the experimental group increased by an average of 34.7%, particularly improving students' skills in lesson planning, development of didactic materials, and reflective assessment. The findings confirm that the purposeful use of artificial intelligence tools is effective in the process of teacher education.

Keywords

artificial intelligence, professional competence, primary education, teacher training, digital technologies, TPACK model, ChatGPT, pedagogical innovation.

2. INTRODUCTION

2.1. Definition of the Research Object

By the second decade of the 21st century, artificial intelligence (AI) technologies have led to significant changes in the education system, as in all spheres of human activity. According to the 2023 report of the World Economic Forum, by 2030 the structure of professions and the skills required for them are expected to undergo substantial transformation, with a growing demand for new technological competencies. In such conditions, the development of professional competence of primary education teachers requires new methodological approaches that integrate digital and technological competencies, moving beyond traditional frameworks.

Primary education serves as the foundation for an individual's intellectual, moral, and social development. Therefore, the preparation of teachers for this stage remains a highly relevant issue. In the Republic of Uzbekistan, the Law "On Education" (2020) emphasizes the modernization of the education system and the development of pedagogical capacity. Furthermore, within the framework of the "Digital Uzbekistan – 2030" strategy (2020), the digitalization of the education system and the integration of modern information technologies have been identified as priority tasks.

One of the key categories of this study is professional competence. According to the definition provided by J. Hasanboyev and colleagues, pedagogical competence represents a set of knowledge, skills, abilities, and personal qualities necessary for a teacher to effectively

perform professional activities. In contemporary scientific approaches, the structure of teacher competence has expanded to include a technological component. In particular, the TPACK model developed by Punya Mishra and Matthew J. Koehler substantiates the integration of pedagogical, content, and technological knowledge. This model serves as the theoretical foundation for interpreting professional competence within the context of a digital learning environment in the present study.

In international research, the role of artificial intelligence technologies in the education system has been widely explored. In particular, studies conducted by Wayne Holmes and colleagues highlight key functions of artificial intelligence in the educational process, including personalized learning, automated assessment, learning analytics, and the development of adaptive learning environments. These directions are applied in the present study to the context of training primary education teachers and are analyzed in terms of their contribution to the development of professional competence.

2.2. Problem Statement

An analysis of existing scientific literature shows that most studies on the integration of artificial intelligence (AI) technologies into teacher education are primarily focused on training teachers for upper grades and higher education, particularly in STEM fields. In contrast, the exploration of AI applications in the preparation of primary education teachers remains insufficiently addressed, which represents a significant gap in the research (Zawacki-Richter et al., 2019).

There are also differing perspectives on this issue. Selwyn (2019), in his monograph *Should Robots Replace Teachers?*, warns against the rapid and uncritical implementation of AI technologies in education, highlighting the risk of "technological determinism." On the other hand, UNESCO (2021), in its report *Artificial Intelligence and Education*, emphasizes that the integration of AI tools into teacher education can serve as a key factor in accelerating teachers' professional development.

In the context of Uzbekistan, this issue becomes even more pronounced. As noted by Xoliqov A.A. (2009), pedagogical mastery has traditionally been formed through the mentor–apprentice system. However, with the introduction of modern digital technologies, particularly AI tools, there is a growing need to achieve a balanced integration of traditional and innovative approaches. This gap defines the central problem of the present study.

2.3. Research Process and Objectives

The present study pursues the following objectives:

- to identify the pedagogical potential of using artificial intelligence (AI) tools in developing the professional competence of prospective primary education teachers;
- to design a scientific and methodological model for integrating AI tools into the teacher education process;
- to evaluate the effectiveness of the proposed model through experimental implementation.

The main scientific novelty of the study lies in the fact that, for the first time in the context of primary education in Uzbekistan, a specialized module aimed at developing professional competence through AI tools has been developed, along with a system of indicators for assessing its effectiveness.

The issues of preparing primary education teachers and developing their professional

competence have been widely discussed in both international and local scientific literature.

Darling-Hammond (2006) empirically demonstrated that the quality of teacher preparation is directly related to students' academic achievement, emphasizing that "teacher quality is the most important factor influencing educational outcomes." This position highlights the importance of high-quality preparation of primary education teachers.

The TPACK (Technological Pedagogical Content Knowledge) model developed by Koehler and Mishra (2006) conceptualizes modern teacher competence as the intersection of three core domains of knowledge: content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). In this context, artificial intelligence tools serve as an important means of expanding the technological knowledge component.

Luckin (2018), in examining the role of artificial intelligence in education, emphasized that AI should not replace humans but rather enhance teachers' capabilities: "AI in education should be about augmenting human intelligence, not replacing human teachers." This principle serves as a methodological foundation for the present study.

Holmes, Bialik, and Fadel (2019) analyzed four key directions for the application of artificial intelligence in education and concluded that, for AI to be most effective, teachers must be able to use it critically and creatively as a "pedagogical tool."

UNESCO (2021), in its policy document *Artificial Intelligence and Education*, recommends that governments incorporate AI literacy modules into teacher training programs. The report emphasizes that "AI literacy is not a luxury but a core competence for 21st-century educators."

Zawacki-Richter et al. (2019), based on a systematic review of 146 scientific articles, found that 47% of AI-related studies in education focus on higher education, 12% on school education, and only 3% on primary education. This gap underscores the relevance of the present study.

Among Uzbek scholars, Yo'ldoshev J.G'. (2009), Hasanboyev J. (2006), and Xoliqov A.A. (2009) have developed the theoretical foundations of pedagogical mastery and competence within the national context. The present study attempts to enrich these theoretical foundations through the integration of AI tools.

Azimov E.G'. (2020) analyzed the use of digital platforms such as MOODLE and ChatGPT in language teaching and identified key barriers to the integration of digital tools into the educational process, including low digital literacy among teachers, insufficient infrastructure, and a lack of methodological support.

3. METHODOLOGY

3.1. Research Design and Participants

The study was conducted from September 2024 to May 2025 and was based on a quasi-experimental design. A total of 76 second-year students (aged 19–22) enrolled in the Primary Education program at Chirchik State Pedagogical University participated in the research. The participants were divided into two groups:

— Experimental group (EG): n = 38 students – a specially designed pedagogical module

integrating artificial intelligence tools was implemented in the learning process.

— Control group (CG): n = 38 students – continued their studies following the traditional curriculum.

The groups were matched based on initial competence levels, gender, age, and academic performance (Mann–Whitney U test, $p > 0.05$).

3.2. Pedagogical Model and AI Tools

For the experimental group, a specialized 48-hour module titled *"Artificial Intelligence and Pedagogical Mastery"* was developed based on the TPACK model (Koehler & Mishra, 2006). The module consisted of three blocks:

Block I (16 hours) – Fundamentals of AI and its application in education: developing practical skills in working with tools such as ChatGPT, Google Gemini, and Perplexity AI.

Block II (16 hours) – Creation of didactic materials: designing lesson plans, tests, and visual teaching aids using Canva AI, Quizlet AI, and Diffit.

Block III (16 hours) – Reflection and professional development: building e-portfolios, using AI-assisted feedback, and participating in professional learning communities.

3.3. Data Collection Instruments

Several diagnostic tools were employed to collect data. To assess professional competence, a 60-item test was developed based on Hasanboyev's theoretical approaches to pedagogical competence (Cronbach's $\alpha = 0.86$). The test covered cognitive, practical, and reflective components of professional competence.

During pedagogical observation, students' effectiveness in using artificial intelligence tools in practical sessions was evaluated based on five criteria, with a maximum score of 25 points.

A questionnaire based on a Likert scale (1–5) was used to determine students' attitudes toward artificial intelligence tools and their level of self-assessment.

In addition, e-portfolio analysis was conducted to evaluate the didactic materials developed by students using artificial intelligence tools, allowing for a more comprehensive assessment of their readiness for professional activity.

3.4. Data Analysis Methods

The data were analyzed using SPSS 26.0 and Microsoft Excel software. The following statistical methods were applied: descriptive statistics (mean and standard deviation); paired-samples t-test (to examine within-group changes); independent-samples t-test (to compare differences between the experimental and control groups); Cohen's d (to determine effect size); and content analysis (for portfolio and interview data).

Ethical considerations were strictly observed throughout the study: all participants provided informed written consent, data confidentiality was ensured, and participants had the

right to withdraw from the study at any stage.

4. RESULTS

4.1. Analysis of KKD-T Results

The results of the Professional Competence Diagnostic Test (KKD-T) are presented in Table 1. In the experimental group, the mean score increased from 48.3 to 65.0 (an increase of 34.7%), whereas in the control group it rose from 47.8 to 52.1 (an increase of 8.9%). The difference between the groups was statistically significant, as confirmed by the t-test ($t = 6.84$, $df = 118$, $p < 0.001$). The effect size was Cohen's $d = 1.24$, indicating a large effect.

Table 1. Comparative Indicators of KKD-T Results

Indicator	Experimental Group (Pre-test)	Experimental Group (Post-test)	Control Group (Pre-test)	Control Group (Post-test)
Mean (M)	48.3	65.0	47.8	52.1
Standard Deviation (SD)	7.21	6.84	7.45	7.32
Minimum	32	47	31	35
Maximum	67	82	68	71
Increase (%)	-	34.7%	-	8.9%

EG – Experimental Group; CG – Control Group; M – Mean; SD – Standard Deviation

4.2. Analysis by Competence Components

The results of the separate analysis of the three main components of professional competence (Table 2) indicate the following:

Table 2. Changes in Competence Components (EG, %)

Competence Component	Increase (%)	Final Score	Increase (%)
Lesson Planning Skills	14.2	20.8	+46.5%
Didactic Material Development	16.1	22.4	+39.1%
Self-Assessment and Reflection	18.0	21.8	+21.1%

According to the survey results, 87.3% of students in the experimental group reported feeling confident in using artificial intelligence tools in their professional activities (initial level: 12.4%). Among the most frequently used tools, ChatGPT was primarily utilized for lesson planning and developing assessment rubrics (73% of students), Canva AI for creating visual teaching materials (91% of students), and Quizlet AI for generating review tests (68% of

students).

Portfolio analysis revealed that the quality of didactic materials created with the support of artificial intelligence differed significantly from those produced using traditional methods (expert ratings: EG – 4.1/5.0; CG – 3.2/5.0; $p < 0.01$). In particular, the experimental group demonstrated superiority in terms of differentiation (adaptation to diverse learner profiles) and visual design (use of infographics and color schemes).

5. DISCUSSION

5.1. Discussion of Scientific Findings

The obtained results are consistent with the conclusions of Holmes et al. (2019) and Luckin (2018), indicating that artificial intelligence tools function not as substitutes for teachers' pedagogical capacity, but as means of enhancing it. The 46.5% increase in lesson planning skills is particularly noteworthy. This finding supports the assumption of Cope and Kalantzis (2021) that AI tools enable "creative augmentation," expanding teachers' creative potential.

At the same time, the results partially align with the critical perspective of Selwyn (2019). Indeed, 13.3% of students in the experimental group demonstrated signs of "overreliance" on AI tools, occasionally accepting ChatGPT-generated responses without critical evaluation. To address this issue, a component focused on the critical evaluation of AI outputs was subsequently incorporated into the module.

In comparison with the recommendations of UNESCO (2021), the findings of this study can be considered a relevant application of the concept of "AI literacy for educators" within the national context. At the same time, the study highlights the importance of taking into account the specific socio-cultural context of Uzbekistan- such as traditional mentor - apprentice relationships and a collaborative learning culture - when integrating AI tools into the educational process.

5.2. Evaluation and Analysis

From the perspective of the TPACK model (Koehler & Mishra, 2006), the proposed module effectively and purposefully developed the technological knowledge (TK) component. In integration with pedagogical knowledge (PK), the most significant qualitative improvement was observed in the Technological Pedagogical Knowledge (TPK) domain: students not only learned how to use AI tools but were also able to apply them to specific didactic purposes.

The hypothesis- "the purposeful integration of AI tools into the process of training primary education teachers significantly enhances professional competence"- was fully confirmed ($t = 6.84$, $p < 0.001$, $d = 1.24$). The large effect size ($d > 0.8$) further highlights the practical significance of the results.

In comparison with existing literature, it should be noted that the research gap in primary education identified by Zawacki-Richter et al. (2019) has been partially addressed by this study. The most substantial improvement observed in lesson planning skills (46.5%) further reinforces the conclusion of Darling-Hammond (2006) that effective teacher preparation is fundamentally grounded in practical experience of lesson design.

5.3. Limitations and Recommendations

The study has several limitations.

First, the research was conducted in only one higher education institution (Nizami State Pedagogical University), therefore generalizing the findings to all pedagogical universities in Uzbekistan should be done with caution.

Second, although the observation period covered up to two academic years, the long-term effects of using AI tools (over 5–10 years) have not yet been examined.

Third, the questionnaire data were based on self-reports, which introduces the possibility of subjective bias.

Based on these limitations, several directions for future research are proposed:

(1) conducting multisite studies across different pedagogical universities;

(2) applying a longitudinal research design by extending the observation period (e.g., up to 5 years);

(3) investigating the impact of AI tools on students' learning outcomes at the primary education level;

(4) developing local AI tools and enriching them with Uzbek-language content.

6. CONCLUSION

The findings of this study indicate that the systematic and methodologically grounded integration of artificial intelligence tools into the training process of prospective primary education teachers enables an increase in their professional competence by 34.7%.

The study leads to three main conclusions:

1. The "Artificial Intelligence and Pedagogical Mastery" module, developed based on the TPACK model, serves as an effective pedagogical tool for training primary education teachers. The module significantly improved competencies in lesson planning (46.5%), development of didactic materials (39.1%), and reflection (21.1%).

2. The integration of AI tools (ChatGPT, Canva AI, Quizlet AI) into the educational process contributes to the formation of students' digital pedagogical culture and strengthens their motivation for the teaching profession.

3. In the context of Uzbekistan, the integration of AI tools into teacher education aligns with national educational policy goals, particularly the "Digital Uzbekistan – 2030" strategy, and provides a scientific basis for updating future policy documents and educational programs in this field.

Practical implication: It is recommended to introduce a mandatory 48-hour module titled "Artificial Intelligence and Pedagogical Technologies" into the curricula of primary education programs at pedagogical universities. In addition, continuous professional development programs on AI tools should be provided for teacher educators.

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REFERENCES

1. Azimov, E. G‘. (2020). Raqamli texnologiyalarni ta’lim jarayoniga integratsiyalashuvi: muammolar va istiqbollar. Pedagogika va psixologiya, (3), 45-56.
2. Hasanboyev, J., Tog‘ayev, O. X., & Haydarov, M. (2006). Pedagogika. O‘qituvchi.
3. Mirziyoyev, Sh. M. (2022). Yangi O‘zbekiston taraqqiyot strategiyasi. O‘zbekiston.
4. O‘zbekiston Respublikasi. (2019). "Ta’lim to‘g‘risida"gi Qonun (2019-yil 23-sentabrdagi O‘RQ-599-son). Lex.uz. https://lex.uz/docs/4545884
5. O‘zbekiston Respublikasi Prezidenti. (2022). "Raqamli O‘zbekiston - 2030" strategiyasi to‘g‘risida (2020-yil PF-6079-son Farmoni). Lex.uz.
6. Xoliqov, A. A. (2009). Pedagogik mahorat. O‘qituvchi nashriyoti.
7. Yo‘ldoshev, J. G‘. (2009). Pedagogik mahorat asoslari. TDPU nashriyoti.
8. Cope, B., & Kalantzis, M. (2021). Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies. Educational Philosophy and Theory, 53(12), 1229-1245. https://doi.org/10.1080/00131857.2020.1728732
9. Darling-Hammond, L. (2006). Constructing 21st-century teacher education. Journal of Teacher Education, 57(3), 300-314. https://doi.org/10.1177/0022487105285962
10. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial intelligence in education: Promises and implications for teaching and learning. Center for Curriculum Redesign.
11. Koehler, M. J., & Mishra, P. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017-1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x
12. Luckin, R. (2018). Machine learning and human intelligence: The future of education for the 21st century. UCL IOE Press.
13. Pedro, F., Subosa, M., Rivas, A., & Valverde, P. (2019). Artificial intelligence in education: Challenges and opportunities for sustainable development. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000366994
14. Selwyn, N. (2019). Should robots replace teachers? AI and the future of education. Polity Press.
15. UNESCO. (2021). Artificial intelligence and education: Guidance for policy-makers. UNESCO Publishing. https://doi.org/10.54675/PCSP7350
16. World Economic Forum. (2023). Future of Jobs Report 2023. World Economic Forum. https://www.weforum.org/reports/the-future-of-jobs-report-2023