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DEVELOPING AI-SUPPORTED PROFESSIONAL COMPETENCE OF PRE-SERVICE ENGLISH LANGUAGE TEACHERS IN 21ST CENTURY EDUCATION

The article addresses the problem of forming AI-based professional competence of pre-service English language teachers in the context of educational digitalization in the Republic of Kazakhstan. The aim of the study is to experimentally substantiate the pedagogical conditions, methods and effectiveness of developing AI competence among the pre-service teachers. The research employed a complex of methods including theoretical analysis, questionnaire survey, observation, expert evaluation, pedagogical experiment and mathematical statistics. The study was conducted at M.Auezov South Kazakhstan University and South Kazakhstan pedagogical university named after O. Zhanibekov. The participants included third-year students enrolled in the educational program Foreign Language: two foreign languages, as well as university instructors. In total, 148 students took part in the study (control group-76 students; experimental group -72 students), along with 27 teachers. During the formative stage, the experimental group systematically implemented AI-based pedagogical technologies, including AI-supported flipped classroom, project-based learning, microteaching with AI feedback, learning analytics and automated assessment. The results demonstrated a statistically significance increase in the high and sufficient levels AI competence in the experimental group, while no substantial changes were observed in the control group. The findings that AI-based professional competence does not develop spontaneously but requires purposeful and systematic pedagogical intervention. The results of the study provide a basis for developing practical recommendations aimed at improving the content of pre-service English teacher education and integrating digital pedagogical technologies into educational process.

Keywords: artificial intelligence, educational digitalization, pre-service English language teacher, professional competence, AI competence, digital pedagogy.

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XXI ғасыр білім беру жағдайында болашақ ағылшын тілі мұғалімдерінің жасанды интеллектіге негізделген кәсіби құзыреттілігін дамыту

Мақалада Қазақстандағы білім беру жүйесінің цифрлық трансформациясы жағдайында болашақ ағылшын тілі мұғалімдерінің жасанды интеллектіге негізделген кәсіби құзыреттілігін қалыптастыру мәселесіне арналған. Зерттеудің мақсаты-болашақ мұғалімдердің ЖИ-құзыреттілігін қалыптастырудың педагогикалық шарттарын әдіс-тәсілдерін және олардың тиімділігін эксперименттік тұрғыда негіздеу. Зерттеу барысында теориялық талдау, сауалнама, бақылау, сараптамалық бағалау, педагогикалық эксперимент және математикалық статистика әдістері кешенді түрде қолданылды. Зерттеу М.Әуезов атындағы Оңтүстік Қазақстан университетінде және Ө. Жәнібеков атындағы Оңтүстік Қазақстан педагогикалық университетінде жүргізілді. Экспериментке «Шетел тілі: екі шетел тілі» білім беру бағдарламасының 3-курс студенттері мен жоғары оқу орны оқушылары қатысты Жалпы зерттеуге 148 студент бақылау тобы-76 студент, эксперименттік топ-72 студент және 27 оқытушы қатысты. Қалыптастырушы кезеңде эксерпиментік топта жасанды интеллект қолдауымен ұйымдастырылған төңкерілген сынып моделі, жобалық оқыту әдісі, жасанды интеллект негізіндегі кері байланыспен микросабақ жүргізу, оқу аналитикасы және автоматтандырылған бағалау жүйелері сияқты жасанды интеллектіге негізделген педагогикалық технологиялар жүйелі түрде енгізілді. Зерттеу нәтижелері эксперименттік топта ЖИ-құзыреттіліктің жоғары және жеткілікті деңгейлерінің статистикалық тұрғыдан мәнді артқанын, ал бақылау тобында айтарлықтай өзгерістердің болмағанын көрсетті. Алынған деректер жасанды интеллектіге негізделген кәсіби құзыреттіліктің өздігінен қалыптаспайтынын, оны дамыту үшін мақсатты әрі жүйелі педагогикалық ықпалдың қажет екенін дәлелдейді. Зерттеу қорытындылары болашақ ағылшын тілі мұғалімдерін даярлау мазмұнын жаңғыртуға және цифрлық педагогикалық технологияларды білім беру үдерісіне тиімді енгізуге арналған практикалық ұстанымдар әзірлеуге негіз болады.

Түйін сөздер: жасанды интеллект, білім беруді цифрландыру, болашақ ағылшын тілі мұғалімі, кәсіби құзыреттілік, ЖИ-құзыреттілік, цифрлық педагогика.

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Развитие профессиональной компетентности будущих учителей английского языка с поддержкой искуственного интеллекта в образовании XXI века

В статье рассматривается проблема формирования профессиональной компетентности будущих учителей английского языка на основе искусственного интеллекта в условиях цифровизации системы образования Казахстана. Цель исследования заключается в экспериментальном обосновании педагогических условий, методов и эффективности формирования ИИ-компетентности у будущих педагогов. В ходе исследования комплексно применялись методы теоретического анализа, анкетирования, наблюдения, экспертной оценки, педагогического эксперимента и математический статистики. Исследование проводилось в Южно-Казахстанском университете имени М. Ауэзова и Южно-Казахстанском педагогическом университете. Всего в исследоваии приняли участие 148 студентов (контрольная группа – 76 студентов; экспериментальная группа – 72 студента) и 27 преподавателей. На формирующем этапе в экспериментальной группе системно внедрялись педагогические технологии, основанные на искусственном интеллекте, включая модель перевёрнутого класса с поддержкой искусственного интеллекта, метод проектного обучения, проведение микропреподавания с обратной связью на основе искусственного интеллекта, учебная аналитика и системы автоматизированного оценивания. Результаты исследования показали статистически значимый рост высокого и достаточного уровней ИИ-компетентности у студентов эксперименталной группы при отсутствии существенных изменений в контрольной группе. Полученные данные доказывают, что профессиональная компетентность, основанная на использовании искуственного интеллекта, формируется не спонтанно, а в результате целенапрвленного и системного педагогического воздействия по совершенствованию содержания подготовки будущих учителей английского языка и внедрению цифровых педагогических технологий в образовательный процесс.

Ключевые слова: искуственный интеллект, цифровизация образования, будущий учитель английского языка, профессиональная компетентность, ИИ-компетентность, цифровая педагогика.

Introduction

At the present stage, the digitalization of education has become one of the leading directions in the development of the higher education system. The rapid advancement of information and communication technologies, particularly artificial intelligence (AI), has brought fundamental changes to the content and structure of pedagogical activity. These transformations impose new requirements on the system of training pre-service teachers.In the Republic of Kazakhstan, the digitalization of education has been identified as a strategic priority aimed at improving the quality of higher education and preparing internationally competitive specialists. Within this context, artificial intelligence is viewed as an important resource that enables the personalization of educational content, the analysis of learning outcomes, and the optimization of pedagogical decision-making.

Pre-service teachers of English must therefore demonstrate not only linguistic and methodological competence, but also digital pedagogical competence, including the ability to effectively integrate AI-based tools into the educational process. However, the issue of systematically forming professional competence through the use of artificial intelligence in pedagogical higher education institutions remains insufficiently explored. In this regard, the prospects for training pre-service foreign language teachers are increasingly associated with viewing artificial intelligence not merely as a technical tool, but as a strategic resource for professional development. AI-based instruction contributes to the enhancement of pre-service teachers' professional flexibility, digital adaptability, and innovative potential. Thus, the objectives of educational digitalization and human capital development underscore the particular relevance of forming AI-based professional competence in the training of pre-service foreign language teach ers. This direction represents one of the key prospects for modernizing the content of higher pedagogical education and shaping a contemporary teacher model.

Under conditions of ongoing socio-economic and technological change, the improvement of the quality of training pre-service specialists and the adaptation of their professional potential to new demands have become central priorities in the national development strategy. Accordingly, the strategic documents of the Republic of Kazakhstan consistently address issues related to the modernization of human resources, the alignment of higher education content with current technological trends, and the development of digital skills. In the Addresses to the Nation, the President of the Republic of Kazakhstan, Kassym-Jomart Tokayev, emphasizes that in the era of rapid global change, the knowledge acquired by university graduates may become outdated even before they enter the labor market. Consequently, the adaptation of educational programs to new social, economic, and technological conditions is identified as an urgent task facing responsible state authorities.

The President's Addresses place particular emphasis on the digital transformation of education, highlighting the need to improve distance learning infrastructure, enhance the efficiency of information systems, and implement the "Digital Teacher" initiative in order to accelerate the provision of high-quality education and the training of competitive professionals. These initiatives further reinforce the importance of developing digital competence among pre-service pedagogical staff. This is especially relevant in today's digital society, where the cognitive characteristics of Generation Z and Generation Alpha differ significantly from those of previous generations, necessitating new pedagogical approaches and innovative instructional solutions.

In addition, in the Address of the President of the Republic of Kazakhstan dated September 8, 2025, entitled "Kazakhstan in the Era of Artificial Intelligence: Key Challenges and Their Resolution through Radical Digital Transformation, " the effective use of artificial intelligence technologies is identified as a strategic resource capable of stimulating the development of the knowledge-based economy. The Head of State emphasized the ne cessity of expanding international cooperation in the field of artificial intelligence, training qualified professionals in this area, and strengthening the research potential of higher education institutions (State of the Nation Address, 2025). These priorities require the enhancement of AI-based professional training for pre-service pedagogical specialists, including foreign language teachers.

The Concept for the Development of Higher Education and Science in the Republic of Kazakhstan for 2023-2029 defines the medium-term priorities for the development of the higher education system. This document highlights key objectives such as the development of universities' digital infrastructure, the internationalization of the educational process, the improvement of lifelong learning models, the recognition of non-formal learning out-comes, and the enhancement of citizens' digital competence. These directions are aimed at accelerating the digital transformation of higher education institutions and increasing the level of digital preparedness among pre-service specialists.The necessity of developing teachers' digital competence is also substantiated at the international level through both scientific research and regulatory frameworks. The European Framework for the Digital Competence of Educators (DigCompEdu), the UNESCO ICT Competency Framework for Teachers, and the International Society for Technology in Education (ISTE) standards all emphasize the formation of digital and technological skills as an integral component of modern pedagogical practice.

These national and international policy documents demonstrate that the development of pre-service teachers' digital competence represents one of the most pressing scientific and pedagogical challenges of the present day. Recent studies indicate that under conditions of digitalization, a significant proportion of citizens including pedagogical staff exhibit insufficient levels of digital literacy. This situation reinforces the need for the purposeful and systematic formation of digital pedagogy and AI-based professional competence within the higher pedagogical education system.

The notion of teachers' digital competence and the active integration of artificial intelligence into education has been widely explored by scholars. For example, Holmes (2019) examined the adoption of intelligent search systems in higher education institution Researchers such as Nouri et al. (2020) analyzed the effectiveness of artificial intelligence in instructional practices, while Luckin (2016) argued that intelligent technologies reduce teachers' psycho-emotional workload by simplifying routine pedagogical tasks. Kessler (2018) addressed the enhancement of teachers' digital literacy through AI-based tools. In addition, Chen (2020) investigated machine learning and semantic search technologies designed to personalize learning experiences for individual users.

Literature review

At present, the process of educational digitalization has introduced significant changes into the content and structure of higher pedagogical education. In particular, the rapid development of artificial intelligence (AI) technologies necessitates reconsidering the formation of pre-service teachers' professional competence at a new scientific level. In this regard, both domestic and international scholars have increasingly focused on the AI-based professional training of pre-service pedagogical staff.

The history of the formation of artificial intelligence is closely connected with humanity's aspiration to model intellect, cognition, and thinking processes through technology. These ideas began to be systematically explored in the mid-twentieth century within the context of rapid scientific and technological progress. The theoretical foundations of artificial intelligence originate from the works of the British mathematician and logician Alan Turing. In his 1950 paper "Computing Machinery and Intelligence," he examined the possibility of machines being able to think and proposed what later became known as the Turing Test.This test represented one of the earliest scientific attempts to evaluate a machine's ability to engage in intellectual interaction comparable to that of a human.

The term "artificial intelligence" was first introduced into scientific discourse in 1956. It was proposed by the American scientist John McCarthy at the Dartmouth Conference held in the United States. This conference marked the establishment of artificial intelligence as an independent field of scientific research.During this period, researchers primarily focused on logical reasoning, symbolic computation, and the development of problem-solving algorithms. In the 1960s and 1970s, the first artificial intelligence programs and expert systems were developed. These systems aimed to model expert knowledge in specific domains such as medicine, engineering, and mathematics through sets of rules and algorithms. However, limitations in computational power and the lack of sufficient data constrained further progress in this area. Although interest in artificial intelligence temporarily declined during the 1980s and 1990s, this period witnessed the active development of machine learning, neural networks, and statistical methods. These approaches later became the foundation for a renewed advancement of artificial intelligence.At the beginning of the twenty-first century, the emergence of big data, high-performance computing systems, and deep neural networks elevated the development of artificial intelligence to a new level. Today, artificial intelligence is widely applied in fields such as natural language processing, image recognition, education, medicine, economics, and industry.

Thus, the history of artificial intelligence reflects a complex scientific evolution consisting of several stages of continuous development. At present, artificial intelligence is not merely a technical tool but an important phenomenon influencing social, cultural, and educational domains.According to contemporary scientific perspectives, artificial intelligence is defined as computing systems capable of performing human-like cognitive processes-such as learning, adaptation, information synthesis, self-improvement, and solving complex problems-through the processing of data (Popenici & Kerr,2017).

In international research, artificial intelligence in education is primarily viewed as a tool for personalized learning, formative assessment, learning analytics, and the development of pedagogical reflection. Wayne Holmes(2016), analyzing the pedagogical potential of artificial intelligence, emphasizes that AI should not be regarded as a technology that replaces teachers, but rather as an intellectual tool that supports and enhances teachers' professional practice. According to the scholar, AI enables data-driven decision-making in the teaching process and contributes to the development of pre-service teachers' professional autonomy.

The role of artificial intelligence in fostering pedagogical reflection is extensively explored in the works of Rose Luckin (2016). The researcher highlights that AI-based tools allow teachers to conduct in-depth analyses of learners' educational activities, identify cognitive difficulties, and adapt instructional strategies accordingly. From this perspective, AI literacy is considered a mandatory component of pre-service teachers' professional competence. At the same time, Neil Selwyn(2024) adopts a critical stance toward educational digitalization, stressing that the integration of artificial intelligence into the learning process must be strictly subordinated to pedagogical objectives. According to the scholar, the application of AI technologies without a sound methodological foundation fails to produce the desired educational outcomes.Therefore, it is essential to prepare pre-service teachers for the conscious, critical, and ethical use of artificial intelligence.

The issue of developing pre-service teachers' digital and AI-related competence is also reflected in the European DigCompEdu framework proposed by Redecker (2022). The author emphasizes that the ability to pedagogically and effectively use digital technologies, including artificial intelligence, constitutes a core element of the modern teacher's professional profile.

Within the context of foreign language teacher education, the significance of artificial intelligence tools is particularly pronounced. Research indicates that AI-based automated writing assessment systems, speech recognition technologies, and intelligent learning platforms contribute to the development of pre-service English language teachers' methodological and digital competence. John Hattie(2007), emphasizing the high effectiveness of immediate feedback in learning, identifies artificial intelligence as a tool capable of systematically ensuring this process .

At the international level, the application of artificial intelligence in education is also widely addressed in UNESCO policy documents. According to UNESCO's position, artificial intelligence does not diminish the teacher's role but rather expands pedagogical opportunities. The organization advocates for the ethical, inclusive, and human-centered integration of AI technologies into teacher education systems .

In Kazakhstan, research on educational digitalization and teacher training has intensified in recent years. Domestic scholars emphasize that the integration of digital technologies into higher education contributes to the development of pre-service teachers' professional mobility, innovative thinking, and pedagogical re-flection. However, the majority of national studies focus on general digital competence, while the issue of forming AI-based professional competence remains insufficiently systematized. In the field of English language teacher education, several domestic studies highlight the importance of preparing pre-service teachers to operate in digital environments and master innovative technologies. Nevertheless, these works do not fully address the systematic instructional and methodological integration of artificial intelligence tools. The shift toward student-centered education in Kazakhstan has led to a redefinition of pedagogical roles within higher education. AI-based technologies contribute to adaptive and interactive learning models, replacing passive knowledge transmission with active student engagement. In English language teaching, driven mobile applications and conversational chatbots represent a significant area of application, providing real-time feedback, supporting speaking and listening skills, and facilitating interactive communication (Y.Saidibragimova, 2024).Thus, an analysis of domestic and international scholarly literature demonstrates that the use of artificial intelligence in forming the professional competence of pre-service English language teachers is both scientifically grounded and highly relevant.At the same time, under the conditions of Kazakhstan's educational system, there remains a need for experimental substantiation of the content, models, and pedagogical conditions for developing Al-based professional competence in pre-service English language teacher training.

In the works of Salybekova F.M. et al. (2021), which examine the preparation of pedagogical staff within the national scientific context, the authors emphasize the necessity of systematically applying digital technologies in the formation of pre-service foreign language teachers' professional competence. The researchers argue that the digital environment plays a decisive role in fostering innovative pedagogical thinking among pre-service teachers. An analysis of additional scholarly perspectives indicates that the integration of artificial intelligence into the system of pre-service English language teacher education is supported by both international and national academic communities. Artificial intelligence is thus defined as a strategic resource that enhances pre-service teachers' professional competence, strengthens pedagogical reflection, and enables effective professional activity within the digital educational environment.

Materials and methods

The theoretical foundation of the study is based on contemporary scientific concepts related to the digitalization of education and the integration of artificial intelligence into the educational process, as well as pedagogical and psychological theories, theories of pedagogical education, and the competence-based approach to professional training. The research draws upon scholarly works devoted to the application of artificial intelligence tools in education, the formation of pre-service teachers' digital and AI-based professional competence, and the use of intelligent technologies in foreign language teaching.

The study is grounded in the assumption that the training of pre-service English language teachers should focus on understanding the philosophical, psychological, and pedagogical foundations of artificial intelligence application; mastering the principles of digital pedagogy; developing skills for the critical and conscious use of AI technologies; adopting a facilitative teaching approach and enhancing the ability to design project-based and research-oriented learning tasks using artificial intelligence tools.

The empirical research was conducted within the framework of the bachelor's degree educational program "Foreign Language: Two Foreign Languages". The research sites included M. Auezov South Kazakhstan University and South Kazakhstan Pedagogical University named after O. Zhanibekov. The study utilized instructional and methodological complexes for psychological-pedagogical and specialized methodological disciplines, methodological guidelines for digital pedagogy and AI-based instruction, best pedagogical practices implemented in Kazakhstan's schools, as well as the results of experimental research.

The main research methods included:

- control questionnaires aimed at identifying pre-service English teachers' level of knowledge, understanding and attitudes toward artificial intelligence;
- survey questionnaires designed to assess students' awareness of the significance of AI technologies in their pre-service professional activities;
- mixed methods combining quantitative and qualitative data analysis;

To determine the level of formation of AI-based professional competence among pre-service English language teachers, psychological and pedagogical diagnostic were conducted, including:

- assessment of students' understanding of artificial intelligence, its educational potential, and its application in school pedagogical practice;
- identification of students' awareness of the role and significance of AI technologies in foreign language teaching;
- evaluation of pre-service teachers' mastery AI-based instructional methods and technologies;
- analysis of students' methodological and technological developments (AI-supported lesson plans, projects, digital tasks) to assess their professional preparedness;
- examination of university instructors' perspectives on current trends and shortcomings in the digital and AI-based training of pre-service foreign language teachers;
- determination of students' readiness to use artificial intelligence through pedagogical observation, within results compared to expert evaluations.

To enhance the reliability of the research findings, the collected data were systematized, compared and analysed. The comprehensive set of methods employed made it possible to conduct a multifaceted assessment of the level of AI-based professional competence formation among pre-service English language teachers.

Results and discussion

The pedagogical experiment was conducted at M. Auezov South Kazakhstan University and South Kazakhstan Pedagogical University named after O. Zhanibekov. Third-year students enrolled in the educational program Foreign Language: Two Foreign Languages" participated in the experiment. A total of 148 students (control group – 76; experimental group – 72) and 27 instructors were involved at various stages of the study.

The experiment aimed to determine the effectiveness of forming Al-based professional competence among pre-service English language teachers, including Al literacy, digital pedagogy, methodological integration, assessment, reflection, and ethical awareness.

1. Identifying students' initial knowledge and understanding of artificial intelligence

At the diagnostic stage, students' understanding of artificial intelligence was examined using a control questionnaire method. The questions were structured into two content-based blocks:

- Block I – the concept of artificial intelligence, its role in the digitalization of education, and its functions in English language teaching;
- Block II – methods of applying AI tools, including lesson planning, task design, assessment, feedback, and ethical considerations.

The questions were designed in accordance with Bloom's taxonomy hierarchy (knowledge → comprehension → application→ analysis → synthesis → evaluation).

Table 1
Knowledge and understanding of AI-based competence among pre-service English language teachers (diagnostic stage. %)

AI competence components	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
AI concept and pedagogical potential	15	44	21	9	6	5
AI-based lesson planning	12	36	29	12	7	4
AI-based assessment and feedback	10	34	30	11	9	6
AI ethics and academic integrity	11	30	26	16	11	6
Average value	12.0	36.0	26.5	12.0	8.3	5.3

Source / Note: This table was compiled by the authors based on the analysis of materials.

The data presented in Table 1. Indicate that the majority of students demonstrate low to moderate levels of knowledge and understanding of artificial intelligence. The low representation of higher cognitive levels (analysis, synthesis and evaluation) suggests that pre-service teachers are not sufficiently prepared to apply AI tools in a pedagogically conscious, reflective and evidence-based manner.

2. Level of students' understanding of the significance of AI technologies.

Students' understanding of the professional significance of artificial intelligence was assessed using a questionnaire survey.

- In response to the question "Reasons for increasing relevance of AI in education" 29% of students identified four to five factors (digitalization, generative AI, globalization, labor market demands and data culture);
- 33% identified one to two factors;
- 38% experienced difficulty in providing an answer.

When answering the question "What does AI offer to school graduates?" only 8% of students identified seven to eight advantages, whereas 43% limited their responses to two to three advantages.

These findings indicate that students predominantly perceive artificial intelligence as a technical tool, while its connection with educational philosophy and instructional methodology remains weak.

3. Expert evaluation of the level of mastery of AI-based methods

The level of students' methodological application of AI tools was determined through expert evaluation conducted by experienced school teachers and university instructors. The assessment was carried out using a 100-point scale.

Table 2
Expert evaluation of the level of mastery of AI-based instructional methods (%)

Assessment parameters	High	Sufficient	Moderate	Low
Methodological use of AI in lessons	5.0	22.0	42.0	31.0
Task design using AI	6.5	19.0	41.0	33.5
AI-based assessment and feedback	8.0	21.0	38.0	33.0
Learning analytics	4.0	15.0	42.0	39.0
AI ethics and safety	5.5	17.0	40.0	37.5

Source / Note: This table was compiled by the authors based on the analysis of materials.

Table 2 demonstrates that for the majority of students, the methodological application of AI tools remains insufficiently developed, particularly in the areas of learning analytics and ethical considerations.

4. Initial indicators of the control and experimental groups

Table 3
Levels of AI-based competence (baseline stage)

Group	N	High	Sufficient	Moderate	Low
Control group	76	4 (5.3%)	12 (15.8%)	36 (47.4%)	24 (31.6%)
Experimental group	72	5(6.9%)	11 (15.3%)	37 (51.4%)	19 (26.4%)

Source / Note: This table was compiled by the authors based on the analysis of materials.

5. Statistical verification using the χ2 criterion (diagnostic stage)

Statistical verification using the chi-square (χ2) test was conducted in accordance with the Grabar-Krasnyanskaya methodology:

$$T = \frac{1}{n_1 n_2} \sum_{i=1}^{4} \frac{(n_1 Q_{2i} - n_2 Q_{1i})^2}{Q_{1i} + Q_{2i}}$$

Where: n_1=76, n_2=72

Control Group (CG): $Q_{1=}$ [4.12.36.24];

Experimental Group (EG):Q_2= [5,11,37,19]

Calculation result:

$T_{calculated}$ =0.64

At the significance level α=0.05 and degrees of freedom v=3, critical value is:

$T_{critical}$=7.815

Since 0.64<7.815, the null hypothesis is accepted, indicating that the control and experimental groups are statistically equivalent at the initial stage of the experiment.

6. Content of the formative stage

The formative stage was aimed at the purposeful and systematic development of artificial intelligence-based professional competence among pre-service English language teachers. At this stage, AI competence was regarded as an integral component of professional teacher training and was gradually and comprehensively integrated into the educational process. During the formative experiment, artificial intelligence was applied not merely as a technical tool but as a methodological resource of digital pedagogy.

In the experimental group, a set of modern At-based teaching methods and approaches was implemented, including:

- AI-supported Flipped classroom;
- Project-based learning (development of digital products using AI);
- Microteaching combined with AI-generated feedback;
- Prompt literacy;
- Automated writing and speaking assessment;
- Learning analytics;
- Ethical AI case studies;
- Lesson design based on the TPACK and SAMR models.

In the control group, instruction was conducted using traditional teaching methods.

In the experimental group, the educational process was organized on the basis of a complex of contemporary AI-driven pedagogical approaches. These methods were aimed at developing pre-service teachers AI literacy, digital pedagogy skills, methodological integration, assessment competence, reflective abilities, and ethical responsibility.

AI-supported Flipped classroom. The AI-supported flipped classroom approach was employed to enhance students' independent learning activities and to ensure more effective use of in-class time. Theoretical materials, video lectures, interactive tasks, and diagnostic tests were developed in advance using artificial intelligence tools and provided to students for self-directed study. Classroom sessions were devoted to deepening the acquired knowledge through problem-based analysis, discussions, and practical tasks. This approach facilitated the development of students' critical thinking, analytical skills, and reflective abilities.

Project-based Learning (development of digital products using AI). Within the framework of Project-Based Learning, students developed authentic pedagogical products using AI tools. In particular, pre-service teachers designed lesson plans, collections of digital tasks, assessment criteria and rubrics, as well as small-scale educational projects supported by artificial intelligence. This activity contributed to the development of students' pedagogical design skills, creativity, and collaborative work culture.

Microteaching + AI feedback. The microteaching format was enhanced through the integration of artificial intelligence based feedback. Students conducted short lesson fragments that were video-recorded and subsequently analyzed using AI tools. The AI-generated feedback provided recommendations regarding lesson structure, linguistic accuracy, clarity of instructions, and the level of interaction with students. This feedback was combined with instructor-led and peer reflection, creating favorable conditions for the development of pre-service teachers' self-assessment and professional reflection skills.

Development of prompt literacy. During the formative stage, particular emphasis was placed on the development of students' prompt literacy skills. Students learned to formulate effective prompts aligned with specific learning objectives, to refine and modify AI-generated responses, and to adapt them to pedagogical contexts. Prompt literacy was regarded as a key prerequisite for developing pre-service teachers' ability to interact with artificial intelligence in a conscious, critical, and effective manner.

Automated writing and speaking assessment. Automated assessment tools for writing and speaking were employed as an integral component of the formative assessment system. Students compared AI-generated assessment results with feedback provided by instructors and peers, analyzing their objectivity and methodological validity. This approach contributed to the development of students" assessment culture, argumentation skills, and their ability to provide fair and constructive feedback.

Application of learning analytics. Elements of learning analytics were used to analyze students' academic performance based on data-driven evidence. By examining the dynamics of learning outcomes, patterns of errors, and individual learning trajectories, students learned how to differentiate tasks and adjust teaching strategies accordingly. As a result, pre-service teachers developed data-informed pedagogical decision-making skills.

Ethical AI case study. Ethical aspects of artificial intelligence use were addressed through the case study method. Students analyzed authentic pedagogical situations related to academic integrity, data privacy, copyright, and fair assessment.

This activity was aimed at shaping pre-service teachers' professional and ethical positions.

Lesson design based on the TPACK and SAMR models**.** During the formative stage, lesson design was carried out based on the TPACK and SAMR models. Students analyzed the interrelationship between technology, pedagogy, and subject content, striving to integrate artificial intelligence tools into the teaching process at a transformative level. These models facilitated the development of pre-service teachers' methodological thinking and professional integration skills.

In the control group, instruction was conducted using traditional teaching methods, and artificial intelligence tools were not applied systematically. This made it possible to conduct a comparative analysis of the formative stage results and to determine the effectiveness of the experimental approaches.

Table 4 presents the dynamics of AI-based professional competence development among future English language teachers at the final stage of the experiment. The data clearly demonstrate contrasting outcomes between the control and experimental groups.

Table 4
Dynamics of AI-based competence development (final stage)

Group	N	High	Sufficient	Moderate	Low
Control group	76	5 (6.6%)	13 (17.1%)	32 (42.1%)	26 (34.2%)
Experimental group	72	29 (40.3%)	32 (44.4%)	13 (18.1%)	2 (2.8%)

Source / Note: This table was compiled by the authors based on the analysis of materials.

In the control group (n= 76), the distribution of competence levels indicates the predominance of moderate (42.1%) and low (34.2%) levels. Only a small proportion of students reached the high level (6.6%), while 17.1% achieved a sufficient level. These results suggest that the use of traditional teaching methods without systematic integration of artificial intelligence did not lead to substantial improvement in students' AI-based professional competence.

In contrast, the experimental group (n = 72) exhibited pronounced positive dynamics.

The majority of students demonstrated sufficient (44.4%) and high (40.3%) levels of AI-based competence. At the same time, the proportion of students at the moderate level decreased to 18.1%, and the low level was reduced to a minimal value of 2.8%.

This shift reflects the effectiveness of the AI-based pedagogical methods implemented during the formative stage.

Overall, the data in Table 4 confirm that targeted and systematic application of AI-supported teaching approaches significantly enhances the development of AI-based professional competence among pre-service English language teachers, whereas traditional instruction alone does not ensure comparable results.

The data presented in Table 5 indicate that the set of AI-based teaching methods applied in the experimental group had a systematic impact on all structural components of pre-service English language teachers' AI competence. In particular, the methods of microteaching combined with AI feedback, project-based learning, and lesson design based on the TPACK and SAMR models significantly contributed to the increase in the sufficient and high levels of AI competence. The effectiveness of prompt literacy and ethical AI case-study approaches is evidenced by the reduction of the low-level indicator to 2.8%. Moreover, the application of learning analytics facilitated the development of students' data-driven pedagogical thinking and led to a pronounced decrease in the average-level indicator. These results are fully consistent with the chi-square (x) criterion obtained at the end of the experiment (x'_calculated = 49.88 > _critical 7.815) and confirm the statistically significant effectiveness of the implemented methods.

Table 5

Impact of AI-based teaching methods on the development of AI competence among pre-service English language teachers

Applied Methods	Developed AI competence components	Specific outcomes in the experimental group	Evidence (based on table 4 data)
AI-supported Flipped Classroom	AI literacy, critical thinking reflection	Conscious application of theoretical knowledge; increased level of analysis during classroom activities	Decrease in the average level from 51.4% to 18.1% cumulative growth of sufficient and high levels
Project-based Learning (digital products with AI support)	Methodological integration, pedagogical design, collaboration	Development of skills in designing lesson plan and tasks using AI	Increase in the sufficient level from 15.3% to 44.4%
Microteaching +AI feedback	Reflection, self-assessment professional adjustment	Development of the ability to analyze and modify lesson structure	Increase in the high level from 6.9% to 40.3%
Prompt literacy	Conscious AI use, methodological thinking	Purposeful interaction with AI and adaptation of generated outputs	Reduction of the low level from 26.4% to 2.8%
Automated writing and speaking assessment	Assessment culture, feedback provision	Implementation of formative assessment and delivery of objective feedback	Growth in the combined share of sufficient and high levels (84,7%)
Learning analytics	Data-driven pedagogical decision-making	Analysis of learning outcomes and task differentiation	Sharp decrease in the average level (51.4%→18.1%)
Ethical AI case study	Ethical responsibility, academic integrity	Formation of professional and ethical principles in AI use	Reduction of the low level to a minimum value (2.8%)
Lesson design based on TRACK/SAMR	Technology-pedagogy integration	Use of AI at a transformative level	High-level indicator reaching 40.3%

Source / Note: This table was compiled by the authors based on the analysis of materials.

This confirms that AI-based professional competence in the experimental group increased at a statistically significant level. The obtained results demonstrate that AI competence does not develop spontaneously; rather, it requires purposeful and systematic pedagogical intervention. The methods applied in the experimental group such as AI-supported flipped classroom, project-based learning, microteaching, and learning analytics significantly enhanced the professional preparation of pre-service English language teachers.

Conclusion

The results of the conducted pedagogical experiment prove the high effectiveness of the purposeful and systematic formation of artificial intelligence-based professional competence among pre-service English language teachers in the context of educational digitalization. At the diagnostic stage of the study, the levels of AI competence among students in both the control and experimental groups were comparable and were predominantly concentrated at the average and low levels. This finding indicates that pre-service teachers initially lacked sufficient readiness to apply artificial intelligence consciously and methodologically in their pedagogical practice.

During the formative stage, the implementation of a comprehensive set of modern pedagogical approaches including AI-supported flipped classroom, project-based learning, microteaching combined with AI feedback, learning analytics, prompt literacy, automated writing and speaking assessment, and ethical AI case studies had a positive impact on students' professional training in the experimental group. By the end of the experiment, a substantial increase in the proportion of students demonstrating sufficient and high levels of AI competence was observed, alongside a sharp decrease in the low-level category.

These differences were confirmed to be statistically significant based on the chi-square (x) test. In contrast, no significant changes in professional competence levels were identified in the control group, where instruction was conducted using traditional teaching methods.

This finding further supports the conclusion that AI-based competence is not formed automatically but requires targeted pedagogical influence. The results of the survey conducted among instructors also reinforce the study's conclusions, indicating that the use of AI technologies in the training of pre-service English language teachers remains largely unsystematic and episodic. In addition, assessment systems and methodological support have not yet been fully adapted to the integration of artificial intelligence into teacher education.

Overall, the findings substantiate the necessity of considering artificial intelligence not merely as a technical tool, but as a methodological resource of digital pedagogy in the professional preparation of pre-service English language teachers.

The formation of AI-based professional competence contributes to the development of methodological thinking, reflective practice, assessment culture, and professional adaptability among prospective teachers.

Practical Recommendations Based on the research findings, the following practical recommendations are proposed to enhance the system of training pre-service English language teachers:

1. Introduce specialized modules integrating Artificial Intelligence and Digital Pedagogy into teacher education curricula.
2. Systematically apply AI-supported flipped classroom and project-based learning approaches in the preparation of English language teachers.
3. Organize practical tasks and training sessions aimed at developing pre-service teachers' prompt literacy skills.
4. Incorporate automated writing and speaking assessment tools into formative assessment systems to enhance students' reflective abilities.
5. Utilize learning analytics elements in the educational process to train students to analyze learning outcomes using data-driven approaches.
6. Include issues of AI ethics, academic integrity, and data security as mandatory components of teacher education programs and address them through case-study methods.
7. Organize regular professional development courses for instructors focused on the pedagogically effective use of artificial intelligence.

The implementation of these measures will contribute to aligning the professional preparation of pre-service English language teachers with contemporary educational demands and to improving the overall quality of teacher education in Kazakhstan.

The analysis of the experience of training pre-service English language teachers in the context of educational digitalization demonstrates that the formation of artificial intelligence based professional competence is a multifaceted and complex pedagogical process. The effectiveness of this process depends on a range of organizational, methodological, and psychological-pedagogical factors.

At the diagnostic stage of the study, the majority of students demonstrated average and low levels of AI-based professional competence. This can primarily be explained by insufficient theoretical knowledge of artificial intelligence tools, weak methodological skills in integrating Al technologies into English language teaching, as well as limited ability to effectively apply AI for assessment, feedback, and instructional design.

This situation is largely associated with the fact that during their school education, artificial intelligence and digital pedagogy were not considered priority directions within the educational process. In Kazakhstan, the issue of applying artificial intelligence in education has become prominent only in recent years, which is linked to the intensification of digitalization processes, changing requirements for higher education graduates, and the growing importance of digital and analytical skills in the labor market.

Furthermore, the analysis of higher education practices revealed that the preparation of pre-service English language teachers is not sufficiently oriented toward the purposeful development of AI-based professional competence. Although artificial intelligence-related topics are formally included in educational programs, implementation lack a systematic approach.

The research findings also indicate insufficient continuity in students' use of AI tools. The combination of theoretical, methodological, and technological knowledge does not fully ensure readiness to integrate artificial intelligence pedagogically effectively into English language teaching. Many students experienced significant difficulties in lesson design, task development, formative assessment, and in addressing issues related to academic integrity, data security, and ethical considerations when using AI.

Most pre-service teachers demonstrated low performance in completing control tasks aimed at solving pedagogical situations involving artificial intelligence. This confirms that AI competence does not develop spontaneously but requires specially organized pedagogical conditions and targeted instruction.

Based on the research results, two key pedagogical objectives were identified:

1. To restructure the content of higher education programs for training pre-service English language teachers toward the formation of AI-based professional competence;

2. To develop and implement specialized educational technologies that ensure pre-service teachers" readiness to pedagogically grounded use of artificial intelligence in English language classrooms. The study identified several pedagogical conditions that enhance the effectiveness of forming AI-based professional competence among pre-service English language teachers:

1. The concept of artificial intelligence should serve as a methodological foundation for teacher training. AI competence should define the target orientation of both general pedagogical and subject-specific courses. Its development should be based on the systematic use of the didactic potential of all components of the Foreign Language: Two Foreign Languages educational program.

2. Continuity in the development of AI competence must be ensured. Psychological and pedagogical diagnostics of first-year students AI readiness should be conducted, followed by systematic interventions aimed at addressing identified gaps. AI competence development should be viewed as a continuous process throughout the entire period of university study.

3. The formation of AI-based professional competence should be organized as a purposeful and systematic pedagogical process, comprising the following components:

- motivational component – fostering students' conscious attitudes and intrinsic motivation toward mastering artificial intelligence;

- cognitive component acquiring theoretical methodological knowledge of AI's pedagogical potential;

- operational component – developing practical skills for applying artificial intelligence in real pedagogical contexts.

4. The role of psychological and pedagogical disciplines in developing AI competence should be strengthened, with particular emphasis on reflection, pedagogical decision-making, digital ethics, and professional responsibility.

5. The AI-based training of pre-service English language teachers should be implemented through the following stages:

Stage 1 – raising awareness of AI skills and fostering conscious engagement among first- and second-year students;

Stage 2 – mastering fundamental knowledge of artificial intelligence within psychological and pedagogical disciplines;

Stage 3-developing AI-based methodological and technological competences during pedagogical practice or dual education:

Stage 4 – enhancing students' instructional, research, and creative activity through the development of AI-supported lessons and projects;

Stage 5 – monitoring and summative assessment of pre-service teachers' professional readiness to apply artificial intelligence in pedagogical practice.

The investigation of content-related and procedural continuity in AI-based competence development between school pupils and university students represents a promising direction for pre-service research.

In conclusion, we would like to say that the study expands the scientific and pedagogical foundations for reorienting the content and technologies of training pre-service English language teachers toward artificial intelligence. The findings contribute to enhancing graduates' professional flexibility, digital adaptability, and competitiveness in the labor market.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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Boranbay A. – supervision, project administration, validation, writing, review and editing. Seraliyeva A., Chingizbayeva A. and Lesbekova N. – data curation, formal analysis, and visualization.

Shvaikovskiy – contributed to resources, software, and validation.

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