

Нурлан Серикович Мукатаев – PhD, доцент кафедры «Системного анализа и управления» Евразийского национального университета имени Л.Н. Гумилева, Астана, Республика Казахстан; e-mail: mukatajev_ns@enu.kz. ORCID: <https://orcid.org/0000-0003-3570-4676>.

Information about the authors:

Zhansaya Yergazy* – PhD doctoral student of the Department of Mathematical and Computer Modelling, L.N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan; e-mail: yergazyevaaaa@gmail.com. ORCID: <https://orcid.org/0009-0003-8070-0970>.

Keylan Alimhan – PhD, Doctor of science (Japan), Professor of the Department of Mathematical and Computer Modelling, L.N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan; e-mail: keylan@live.jp. ORCID: <https://orcid.org/0000-0003-0766-2229>.

Нурлан Серикович Мукатаев – PhD, Associate Professor of the Department of Systems Analysis and Management, L.N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan; e-mail: mukatajev_ns@enu.kz. ORCID: <https://orcid.org/0000-0003-3570-4676>.

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Zh.Zh. Bagisov*, T.K. Dushaeva, A.Kh. Vakhitova, A.B. Akhmetova, A.Kh. Kassymova

West Kazakhstan Agricultural and Technical University named after Zhangir Khan,
090009, Republic of Kazakhstan, Oral, Zhangir khan street, 51

*e-mail Bag_8585@mail.ru

METHODOLOGICAL FOUNDATIONS FOR THE APPLICATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN TEACHING SPECIALIZED DISCIPLINES: OPPORTUNITIES AND RISKS

Abstract: The article examines the methodological foundations of applying artificial intelligence technologies in the teaching of specialized disciplines, with a focus on identifying both their pedagogical potential and associated risks. The relevance of the study is determined by the ongoing digital transformation of education and the growing demand for innovative tools that enhance the effectiveness and adaptability of the learning process. The paper analyzes key directions of AI integration into educational practice, including adaptive learning systems, intelligent tutoring, automated assessment, and personalized learning pathways. Particular attention is given to the methodological principles that ensure the effective implementation of these technologies, such as alignment with learning objectives, didactic appropriateness, and the role of the instructor in a technology-enhanced environment.

At the same time, the study highlights a range of challenges and risks related to the use of artificial intelligence, including potential bias in algorithmic decision-making, issues of academic integrity, reduced critical thinking, and increased dependence on digital tools. The importance of maintaining a balance between technological innovation and pedagogical control is emphasized. The results of the study contribute to the development of a structured approach to integrating artificial intelligence into higher education, aimed at improving the quality of teaching specialized disciplines while minimizing potential negative impacts.

Key words: artificial intelligence, higher education, specialized disciplines, teaching methodologies, adaptive learning, intelligent tutoring systems, automated assessment, educational technologies, academic integrity, learning personalization.

Introduction

The contemporary stage of higher education development is characterized by the rapid integration of digital technologies into the teaching and learning process. Among these technologies, artificial intelligence (AI) is gaining particular significance as a tool capable of transforming traditional pedagogical approaches and enhancing the effectiveness of knowledge transfer [1]. This is

especially relevant in the context of teaching specialized disciplines, which are inherently complex, content-intensive, and require a high level of cognitive engagement, analytical thinking, and sustained concentration from students.

Specialized disciplines, such as those related to engineering, biotechnology, information systems, and other professional fields, are distinguished by a high degree of abstraction, interdisciplinary connections, and the need for deep conceptual understanding. Students often face difficulties in mastering such material due to its complexity, the volume of information, and the necessity to integrate theoretical knowledge with practical application. In this regard, conventional teaching methods are not always sufficient to ensure the desired level of comprehension and skill acquisition.

The use of artificial intelligence technologies offers new opportunities to address these challenges by providing adaptive, personalized, and interactive learning environments. AI-based systems can support students by offering detailed explanations, visualizations of complex concepts, real-time feedback, and individualized learning trajectories. Such tools contribute to a deeper understanding of the subject matter, facilitate knowledge retention, and enhance students' ability to apply theoretical concepts in practice.

However, the integration of AI into the teaching of specialized disciplines also raises important methodological and pedagogical questions [2]. It is necessary to determine how these technologies can be effectively incorporated into the educational process without diminishing the role of the instructor, while maintaining academic integrity and fostering independent thinking among students.

The purpose of this study is to explore the methodological foundations for the application of artificial intelligence technologies in teaching specialized disciplines, with particular emphasis on their potential to improve the clarity and depth of explanation, as well as to identify the associated risks. The study aims to contribute to the development of balanced and scientifically grounded approaches to the use of AI in higher education, ensuring both the enhancement of learning outcomes and the preservation of essential pedagogical principles (Figure 1).

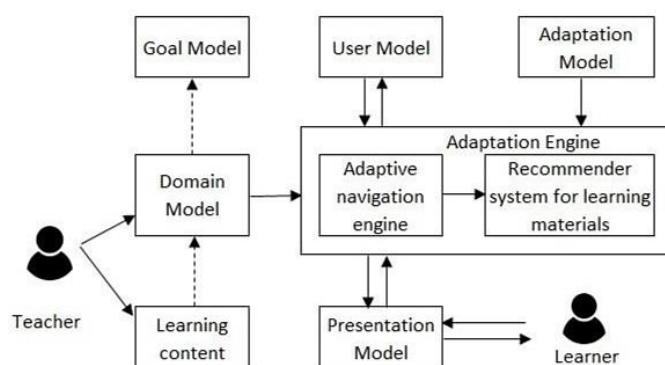


Figure 1 – The Role of Artificial Intelligence Technologies in Enhancing Learning Effectiveness in Specialized Disciplines

The figure presents a conceptual model of the use of artificial intelligence technologies in teaching specialized disciplines. It illustrates the interaction between the student, the instructor, and the intelligent system, which provides content adaptation, personalized learning, and additional explanations of complex topics. As a result, learning effectiveness and depth of understanding are significantly improved.

Materials and Methods

The purpose of this study is to develop a methodological framework for the application of artificial intelligence technologies in the teaching of specialized disciplines, focusing on improving the clarity, depth, and effectiveness of knowledge acquisition. The research is based on the premise that complex subject areas require enhanced instructional support, which can be achieved through the integration of intelligent educational tools.

The materials of the study include educational content from specialized disciplines, such as lecture materials, practical assignments, and assessment tasks, as well as digital learning resources

and datasets generated within the educational process [3]. These materials are characterized by a high level of complexity and abstraction, requiring systematic structuring and adaptive delivery methods.

The methodological approach combines theoretical analysis and applied methods. At the initial stage, a review of existing approaches to the use of artificial intelligence in education was conducted, with particular attention to adaptive learning systems, intelligent tutoring systems, and automated assessment tools. This analysis made it possible to identify key principles for integrating AI technologies into the teaching of specialized disciplines.

At the next stage, a conceptual model of the educational process enhanced by artificial intelligence was developed. The model is based on the interaction between three main components: the student, the instructor, and the AI system. The AI component performs several functions, including analysis of student performance, identification of knowledge gaps, generation of personalized recommendations, and provision of detailed explanations of complex concepts.

To support these functions, methods of natural language processing and machine learning were applied, enabling the extraction and interpretation of educational content, as well as the adaptation of instructional materials to individual learning needs. In addition, rule-based approaches were considered to ensure the alignment of AI-generated outputs with academic standards and learning objectives.

The effectiveness of the proposed approach was evaluated through qualitative analysis of its potential impact on learning outcomes, including improvements in comprehension, engagement, and knowledge retention. The integration of AI technologies within the described methodological framework allows for the creation of a more flexible and responsive educational environment, tailored to the demands of specialized disciplines.

The use of the table provides a clearer understanding of the methodological framework of the study, as it demonstrates which specific artificial intelligence tools are considered and how they can be integrated into the educational process (Table 1). This is particularly important in the context of specialized disciplines, where a high level of precision, depth of explanation, and adaptation of learning materials to individual student characteristics are required [4].

Table 1 – Artificial Intelligence Technologies and Their Applications in Teaching Specialized Disciplines

№	AI Technology	Description	Application Area	Purpose
1	Machine Learning	Algorithms that analyze data and identify patterns	Student performance analysis	Predicting learning outcomes and identifying knowledge gaps
2	Natural Language Processing (NLP)	Technologies for processing and understanding textual information	Assignment evaluation, chatbots, response generation	Enhancing understanding and automating feedback
3	Intelligent Tutoring Systems	Systems that simulate the role of a human instructor	Personalized learning	Adapting content and improving individual learning outcomes
4	Adaptive Learning Platforms	Systems that adjust content based on student performance	Online learning environments	Increasing learning efficiency and engagement
5	Expert Systems	Rule-based systems using expert knowledge	Problem-solving and simulation tasks	Supporting decision-making and practical skill development
6	Computer Vision	Technologies for analyzing images and video data	Student engagement monitoring, lab activities	Enhancing practical learning and monitoring participation
7	Recommender Systems	Algorithms for suggesting relevant content	Personalized learning paths	Improving motivation and learning outcomes

Furthermore, the table performs an analytical function by enabling the comparison of different AI technologies with their corresponding pedagogical objectives, such as personalized learning, automated assessment, increased student engagement, and decision support. This contributes to the justification of the selected methods used in the study and confirms their practical significance.

The proposed methodology was supported by the use of AI-based tools for text processing and content generation. A simplified algorithm of the system includes preprocessing of educational content, identification of key concepts, and generation of adapted explanations based on student needs. The implementation of these methods allowed improving the quality of learning materials and enhancing student understanding of complex topics.

```
from transformers import pipeline model = pipeline("text-generation") def
generate_explanation(topic): prompt = f"Explain the concept of {topic} in simple terms" return
model(prompt, max_length=100)[0]['generated_text'] print(generate_explanation("machine
learning"))
```

The algorithm illustrates the general logic of operation of an intelligent educational module, including several sequential stages: preprocessing of educational content, identification of key concepts, semantic analysis of the topic, and automated generation of simplified explanations adapted to the educational needs of students. The use of such AI-assisted mechanisms contributes to improving the accessibility of complex theoretical material and supports personalized learning within specialized disciplines. The application of artificial intelligence technologies for generating explanations of educational material has demonstrated a positive impact on the learning process in specialized disciplines [5]. The use of automated explanation generation algorithms has simplified the perception of complex concepts and provided a more accessible presentation of theoretical content. The inclusion of this algorithm in the study serves as a methodological illustration of how artificial intelligence technologies can be integrated into educational environments for adaptive support of the learning process. The proposed approach demonstrates the potential of AI systems to improve comprehension of complex concepts, increase accessibility of educational materials, and enhance the effectiveness of teaching specialized disciplines.

The analysis revealed that the proposed method contributes to improving the level of understanding of educational content by adapting explanations to the learners' level of preparation. The ability to receive prompt and detailed feedback enables students to identify knowledge gaps more quickly and address them effectively during the learning process.

Results

The results of the study demonstrate that the integration of artificial intelligence technologies into the teaching of specialized disciplines has a positive impact on the quality of the educational process. The proposed methodological approach, based on the use of AI tools for generating explanations and adapting educational content, enabled a more effective presentation of complex theoretical material.

The analysis conducted in this study demonstrated the potential applicability of artificial intelligence technologies in the teaching of specialized disciplines. The proposed methodological approach showed that AI-based tools can support the adaptation of educational materials, simplify the explanation of complex theoretical concepts, and facilitate more flexible organization of the learning process.

In addition, the implementation of automated feedback mechanisms significantly enhances the learning process. Students are able to receive immediate responses to their queries, which accelerates the identification and correction of knowledge gaps. This, in turn, leads to increased learning efficiency and improved academic performance [6].

The results also indicate a positive effect on student engagement. The use of interactive AI-based tools stimulates active participation in the learning process and supports continuous interaction with educational content. As a result, students demonstrate a higher level of motivation and interest in mastering specialized disciplines.

Despite the significant advantages of artificial intelligence in education, its integration into the teaching of specialized disciplines is associated with a number of risks that must be carefully considered.

One of the primary risks is the potential reduction of critical thinking skills among students. The availability of ready-made explanations and automated solutions may lead to passive learning behavior, where students rely on AI-generated responses instead of independently analyzing complex problems.

Another important concern is the issue of academic integrity. The use of AI tools for generating answers, assignments, or even research content increases the risk of plagiarism and

reduces the authenticity of students' work. This creates challenges for assessment and requires the development of new evaluation strategies.

The problem of algorithmic bias also remains significant. AI systems are trained on existing data, which may contain inaccuracies or biases, potentially leading to incorrect or misleading explanations. In the context of specialized disciplines, this may negatively affect the quality of knowledge acquisition.

Additionally, there is a risk of overdependence on technology, where students may lose the ability to learn independently without AI support. This can weaken fundamental competencies and reduce long-term learning effectiveness.

From a pedagogical perspective, the diminishing role of the instructor is another concern. Excessive reliance on AI tools may shift the focus away from teacher-student interaction, which remains a critical component of effective education.

Finally, issues related to data privacy and security must be considered, as the use of AI systems often involves the collection and processing of sensitive student data.

Excessive student engagement with artificial intelligence systems and their constant reliance on automatically generated responses may lead not only to positive outcomes but also to negative educational consequences [7-8]. When AI is used without proper control, there is a risk of a decline in the quality of students' independent intellectual work. In particular, learners may lose the ability for thoughtful reading of academic texts, develop a tendency to seek ready-made concise answers without in-depth analysis, and gradually experience a reduction in their level of concentration when working with complex material.

This tendency is particularly critical in the study of specialized disciplines, where successful knowledge acquisition requires sequential analysis, terminological accuracy, logical reasoning, and the ability to work with professional sources. If students consistently replace their own cognitive effort with reliance on AI tools, this may result in superficial learning, reduced ability to interpret professional information, and a weakening of critical thinking skills.

Furthermore, continuous dependence on intelligent digital tools may foster a simplified perception of information, in which learners expect ready-made interpretations rather than engaging in independent meaning-making. In the long term, this can negatively affect academic autonomy, attention stability, and the ability to achieve a deep professional understanding of the disciplines being studied.

Discussion

The findings of the study demonstrate that artificial intelligence technologies can contribute to the modernization of teaching specialized disciplines by improving personalization, feedback efficiency, and accessibility of educational content. These results are consistent with recent studies emphasizing the role of intelligent systems in increasing learning efficiency and supporting individualized educational pathways.

At the same time, the use of AI in education should be interpreted not only from the perspective of technological effectiveness, but also from the standpoint of pedagogical risks. Excessive reliance on AI-generated content may reduce students' independent cognitive activity, weaken critical thinking, shorten attention span, and encourage superficial learning strategies [9]. This creates a methodological contradiction between the efficiency of digital tools and the need to preserve deep, reflective learning.

Therefore, AI should not be considered a replacement for the instructor. Its role should be limited to supporting the learning process through content adaptation, explanation generation, automated feedback, and individualized assistance. The teacher remains central in guiding students, developing analytical thinking, ensuring academic integrity, and helping learners meaningfully interpret knowledge.

Conclusion

The present study addressed the methodological foundations for the application of artificial intelligence technologies in teaching specialized disciplines, with the aim of improving the clarity, depth, and effectiveness of knowledge acquisition. The results obtained confirm that this objective has been achieved.

It has been demonstrated that the integration of AI-based tools into the educational process enhances the presentation of complex theoretical material, supports personalized learning, and improves students' comprehension of subject-specific concepts. The use of adaptive explanation

systems and automated feedback mechanisms contributed to increased engagement and more efficient identification and elimination of knowledge gaps.

At the same time, the study revealed that the effectiveness of artificial intelligence in education is directly dependent on the conditions of its application. Alongside the identified advantages, significant risks were highlighted, including reduced critical thinking, overdependence on AI tools, and potential negative effects on students' concentration and independent analytical abilities [10]. These findings emphasize that artificial intelligence should not replace traditional pedagogical approaches, but rather complement them within a controlled and methodologically grounded framework.

Thus, the study achieved its main objective by substantiating both the potential and the limitations of artificial intelligence technologies in teaching specialized disciplines. The proposed approach contributes to the development of balanced strategies for integrating AI into higher education, ensuring the enhancement of learning outcomes while preserving essential cognitive and pedagogical principles.

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Ж.Ж. Багисов*, Т.К. Душаева, А.Х. Вахитова, А.Б. Ахметова, А.Х. Касымова

Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті,

090009, Қазақстан Республикасы, Орал қ-сы, Жәңгір хан көшесі, 51

*e-mail Bag_8585@mail.ru

АРНАЙЫ ПӘНДЕРДІ ОҚЫТУДА ЖАСАНДЫ ИНТЕЛЛЕКТ ТЕХНОЛОГИЯЛАРЫН ҚОЛДАНУДЫҢ ӘДІСНАМАЛЫҚ НЕГІЗДЕРІ: МҮМКІНДІКТЕР МЕН ТӘУЕКЕЛДЕР

Мақалада арнайы пәндерді оқытуда жасанды интеллект технологияларын қолданудың әдіснамалық негіздері, олардың педагогикалық әлеуеті мен соған байланысты тәуекелдерді анықтау тұрғысынан қарастырылады. Зерттеудің өзектілігі білім беру жүйесінің цифрлық трансформациясының қарқынды жүруімен және оқу үдерісінің тиімділігі мен бейімделгіштігін арттыруға мүмкіндік беретін инновациялық құралдарға деген сұраныстың өсуімен түсіндіріледі. Жұмыста жасанды интеллектті білім беру тәжірибесіне енгізудің негізгі бағыттары талданған, оның ішінде бейімделген оқыту жүйелері, интеллектуалды оқыту платформалары, білімді автоматтандырылған бағалау және дербестендірілген білім беру траекториялары қамтылған. Сонымен қатар, аталған технологияларды тиімді енгізуді қамтамасыз ететін әдіснамалық қағидаттарға, атап айтқанда білім беру мақсаттарына сәйкестігіне, дидактикалық негізділігіне және технологиялық тұрғыдан кеңейтілген білім беру ортасындағы оқытушының рөліне ерекше назар аударылған.

Алайда зерттеуде жасанды интеллектті қолданумен байланысты бірқатар сын-қатерлер мен тәуекелдер қарастырылған. Олардың қатарына алгоритмдік шешімдердің ықтимал біржақтылығы, академиялық адалдық мәселелері, сыни ойлау деңгейінің төмендеуі және білім алушылардың цифрлық құралдарға тәуелділігінің артуы жатады. Технологиялық инновациялар мен педагогикалық бақылау арасындағы тепе-теңдікті сақтау қажеттілігі атап көрсетілген. Зерттеу нәтижелері жоғары білім беру жүйесіне жасанды интеллект технологияларын құрылымдалған түрде енгізуге, арнайы пәндерді оқыту сапасын арттыруға және ықтимал теріс әсерлерді азайтуға бағытталған ғылыми-әдістемелік тәсілді қалыптастыруға ықпал етеді.

Түйін сөздер: жасанды интеллект, жоғары білім, арнайы пәндер, оқыту әдістемесі, бейімделмелі оқыту, интеллектуалды оқыту жүйелері, автоматтандырылған бағалау, білім беру технологиялары, академиялық адалдық, оқытуды жекелендіру.

Ж.Ж. Багисов*, Т.К. Душаева, А.Х. Вахитова, А.Б. Ахметова, А.Х. Касымова

Западно-Казахстанский аграрно-технический университет имени Жангир хана,

090009, Республика Казахстан, г. Уральск, ул. Жангир хана, 51

*e-mail Bag_8585@mail.ru

МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ПРИМЕНЕНИЯ ТЕХНОЛОГИЙ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ПРЕПОДАВАНИИ СПЕЦИАЛЬНЫХ ДИСЦИПЛИН: ВОЗМОЖНОСТИ И РИСКИ

В статье рассматриваются методологические основы применения технологий искусственного интеллекта в преподавании специальных дисциплин с акцентом на выявление их педагогического потенциала и сопутствующих рисков. Актуальность исследования обусловлена продолжающейся цифровой трансформацией системы образования и возрастающей потребностью в инновационных инструментах, способствующих повышению эффективности и адаптивности образовательного процесса. В работе проанализированы основные направления интеграции искусственного интеллекта в образовательную практику, включая адаптивные системы обучения, интеллектуальные обучающие платформы, автоматизированную оценку знаний и персонализированные образовательные траектории. Особое внимание уделено методологическим принципам, обеспечивающим эффективное внедрение данных технологий, таким как соответствие образовательным целям, дидактическая целесообразность и роль преподавателя в условиях технологически расширенной образовательной среды.

Одновременно в исследовании рассматривается ряд вызовов и рисков, связанных с использованием искусственного интеллекта, включая возможную предвзятость алгоритмических решений, проблемы академической добросовестности, снижение уровня критического мышления и усиление зависимости обучающихся от цифровых инструментов. Подчеркивается необходимость сохранения баланса между технологическими инновациями и педагогическим контролем. Полученные результаты способствуют формированию структурированного подхода к интеграции искусственного интеллекта в систему высшего образования, направленного на повышение качества преподавания специальных дисциплин при минимизации возможных негативных последствий.

Ключевые слова: искусственный интеллект, высшее образование, специальные дисциплины, методика преподавания, адаптивное обучение, интеллектуальные обучающие системы, автоматизированная оценка, образовательные технологии, академическая добросовестность, персонализация обучения.

Авторлар туралы ақпарат

Женис Жайлиевич Багисов* – магистр, доктор DBA, Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал, Қазақстан; e-mail: Bag_8585@mail.ru. ORCID: <https://orcid.org/0000-0002-8084-1234>.

Турсунгуль Канатовна Душаева – аға оқытушы, Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал, Қазақстан; e-mail: sultanna2011@mail.ru. ORCID: <https://orcid.org/0000-0002-1244-823>.

Айзада Хабержановна Вахитова – аға оқытушы, Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал, Қазақстан; e-mail: aiza_200485@mail.ru. ORCID: <https://orcid.org/0000-0001-8433-956X>.

Айдана Бакытжановна Ахметова – оқытушы, Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал, Қазақстан; e-mail: dab922636@gmail.com. ORCID: <https://orcid.org/0009-0006-1335-9786>.

Акмарал Хамзиевна Касымова – п.ғ.к., доцент, профессор м.а., Жәңгір хан атындағы Батыс Қазақстан аграрлық-техникалық университеті, Орал, Қазақстан; e-mail: kasimova.akmaral2020@gmail.com. ORCID: <https://orcid.org/0000-0002-4614-4021>.

Сведения об авторах

Женис Жайлиевич Багисов* – магистр, доктор DBA, Западно-Казахстанский аграрно-технический университет имени Жангир хана, Уральск, Казахстан; e-mail: Bag_8585@mail.ru. ORCID: <https://orcid.org/0000-0002-8084-1234>.

Турсунгуль Канатовна Душаева – старший преподаватель, Западно-Казахстанский аграрно-технический университет имени Жангир хана, Уральск, Казахстан; e-mail: sultanna2011@mail.ru. ORCID: <https://orcid.org/0000-0002-1244-823>.

Айзада Хабержановна Вахитова – старший преподаватель, Западно-Казахстанский аграрно-технический университет имени Жангир хана, Уральск, Казахстан; e-mail: aiza_200485@mail.ru. ORCID: <https://orcid.org/0000-0001-8433-956X>.

Айдана Бакытжановна Ахметова – преподаватель, Западно-Казахстанский аграрно-технический университет имени Жангир хана, Уральск, Казахстан; e-mail: dab922636@gmail.com. ORCID: <https://orcid.org/0009-0006-1335-9786>.

Акмарал Хамзиевна Касымова – к.п.н., доцент, и.о. профессора, Западно-Казахстанский аграрно-технический университет имени Жангир хана, Уральск, Казахстан; e-mail: kasimova.akmaral2020@gmail.com. ORCID: <https://orcid.org/0000-0002-4614-4021>.

Information about the authors

Zhenis Zhailyevich Bagisov* – Master, doctor of DBA, West Kazakhstan Agrarian and Technical University named after Zhangir Khan, Uralsk, Kazakhstan; e-mail: Bag_8585@mail.ru. ORCID: <https://orcid.org/0000-0002-8084-1234>.

Tursungul Kanatovna Dushaeva – Senior Lecturer, Zhangir Khan West Kazakhstan Agrarian and Technical University, Oral, Kazakhstan; e-mail: sultanna2011@mail.ru. ORCID: <https://orcid.org/0000-0002-1244-823>.

Aizada Khabierzhanovna Vakhitova – Senior Lecturer, Zhangir Khan West Kazakhstan Agrarian and Technical University, Oral, Kazakhstan; e-mail: aiza_200485@mail.ru. ORCID: <https://orcid.org/0000-0001-8433-956X>.

Aidana Bakytzhanovna Akhmetova – Lecturer, Zhangir Khan West Kazakhstan Agrarian and Technical University, Oral, Kazakhstan; e-mail: dab922636@gmail.com. ORCID: <https://orcid.org/0009-0006-1335-9786>.

Akmaral Khamzиевна Kassymova – Candidate of Pedagogical Sciences, Associate Professor, Acting Professor, Zhangir Khan West Kazakhstan Agrarian and Technical University, Oral, Kazakhstan; e-mail: kasimova.akmaral2020@gmail.com. ORCID: <https://orcid.org/0000-0002-4614-4021>.

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Y.E. Kozhanzharov^{1*}, S.V. Grigoryeva¹, A.Zh. Alimkhanova²

¹D. Serikbayev East Kazakhstan technical university,
070004, Republic of Kazakhstan, Ust-Kamenogorsk, D. Serikbayev str., 19

²K. Kulazhanov Kazakh University of Technology and Business,
010000, Republic of Kazakhstan, Astana, Kaiym Mukhamedkhanova str., 37 A.

*e-mail: kozhanzharov_ersin@mail.ru

MODELING AND ANALYSIS OF INTERFERENCE IN WIRELESS DATA TRANSMISSION SYSTEMS

Abstract: This paper presents a hardware and software platform for modeling and analyzing interference in wireless data transmission systems aimed at studying the reliability and stability of modern wireless communication networks. The relevance of the research is driven by the rapid growth of Internet of Things devices, the active deployment of Wi-Fi and 5G technologies, and the increasing requirements for communication quality and reliability under external electromagnetic interference conditions. The main