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MECHANISMS FOR INTEGRATING ARTIFICIAL INTELLIGENCE INTO DISTANCE LEARNING PLATFORMS AND THEIR PROSPECTIVE PEDAGOGICAL IMPACTS

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Abstract. Distance learning platforms are increasingly becoming an essential part of higher education, yet their pedagogical effectiveness depends on the extent to which they support personalization, timely feedback, learning motivation and self-regulated learning. This study examines the mechanisms for integrating artificial intelligence into distance learning platforms and evaluates their prospective pedagogical effects. The research was conducted using a mixed-method design involving 400 undergraduate students and 15 experts in digital education. Student responses were analyzed using the Modified Priority Needs Index (PNI modified), while expert judgments were used to calculate the Composite Priority Index (CPI), which combined perceived need, pedagogical significance and feasibility of implementation. The results showed that the highest priority areas for AI integration were adaptive learning, intelligent educational data analytics, personalized recommendation systems and automated assessment. Among the expected pedagogical effects, the most significant were personalization of learning, improvement of feedback quality and enhancement of learning motivation. Expert assessment confirmed the high pedagogical significance and practical feasibility of the proposed AI integration model. The study contributes to the development of a structured framework for planning AI implementation in distance learning platforms and provides practical guidance for educational institutions seeking to improve the quality of digital learning environments.

Key words: distance learning, artificial intelligence, AI integration, adaptive learning, learning analytics, personalized learning, feedback quality, educational motivation, digital education

Introduction

The modern higher education system is going through a period of deep digital transformation due to the rapid development of information and communication technologies, the massive spread of distance learning and the growing need for personalized educational trajectories. Distance learning platforms have become an integral part of the educational infrastructure of universities, providing flexible access to educational resources, interaction between teachers and students, and management of the educational process regardless

of geographical and time constraints. At the same time, traditional e-learning environments face several challenges related to ensuring individualization of learning, maintaining learning motivation, timely feedback and an objective assessment of educational outcomes [1].

In these conditions, the use of artificial intelligence (AI) technologies is becoming particularly relevant, which are considered as one of the key factors in the modernization of digital education. In recent years, there has been a significant increase in scientific interest in the implementation of intelligent algorithms in educational platforms, due to their ability to analyze large amounts of educational data, adapt the learning content to the individual needs of students and support pedagogical decision-making based on objective analytical indicators [2]. Research shows that artificial intelligence systems can significantly improve the effectiveness of the educational process through the personalization of educational content, intellectual support for students and automation of routine pedagogical tasks.

One of the most promising areas of application of artificial intelligence in distance learning is the creation of adaptive educational systems capable of dynamically changing the content, complexity and sequence of educational materials depending on the level of training, educational needs and individual progress of students. Such systems provide a higher level of student involvement in the learning process, promote the development of independence and allow the implementation of the principles of student-centered learning [3]. In addition, machine learning and data mining algorithms make it possible to identify hidden patterns in the educational behavior of users, predict academic performance and timely identify the risks of reducing learning activity.

Considerable attention of researchers is also paid to the use of intelligent recommendation systems, virtual assistants, chatbots and generative models of artificial intelligence in the educational environment. The emergence of large language models, including ChatGPT and similar systems, has opened up new opportunities for personalized student support, automated counseling, the generation of educational materials, and the development of critical thinking skills [4]. At the same time, the spread of such technologies is accompanied by a number of controversial issues related to academic integrity, the reliability of the information generated, the protection of personal data and the need to form digital literacy of users.

The effectiveness of the introduction of artificial intelligence into distance learning platforms is largely determined not only by the technological characteristics of the solutions used, but also by the pedagogical mechanisms of their integration into the educational process [5]. Modern research highlights the need to develop comprehensive models of interaction between teachers, students, and intellectual educational systems that ensure the achievement of educational goals while maintaining the leading role of the teacher in organizing

learning. In this context, artificial intelligence is considered not as a substitute for a teacher, but as a tool for expanding his professional capabilities, allowing for better monitoring of educational outcomes, prompt feedback and effective student support.

Of particular interest are the promising pedagogical effects of integrating artificial intelligence into distance learning. Among the most significant effects are an increase in the level of personalization of learning [6], the development of students' self-organization and self-regulation skills, an increase in learning motivation, an improvement in the quality of feedback, the formation of critical thinking and the expansion of opportunities for the implementation of adaptive educational scenarios. An additional advantage is the ability to build intelligent analytical systems that support decision-making both at the level of an individual student and at the level of an educational organization as a whole.

Despite the active development of this area, existing research is mainly focused on individual artificial intelligence technologies or particular aspects of their application in education. There is still insufficient attention in the scientific literature to a comprehensive analysis of the mechanisms of integrating artificial intelligence into distance learning platforms and assessing their potential pedagogical impact in the long term [7]. The lack of a unified conceptual approach makes it difficult to develop effective strategies for introducing intelligent technologies into educational practice.

In this regard, the purpose of this study is to analyze the mechanisms of integration of artificial intelligence technologies into distance learning platforms and identify their promising pedagogical effects to improve the quality of the educational process [8]. Special attention is paid to the study of the possibilities of adaptive learning, intelligent analytics, automated support for students and teachers, as well as the impact of these technologies on learning outcomes, motivation and educational activity of students.

To achieve this goal, the following research questions were formulated:

RQ1. What mechanisms of integration of artificial intelligence are most effectively implemented in modern distance learning platforms?

RQ2. What pedagogical effects arise as a result of the use of artificial intelligence technologies in the online educational environment and how do they affect the quality of student learning?

RQ3. How does the integration of artificial intelligence contribute to the development of personalized learning, increase learning motivation and improve educational analytics in the distance education system?

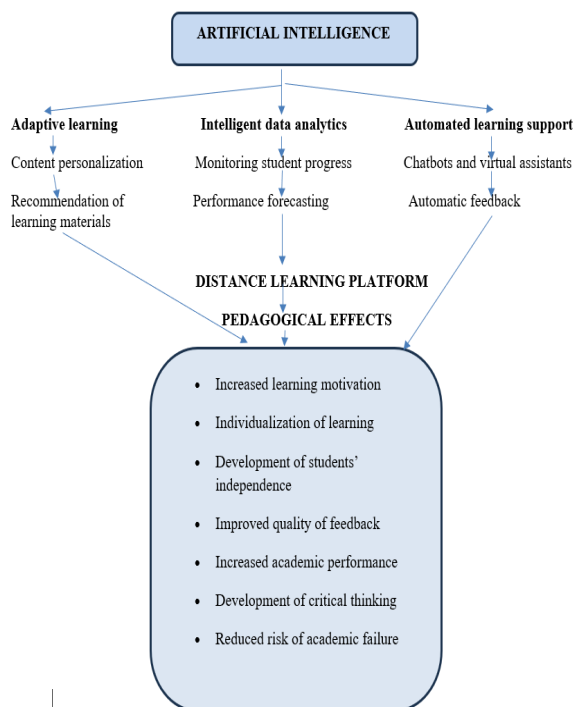


Figure 1 - A conceptual model of the mechanisms for integrating artificial intelligence into distance learning platforms and their pedagogical effects

Materials and methods

Research design

This study uses a mixed research design aimed at a comprehensive study of the mechanisms of integrating artificial intelligence into distance learning platforms and identifying their promising pedagogical effects. This approach allowed us to consider the problem not only from a technological, but also from a pedagogical perspective, since the introduction of AI into educational platforms is simultaneously linked to the digital infrastructure, the organization of the educational process, the nature of teacher-student interaction, as well as the quality of educational outcomes.

At the first stage of the research, a theoretical and analytical review of scientific sources devoted to the use of artificial intelligence in distance learning, adaptive educational systems, intelligent analytics, automated feedback, recommendation algorithms and digital educational platforms was conducted. This made it possible to identify key areas of AI integration into the online educational environment and identify the main pedagogical effects associated with the personalization of learning, increased learning motivation, the development of student independence and improved feedback quality [9].

At the second stage, the mechanisms for integrating artificial intelligence into distance learning platforms were systematized. These included adaptive presentation of educational content, intellectual support for students, automated

assessment of academic achievements, analysis of educational data, forecasting academic performance, and support for pedagogical decision-making. These mechanisms were considered as interrelated elements of a single digital educational environment.

At the third stage, the potential pedagogical effects of the introduction of AI technologies in distance learning were assessed. The analysis was aimed at identifying ways in which intellectual tools can contribute to the individualization of educational trajectories, increase student engagement, timely identify learning difficulties, and create a more flexible pedagogical support system.

Research context and participants

The study was conducted in the context of the use of distance learning platforms in the higher education system. The main focus was on studying how artificial intelligence technologies can be integrated into digital educational platforms and what promising pedagogical effects can arise as a result of their application.

Educational organizations using distance learning platforms for organizing the learning process, hosting electronic learning materials, conducting online classes, monitoring academic performance, communicating between teachers and students, and providing feedback were considered as a research context. This context allowed us to analyze not only the technical capabilities of digital platforms, but also the pedagogical conditions necessary for the effective implementation of AI tools.

400 undergraduate students of various fields of study and courses of study participated in the quantitative stage of the study. The selection of respondents was carried out taking into account the direction of the educational program and the year of study, which allowed for a more uniform representation of students of different academic levels. A total of 421 questionnaires were distributed, of which 400 were found valid and included in further analysis. The level of return and suitability of the questionnaires was 95%, which is sufficient to analyze students' perception of the possibilities of remote platforms and the potential effects of integrating artificial intelligence.

The students' responses were considered as a subjective assessment of user experience in a digital educational environment. In particular, students' perceptions of the accessibility of educational content, the quality of feedback, the level of personalization of learning, the convenience of communication, the possibilities of monitoring progress and supporting independent learning activities were analyzed. At the same time, the data obtained was interpreted not as an objective technical examination of the platforms, but as an assessment of the educational experience of users.

At the qualitative stage of the research, an expert group consisting of 15 specialists with experience in the field of digital education, distance learning, methodological support of educational programs and the use of AI tools in the educational process was involved. The expert group included teachers, methodologists, heads of educational programs, specialists in digital educational

technologies and representatives of the academic administration. The expert assessment was used to clarify the most significant mechanisms for integrating artificial intelligence and to determine their pedagogical prospects.

The distribution of students by field of study and courses is shown in table 1.

Table 1. Distribution of participants in the quantitative stage of the study

Group code	The direction of training	1st course	2nd year	3rd year	4th year	Total
G-1	Information technology and programming	12	10	9	9	40
G-2	Pedagogy and teaching methods	10	11	10	9	40
G-3	Economics and Management	11	10	10	9	40
G-4	Engineering and technical sciences	10	10	10	10	40
G-5	Natural sciences and applied disciplines	9	10	11	10	40
G-6	Information systems and digital technologies	10	9	10	11	40
G-7	Humanities and Social sciences	10	10	9	11	40
G-8	Educational technologies	9	11	10	10	40
G-9	Design, media and digital communication	10	10	11	9	40
G-10	Applied Computer Science and data analysis	9	9	10	12	40
Total		100	100	100	100	400

Note. The table shows only valid questionnaires included in the analysis.

Quantitative stage of the study: n=400; valid responses — 400 out of 421 common questionnaires, which is 95%.

Questionnaire for assessing the mechanisms of integration of artificial intelligence and pedagogical effects of distance learning.

The research questionnaire was developed based on a conceptual model for integrating artificial intelligence into distance learning platforms, shown in Figure 1. The structure of the tool included two interrelated blocks: mechanisms for integrating artificial intelligence into an educational platform and promising pedagogical effects of using AI in distance learning.

The first block was aimed at assessing the key mechanisms for introducing artificial intelligence technologies into the digital educational environment. It included four main areas: adaptive learning, intelligent educational data analytics, automated assessment, and intelligent recommendation systems. Each area was represented by several statements reflecting the real-world functions of distance learning platforms, such as personalization of educational content, automatic feedback generation, prediction of academic performance, and support for pedagogical decision-making.

The second block of the questionnaire was devoted to assessing the pedagogical effects of using artificial intelligence in the educational process. It includes the following subscales: personalizing learning, increasing learning motivation, improving the quality of feedback, developing self-learning and self-regulation skills, improving academic performance, and developing critical thinking. The statements were formulated to focus on students' perception of

the possibilities of the distance learning environment and their educational experience when using intelligent digital tools.

An important feature of the tool was the double assessment format. For each statement, respondents indicated two estimates: the current level of implementation (Current State, CS), reflecting the degree of actual use of the relevant mechanism or effect in the educational platform, and the desired level of implementation (Desired State, DS), reflecting students' expectations regarding the optimal functioning of the intellectual educational environment. The assessment was conducted on a five-point Likert scale from 1 ("totally disagree") to 5 ("totally agree").

The substantive validity of the tool was ensured through expert evaluation by experts in the field of digital education, artificial intelligence and pedagogical design. Based on the results of the expert analysis, the wording of individual paragraphs was clarified and issues with insufficient consistency of expert assessments were excluded.

To confirm the reliability of the instrument, an analysis of the internal consistency of the scales was performed using Cronbach's coefficient. Additionally, a confirmatory factor analysis (CFA) procedure was performed to verify that the empirical data corresponded to the intended factor structure of the study. The obtained indicators indicate high reliability and satisfactory quality of the measuring model table 2.

Table 2. Reliability indicators and results of confirmatory factor analysis

The construction block	Subscales	Number of subscales	Cronbach's α	The CFA model	χ^2/df	CFI	TLI	RMSEA	SRMR
AI integration mechanisms	Adaptive learning; intelligent analytics; automated assessment; recommendation systems	4	0,82–0,94	Hierarchical CFA (4 first-order factors → 1 second-order factor)	2,31	0,95	0,94	0,052	0,045
Pedagogical effects	Personalization of learning; motivation; quality of feedback; self-study; academic performance; critical thinking	6	0,84–0,93	Hierarchical CFA (6 first-order factors → 1 second-order factor)	2,26	0,96	0,95	0,050	0,043

Note. Each item of the questionnaire was evaluated twice: according to the current level of implementation and according to the desired level of implementation. The values of the Kronbach coefficient reflect the internal

consistency of the subscale. The CFA indicators indicate a good agreement of the measurement model with empirical data and confirm the internal consistency of the selected structures.

Expert questionnaire for assessing the feasibility and pedagogical significance of AI integration.

The expert questionnaire was developed to clarify the results of the student survey and evaluate the mechanisms of integration of artificial intelligence from the perspective of institutional strategy and pedagogical expediency. Unlike the student questionnaire, which focused on students' perception of the digital educational environment, the expert tool was aimed at determining the practical feasibility of AI solutions in distance learning platforms and their expected impact on the quality of the educational process.

For each AI integration mechanism, the experts assessed two parameters: i) the expected pedagogical significance, that is, the expected contribution of technology to improving the quality of education, personalization, motivation, feedback and academic results of students; ii) the feasibility of implementation, reflecting the availability of the necessary digital resources, human resources, methodological support, organizational support and ethical conditions of application AI.

The assessment was conducted on a five-point Likert scale. Additionally, the experts determined the estimated horizon for the implementation of each mechanism: short-term, medium-term or long-term. To increase the consistency of expert assessments, the scales were accompanied by brief explanations, including requirements for digital infrastructure, the level of teacher training, the amount of methodological work, data protection and management of educational processes.

Before filling out the questionnaire, the experts received a brief description of the conceptual research model and summarized the results of the student survey. At the same time, they were asked to base their assessments not only on the data presented, but also on their own professional experience in the field of distance learning, digital pedagogy, and the use of artificial intelligence in the educational environment.

Data collection procedure

Data collection was carried out in several successive stages. At the first stage, students were provided with information about the purpose of the study, its content, the voluntary nature of participation, and the confidentiality of the responses received. After reviewing the information sheet and the consent form, the respondents filled out the questionnaire anonymously.

The survey of students was conducted either face-to-face under the supervision of a researcher, or in an online format through the educational platforms of distance learning used. Before filling out the questionnaire, the participants were given instructions explaining the difference between the current level of implementation of AI mechanisms in the educational platform and the

desired level of their development. The respondents were asked to evaluate not only their existing experience of using the digital environment, but also their own expectations about how artificial intelligence can improve the quality of distance learning in the future.

At the second stage, an expert survey was conducted. Personal e-invitations containing a brief description of the study and a link to an online questionnaire were sent to the experts. The participants of the expert survey were informed about the research objectives, the confidential nature of data processing and the use of their assessments to determine the most promising mechanisms for integrating artificial intelligence into distance learning platforms.

The experts filled out an online questionnaire during a pre-determined period. In the assessment process, they were asked to consider the pedagogical significance of AI tools, the technical and organizational feasibility of their implementation, the willingness of teachers and students to use intelligent technologies, as well as possible risks associated with ethics, academic integrity and personal data protection.

Data analysis

Descriptive statistics methods, the Modified Priority Needs Index (PNI modified), as well as an integral indicator of the priority of introducing artificial intelligence technologies into distance learning platforms were used to analyze the data.

At the first stage of the study, a modified needs priority index (PNI modified) was calculated for each indicator, which was determined using the following formula:

$$\text{PNI modified} = (\text{DS} - \text{CS}) / \text{CS}$$

where:

DS (Desired State) is the average value of the desired level of implementation of the AI integration mechanism or pedagogical effect.;

CS (Current State) is the average value of the current implementation level of the corresponding mechanism or effect.

The positive values of the index indicate that there is a gap between the current state of the educational environment and the expectations of students. The higher the PNI modified value, the more significant the need to develop an appropriate artificial intelligence integration mechanism is. Negative or close to zero values indicate that there is no significant gap between the current and desired state.

The PNI modified index was calculated initially for individual points in the questionnaire, after which the indicators were aggregated according to the main research areas: adaptive learning, intelligent analysis of educational data, automated assessment, recommendation systems, as well as groups of pedagogical effects related to the personalization of learning, learning motivation, the development of student independence and improving the quality of educational outcomes.

The obtained values allowed us to identify the most demanded areas of integration of artificial intelligence into distance learning platforms and answer the first research question related to identifying the most significant needs of students in the field of intellectualization of the digital educational environment.

To solve the second research question, the results of the student survey were supplemented with expert assessments. For this purpose, an integral index of implementation priority (Composite Priority Index, CPI) was calculated, considering not only the needs of users, but also the opinion of experts regarding the pedagogical significance and practical feasibility of the considered AI mechanisms.

The integral index was calculated using the formula:

$$\text{CPI} = \text{PNI modified} \times (\text{Impact} / 5) \times (\text{Feasibility} / 5)$$

where:

Impact is an average expert assessment of the pedagogical significance of the artificial intelligence integration mechanism;

Feasibility is an average expert assessment of the feasibility of its implementation in educational practice.

To ensure comparability with the results, the values obtained were normalized according to the formula:

$$\text{CPI} = \text{CPI raw} / \text{Max (CPI raw)}$$

The normalized CPI indicator made it possible to rank the mechanisms of integration of artificial intelligence according to the degree of their prospects and identify priority areas for implementation in the short, medium and long term.

At the final stage of the study, the results obtained from student assessments and expert judgments were compared. A comparison of PNI modified and CPI values revealed the degree of consistency between the educational needs of students and the strategic ideas of specialists about the prospects for introducing artificial intelligence into distance learning.

The coincidence of priorities was seen as confirmation of the pedagogical significance of the relevant AI mechanisms and their high demand in the digital educational environment. On the contrary, the identified discrepancies indicated the need for additional analysis of organizational, technological or methodological factors affecting the effectiveness of integrating artificial intelligence into distance learning platforms.

Results and discussion

RQ1: Priority areas for the integration of artificial intelligence and expected pedagogical effects

The first research question was aimed at identifying the mechanisms for integrating artificial intelligence into distance learning platforms, which are characterized by the highest values of the PNI modified index and, therefore, require priority attention from educational platform developers and the teaching community.

At the level of the main artificial intelligence integration mechanisms, the highest PNI modified score was recorded for adaptive learning (PNI modified=0.52; rank 1). The second place was taken by intellectual analytics of educational data (PNI modified=0.41; rank 2). This was followed by intelligent recommendation systems (PNI modified=0.33; rank 3) and automated assessment of academic achievements (PNI modified=0.28; rank 4).

The results obtained indicate that students have the greatest need for learning personalization tools that can adapt the content of educational materials to the individual characteristics of students. High index values also indicate a significant demand for the use of analytical tools to track academic progress and identify educational difficulties in a timely manner.

At the level of pedagogical effects, the most pronounced needs were identified in the areas of personalizing learning (PNI modified=0.61), improving the quality of feedback (PNI modified=0.55), and increasing learning motivation (PNI modified=0.47). Slightly lower, but also significant values were obtained for developing self-learning skills (PNI modified=0.39), improving academic performance (PNI modified=0.35), and developing critical thinking (PNI modified=0.31).

The results obtained suggest that students consider artificial intelligence primarily as a means of individualizing the educational process and increasing the effectiveness of interaction between students and the educational platform table 3.

Table 3. PNI modified values for AI integration mechanisms and pedagogical effects

Block	Category	Average Current Level (CS)	Average Desired Level (DS)	PNI modified	Rank
AI mechanisms	Adaptive learning	3,10	4,72	0,52	1
	Intelligent Analytics	3,20	4,51	0,41	2
	Recommendation systems	3,30	4,39	0,33	3
	Automated assessment	3,40	4,35	0,28	4
Pedagogical effects	Personalizing learning	2,95	4,75	0,61	1
	Quality of feedback	3,00	4,65	0,55	2
	Educational motivation	3,10	4,56	0,47	3
	Self-learning and self-regulation	3,25	4,52	0,39	4
	Academic performance	3,35	4,52	0,35	5
	Critical thinking	3,42	4,48	0,31	6

A more detailed analysis showed that within the adaptive learning block, the highest PNI modified values are observed for personalized selection of educational materials (0.64), adaptation of the level of complexity of tasks (0.58) and the formation of individual educational trajectories (0.55).

Within the framework of intelligent educational data analytics, the highest index values were recorded for predicting academic performance (0.49),

early identification of learning difficulties (0.46) and monitoring of students' educational activity (0.42).

Among the functions of automated assessment, automatic task verification (0.35), instant feedback (0.33) and intelligent analysis of student errors (0.29) turned out to be the most in demand.

The block of pedagogical effects deserves special attention. The highest PNI modified values were associated with the possibility of receiving personalized student support, prompt feedback and the formation of individual educational routes. This indicates that students associate the main advantages of artificial intelligence primarily with improving the quality and flexibility of the educational process table 4.

Table 4. PNI modified values for individual artificial intelligence integration mechanisms

The AI integration mechanism	General PNI modified
Personalized content selection	0,64
Adapting the complexity of tasks	0,58
Individual educational trajectories	0,55
Predicting academic performance	0,49
Identification of learning difficulties	0,46
Monitoring of educational activity	0,42
Intelligent recommendations	0,40
Automatic feedback	0,38
Automatic task verification	0,35
Student error analysis	0,29

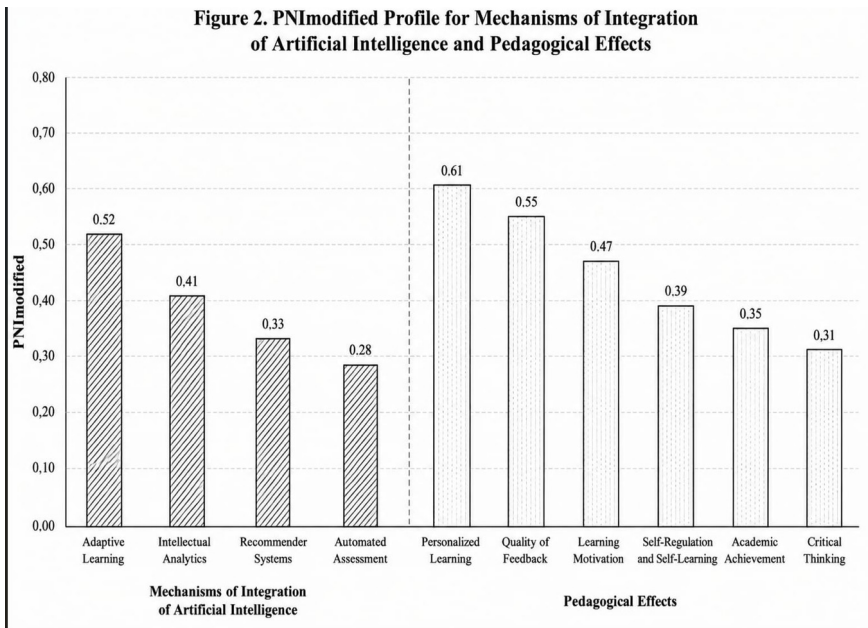


Figure 2 – PNI modified profile for artificial intelligence integration mechanisms and pedagogical effects

As shown in Figure 2, the highest PNI modified values are observed for learning personalization (0.61), feedback quality (0.55), and adaptive learning (0.52). This indicates that students associate the main expectations from the introduction of artificial intelligence primarily with the possibility of building individual educational trajectories and receiving more operational support in the learning process. The lowest index values were obtained for automated assessment (0.28) and critical thinking development (0.31), which indicates a comparatively smaller gap between the current and desired state in these areas.

RQ2: Expert assessment of the feasibility and pedagogical significance of artificial intelligence integration mechanisms

The second research question was aimed at determining how expert assessments of pedagogical significance and feasibility can refine and complement the results obtained based on the PNI modified index. If the first stage of the study allowed us to identify the most in-demand mechanisms for integrating artificial intelligence from the point of view of students, then the expert analysis was focused on assessing the practical possibilities of their implementation in the educational environment.

The experts were asked to evaluate the proposed model for integrating artificial intelligence into distance learning platforms based on two main criteria: pedagogical significance and feasibility of implementation. The assessment was conducted on a five-point scale. Special attention was paid to such aspects as the conceptual validity of the model, the possibility of its practical use in educational organizations, the expected pedagogical effects, as well as organizational and technological conditions for implementation.

The results of the expert assessment are presented in table 5. In general, experts highly appreciated the proposed model of integration of artificial intelligence. The average indicator of pedagogical significance was 4.61 points, and the average indicator of realizability was 4.57 points out of 5 possible.

Table 5. Expert assessment of the pedagogical significance and feasibility of AI integration mechanisms

Indicator	Pedagogical significance	Feasibility	Interpretation
1. The conceptual model of AI integration	4,75	4,72	Very high
2. Adaptive learning	4,70	4,65	Very high
3. Intellectual analysis of educational data	4,65	4,60	Very high
4. Intelligent recommendation systems	4,55	4,52	High
5. Automated assessment	4,48	4,50	High
6. Personalizing learning	4,78	4,70	Very high
7. Improving the quality of feedback	4,70	4,65	Very high
8. Increasing learning motivation	4,62	4,58	High
9. Developing self-study skills	4,55	4,50	High
10. General assessment of the model	4,61	4,57	High

The highest marks were given to the personalization of learning, the conceptual model of integration of artificial intelligence and adaptive learning. According to experts, it is these areas that can have the most significant impact on improving the quality of distance education soon.

To compare the results of student and expert surveys, an integral priority Index (CPI) was calculated, which simultaneously considers the level of student needs, the pedagogical significance and the feasibility of each mechanism for integrating artificial intelligence.

The results of the CPI calculation are presented in Table 6.

Table 6. Integral Priority Index (CPI) and the stages of implementation of AI mechanisms

The AI integration mechanism	PNI modified	Significance	Feasibility	CPI	The implementation stage
Adaptive learning	0,52	4,70	4,65	1,00	Stage 1 (short-term)
Intelligent Analytics	0,41	4,65	4,60	0,78	Stage 1 (short-term)
Personalized recommendations	0,33	4,55	4,52	0,63	Stage 2 (medium-term)
Automated assessment	0,28	4,48	4,50	0,53	Stage 3 (long-term)
Personalizing learning	0,61	4,78	4,70	0,97	Stage 1 (short-term)
Quality of feedback	0,55	4,70	4,65	0,91	Stage 1 (short-term)
Educational motivation	0,47	4,62	4,58	0,76	Stage 2 (medium-term)
Self-learning and self-regulation	0,39	4,55	4,50	0,66	Stage 2 (medium-term)

The results show that adaptive learning, personalization of learning, and intelligent analysis of educational data are characterized by the highest CPI values. These mechanisms simultaneously demonstrate a high level of demand on the part of students and high assessments of pedagogical significance and feasibility on the part of experts.

In contrast, automated assessment received a relatively lower CPI value. Despite the high potential of this technology, experts noted the need for additional methodological and organizational training for its full implementation in educational practice.

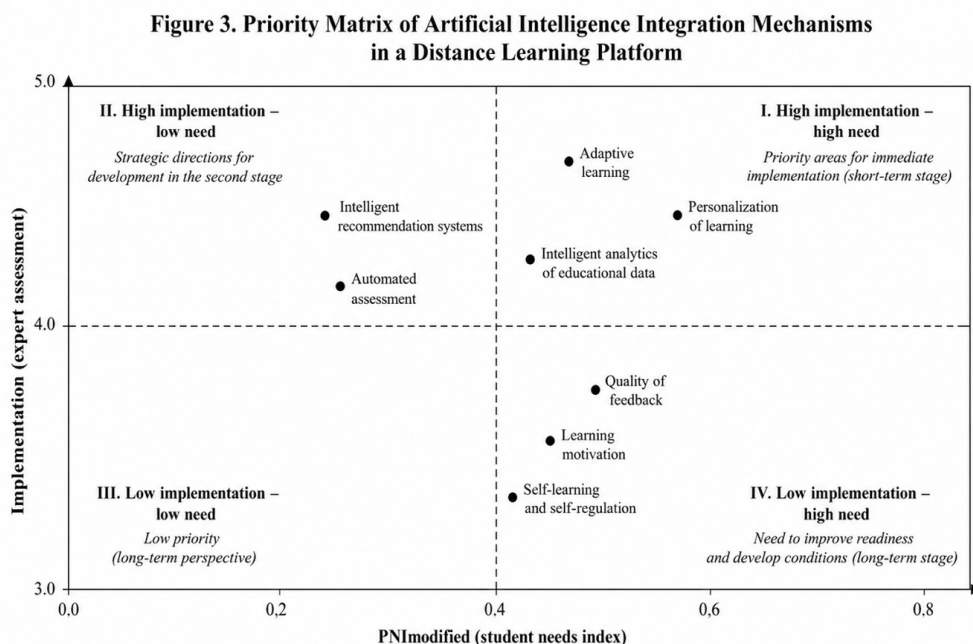


Figure 3 – Matrix of priority of mechanisms for integrating artificial intelligence into distance learning platforms

Figure 3 shows the PNI modified values along the X-axis, reflecting the needs of students, and the Y-axis shows the feasibility of implementation according to expert estimates. In the upper right quadrant, there are mechanisms that are both highly demanded and highly feasible (adaptive learning, personalization of learning, intelligent analytics), which are considered as priority areas of short-term implementation.

RQ3: Validation of a conceptual model for integrating artificial intelligence into distance learning platforms

The third research question was aimed at determining to what extent the identified priorities confirm the conceptual validity and practical significance of the proposed model for integrating artificial intelligence into distance learning platforms. Special attention was paid to assessing whether the identified structure of students' needs and expert assessments corresponded to the logic of the developed model and whether it could be used as a tool for planning further development of the digital educational environment.

From the point of view of internal consistency, the research results demonstrate a high degree of correspondence between the identified needs of students and the main provisions of the conceptual model. According to the proposed model, adaptive learning, intelligent educational data analytics, recommendation systems, and automated assessment are key areas of artificial integration. The results of the analysis showed that it was these mechanisms

that received the highest values of the PNI modified index, which confirms their relevance and relevance in modern distance education.

The highest rates were identified for adaptive learning and personalization of the educational process. These results are consistent with the theoretical assumptions of the model, according to which the use of artificial intelligence algorithms should consider the individual characteristics of students, adapt the content of educational materials and build personalized educational trajectories. High index values were also obtained for intellectual analysis of educational data, which confirms the importance of monitoring, forecasting and support tools for pedagogical decision-making in the digital educational environment.

From the point of view of the strategic validity of the research, an important result was the coincidence of priorities identified since student assessments and expert opinions. The ranking of artificial intelligence integration mechanisms obtained using the PNI modified index has largely been preserved after considering expert assessments of pedagogical significance and feasibility through the integral CPI index. Adaptive learning, personalization of learning, and intelligent analysis of educational data occupied the highest positions in both cases.

At the same time, experts drew attention to additional factors that are not always directly perceived by students but have a significant impact on the success of the introduction of artificial intelligence technologies. These include developing the digital infrastructure of educational institutions, training teachers to use intelligent technologies, ensuring information security, protecting personal data, and creating a regulatory and methodological framework for the use of AI in education. The inclusion of these factors in the implementation strategy made it possible to expand the initial model and increase its practical applicability.

An additional confirmation of the validity of the proposed model was the high expert assessments of its pedagogical significance and feasibility. The average values for these indicators exceeded 4.5 points on a five-point scale, which indicates a positive perception of the model by experts in the field of digital education. The experts noted the logical structure of the model, its compliance with modern trends in the development of educational technologies and the possibility of using it as a basis for further modernization of distance learning platforms.

Taken together, the data obtained suggest that the integration of artificial intelligence into distance learning platforms can provide significant pedagogical benefits, including personalizing learning, improving the quality of feedback, increasing learning motivation, developing self-learning skills, and improving educational outcomes. Therefore, the proposed model can be considered as an effective conceptual framework for the further development of intelligent educational systems and the design of a new generation of digital educational environment.

The results obtained allow us to consider artificial intelligence as one of the key factors for the further development of distance learning platforms and improving the quality of the educational process. The analysis showed that the

most significant gaps between the current and desired state of the educational environment are related to adaptive learning, personalization of educational content, intelligent data analytics and the quality of feedback. These areas demonstrated the highest values of the PNI modified index and were additionally confirmed by high expert assessments of pedagogical significance and feasibility.

From a pedagogical point of view, the results of the study indicate an increasing need for students in more flexible and personalized educational trajectories. In most cases, traditional distance learning platforms are focused on a single scenario for learning educational material, which limits the ability to consider the individual characteristics of students. In contrast, artificial intelligence technologies make it possible to adapt the content of learning, the level of complexity of tasks and the forms of interaction in accordance with the educational needs of a particular student. The high PNI modified values for adaptive learning confirm that there is a significant demand for such support mechanisms.

The results related to intellectual analysis of educational data are of particular importance. Modern artificial intelligence systems are capable of continuously monitoring educational activity, predicting academic performance and identifying potential risks of reduced academic motivation or academic failure. The data obtained show that students and experts consider such tools as an important element of the digital educational environment, providing more effective support for the learning process and making pedagogical decisions based on objective data.

A significant result of the study is a high assessment of the prospects for personalizing learning and improving the quality of feedback. These areas have received the highest rates among both students and experts. This indicates that the key value of artificial intelligence in distance learning lies not so much in automating individual processes as in creating conditions for more individualized interaction between the educational platform and the student. The use of intelligent recommendation systems, chatbots, virtual assistants and generative models make it possible to provide timely support to students and increase the efficiency of learning educational material.

The results of the expert assessment also showed that the successful integration of artificial intelligence requires an integrated approach. Despite the high potential of intelligent technologies, their implementation is impossible without developing the digital infrastructure of educational institutions, training teachers to use new tools, developing methodological recommendations, and complying with information security requirements. In this regard, the most promising mechanisms for integrating artificial intelligence should be considered not as separate technological solutions, but as elements of a single digital educational ecosystem.

An important result of the study was the convergence of priorities identified based on student opinions and expert assessments. The high consistency of the PNI modified and CPI results indicates that the most sought-after artificial intelligence

integration mechanisms are at the same time the most promising in terms of their practical implementation. First, this applies to adaptive learning, intelligent analysis of educational data and personalized student support. This result confirms the possibility of forming a step-by-step strategy for the introduction of artificial intelligence technologies into distance learning platforms.

It should be noted that the introduction of intelligent technologies is associated not only with new opportunities, but also with several challenges. Among them, the issues of academic integrity, the reliability of automatically generated content, the protection of personal data and the preservation of the leading role of the teacher in the educational process are of particular importance. Therefore, the further development of intelligent educational systems should be accompanied by the development of ethical and regulatory mechanisms for regulating the use of artificial intelligence in education.

Conclusion

The present study was aimed at studying the mechanisms of integrating artificial intelligence into distance learning platforms and identifying their promising pedagogical effects. Unlike existing studies, which mainly consider individual artificial intelligence technologies, this work proposed a comprehensive approach to analyzing the possibilities of intellectualizing the digital educational environment, combining an assessment of students' needs and expert views on the pedagogical significance and feasibility of AI technologies.

During the research, the most demanded areas of integration of artificial intelligence into distance learning platforms were identified. The analysis results showed that the highest values of the PNI modified index were recorded for adaptive learning (0.52), intelligent educational data analytics (0.41), intelligent recommendation systems (0.33) and automated assessment (0.28). Among the expected pedagogical effects, the highest rates were obtained for personalizing learning (0.61), improving the quality of feedback (0.55), and increasing learning motivation (0.47). The results indicate that there is a significant gap between the current capabilities of most distance learning platforms and the expectations of students regarding the use of intelligent technologies in the educational process.

The expert assessment confirmed the high pedagogical significance and feasibility of the proposed model of integration of artificial intelligence. The average values of pedagogical significance and feasibility were 4.61 and 4.57 points, respectively, on a five-point scale. Adaptive learning, personalization of the educational process, and intelligent analysis of educational data were recognized as the most promising areas of implementation. The results of the calculation of the integral priority index (CPI) have shown that it is these mechanisms that should be considered as the primary directions of the digital transformation of the educational environment.

Of particular importance is the fact that the results of student and expert surveys have demonstrated a high level of consistency. The coincidence of priorities identified using the PNI modified index and CPI expert assessments

confirms not only the relevance of the identified mechanisms for integrating artificial intelligence, but also the possibility of their practical implementation in modern educational institutions. This indicates that the development of intelligent educational technologies should be focused primarily on the personalization of learning, improving the quality of feedback and the use of analytical tools to support pedagogical decision-making.

From a theoretical point of view, the study confirms that artificial intelligence can act not only as a technological tool for automating individual processes, but also as an important factor in the transformation of pedagogical approaches in distance learning. The integration of adaptive algorithms, intelligent analytics and recommendation systems creates conditions for building a more flexible, student-oriented educational environment that promotes the development of students' independence, motivation and academic success.

The practical significance of the research lies in the possibility of using the results obtained in developing strategies for the digital transformation of educational organizations, improving distance learning platforms and designing intelligent educational services. The proposed model can serve as a basis for decision-making regarding priority areas for the introduction of artificial intelligence into educational practice.

However, studying has several limitations. The assessment of pedagogical effects was based primarily on students' perceptions and expert judgments, which requires further experimental verification of the effectiveness of specific AI technologies in the real educational process. In addition, the dynamic development of artificial intelligence implies the need for constant updating of models and approaches to its use in education.

The prospects for further research are related to the experimental implementation of intelligent educational services in distance learning platforms, the study of the impact of generative artificial intelligence on student educational outcomes, the analysis of issues of academic integrity and digital ethics, as well as the development of models of interaction between teachers and intelligent educational systems in the context of digital transformation of education.

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ҚАШЫҚТЫҚТАН ОҚЫТУ ПЛАТФОРМАЛАРЫНА ЖАСАНДЫ ИНТЕЛЛЕКТТІ ИНТЕГРАЦИЯЛАУ МЕХАНИЗМДЕРІ ЖӘНЕ ОЛАРДЫҢ БОЛАШАҚТАҒЫ ПЕДАГОГИКАЛЫҚ ӘСЕРІ

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Аңдатпа. Қашықтықтан оқыту платформалары жоғары білім беру жүйесінің маңызды құрамдас бөлігіне айналып отыр. Алайда олардың тиімділігі оқытуды жекелендіру, сапалы кері байланыс ұйымдастыру, білім алушылардың оқу мотивациясын қолдау және өзін-өзі реттеп оқу

дағдыларын дамыту мүмкіндіктеріне байланысты. Осы зерттеудің мақсаты – жасанды интеллектті қашықтықтан оқыту платформаларына интеграциялау механизмдерін анықтау және олардың болашақтағы педагогикалық әсерлерін бағалау. Зерттеу аралас әдіснама негізінде жүргізіліп, оған 400 бакалавриат студенті мен цифрлық білім беру саласындағы 15 сарапшы қатысты. Студенттердің қажеттіліктерін анықтау үшін өзгертілген басым қажеттіліктер индексі (PNI modified), ал жасанды интеллект құралдарын енгізудің басымдықтарын бағалау үшін қажеттілік деңгейін, педагогикалық маңыздылығын және іске асыру мүмкіндігін біріктіретін кешенді басымдық индексі (CPI) қолданылды. Нәтижелер жасанды интеллектті енгізудің ең перспективалы бағыттары ретінде адаптивті оқыту, білім беру деректерінің интеллектуалды аналитикасы, жекелендірілген ұсынымдық жүйелер және автоматтандырылған бағалау механизмдерін көрсетті. Педагогикалық әсерлер арасында оқытуды жекелендіру, кері байланыстың сапасын арттыру және оқу мотивациясын күшейту ең маңызды факторлар ретінде анықталды. Сарапшылардың бағалауы ұсынылған жасанды интеллектті интеграциялау моделінің жоғары педагогикалық маңыздылығы мен практикалық іске асырылу мүмкіндігін растады. Зерттеу нәтижелері білім беру ұйымдарын цифрлық трансформациялау стратегияларын әзірлеуде және қашықтықтан оқыту платформаларын жетілдіруде қолданылуы мүмкін.

Тірек сөздер: қашықтықтан оқыту, жасанды интеллект, жасанды интеллектті интеграциялау, адаптивті оқыту, білім беру аналитикасы, жекелендірілген оқыту, кері байланыс, оқу мотивациясы, цифрлық білім беру

МЕХАНИЗМЫ ИНТЕГРАЦИИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В ПЛАТФОРМЫ ДИСТАНЦИОННОГО ОБУЧЕНИЯ И ИХ ПЕРСПЕКТИВНЫЕ ПЕДАГОГИЧЕСКИЕ ЭФФЕКТЫ

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Аннотация. Платформы дистанционного обучения становятся неотъемлемой частью современной системы высшего образования, однако эффективность их использования во многом определяется возможностями персонализации обучения, обеспечения своевременной обратной связи, поддержки учебной мотивации и развития навыков саморегулируемого обучения. Целью данного исследования является изучение механизмов интеграции искусственного интеллекта в платформы дистанционного обучения и оценка их перспективных педагогических эффектов. Исследование выполнено с использованием смешанного дизайна и охватило 400 студентов бакалавриата и 15 экспертов в области цифрового образования. Для анализа потребностей обучающихся был использован модифицированный индекс приоритетных потребностей (PNI modified), а для определения приоритетности внедрения механизмов искусственного

интеллекта применён интегральный индекс приоритетности (CPI), учитывающий уровень потребности, педагогическую значимость и реализуемость решений. Результаты показали, что наиболее перспективными направлениями интеграции искусственного интеллекта являются адаптивное обучение, интеллектуальная аналитика образовательных данных, персонализированные рекомендательные системы и автоматизированное оценивание. Среди ожидаемых педагогических эффектов наибольшее значение имеют персонализация обучения, повышение качества обратной связи и усиление учебной мотивации. Экспертная оценка подтвердила высокую педагогическую значимость и практическую реализуемость предложенной модели интеграции искусственного интеллекта. Полученные результаты могут быть использованы при разработке стратегий цифровой трансформации образовательных организаций и совершенствовании платформ дистанционного обучения.

Ключевые слова: дистанционное обучение, искусственный интеллект, интеграция искусственного интеллекта, адаптивное обучение, образовательная аналитика, персонализированное обучение, обратная связь, учебная мотивация, цифровое образование

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