Integration Of Artificial Intelligence Into The Structure Of Modern Digital Teaching Materials

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Abstract:
The article discusses the theoretical, methodological, and technological aspects of integrating artificial intelligence into the structure of modern digital teaching materials in the context of the digitalization of higher education in 2025–2026.

It is argued that digital teaching materials are transforming from static electronic resources into multi-component intelligent educational environments that include theoretical, practical, assessment, analytical, and methodological modules. It is shown that the introduction of machine learning algorithms and natural language processing technologies provides adaptive content management, automated knowledge assessment, semantic analysis of educational works, learning analytics, and prediction of educational outcomes. Particular attention is paid to the mechanisms of personalization of learning, the formation of individual educational trajectories, and the functioning of intelligent learning systems. The pedagogical, technological, and ethical conditions for the effective integration of AI are identified, including methodological soundness, digital competence, and ethical considerations.

Background: *Artificial intelligence (AI) is the capability of computational systems to perform tasks typically associated with human intelligence, such as learning, reasoning, problem-solving, perception, and decision-making. It is a field of research in computer science that develops and studies methods and software that enable machines to perceive their environment and use learning and intelligence to take actions that maximize their chances of achieving defined goals.[1] High-profile applications of AI include advanced web search engines (e.g., Google Search); recommendation systems (used by YouTube, Amazon, and Netflix); virtual assistants (e.g., Google Assistant, Siri, and Alexa); autonomous vehicles (e.g., Waymo); generative and creative tools (e.g., language models and AI art); and superhuman play and analysis in strategy games (e.g., chess and Go). However, many AI applications are not perceived as AI: "A lot of cutting edge AI has filtered into general applications, often without being called AI because once something becomes useful enough and common enough it's not labeled AI anymore."[2][3].*

Materials and Methods: *This study employed a mixed-methods design combining theoretical analysis, empirical survey research, and machine learning modeling.*

The empirical component was conducted in 2025 at the Naryn Campus of the Kyrgyz National University named after Jusup Balasagyn. The sample included 101 undergraduate students of the Agricultural and Technical Faculty. A structured questionnaire (in Kyrgyz and Russian) was used to assess the frequency, purposes, and attitudes toward artificial intelligence (AI) use in learning. Participation was voluntary and data were anonymized.

Digital teaching materials analyzed in the study consisted of multi-component modules including theoretical content, practical tasks, automated assessment, and analytical dashboards. AI technologies examined included machine learning algorithms, natural language processing tools, adaptive learning mechanisms, intelligent tutoring systems, and learning analytics.

Student academic performance was modeled using logistic regression. Predictors included learning pace, error frequency, and engagement indicators derived from digital learning traces. Data preprocessing and modeling procedures were implemented in Jupyter Notebook. Model performance was evaluated using classification accuracy and predictive probability estimation.

Results: *The analysis showed that integrating artificial intelligence into modern digital teaching materials is a strategic direction for higher education development in the context of global digital transformation. AI is not an auxiliary tool, but a system-forming component of the digital educational environment, ensuring its adaptability, analytically, and personalized focus.*

The introduction of machine learning algorithms, natural language processing technologies, and educational analytics tools contributes to the formation of individual educational trajectories, increased objectivity of assessment, and prompt feedback. The intellectualization of the theoretical, practical, assessment, analytical, and

methodological modules of digital teaching materials enables continuous monitoring of educational outcomes and timely pedagogical correction.

At the same time, it has been established that the effectiveness of AI integration is determined by a combination of methodological, organizational, and ethical conditions. Key factors include scientifically sound design of digital materials, development of teachers' digital and analytical skills, ensuring transparency of algorithms, and compliance with the principles of protecting students' personal data. Ignoring these conditions can lead to a reduction in the role of pedagogical interaction, formalization of knowledge assessment, and increased risks of algorithmic bias.

Conclusion: *Thus, artificial intelligence transforms the structure of digital teaching materials, turning them into dynamic intelligent educational systems. Prospects for further research are linked to the development of models for the pedagogically appropriate integration of AI, criteria for evaluating the effectiveness of adaptive digital environments, and mechanisms for ensuring the ethical sustainability of educational technologies. The implementation of these areas will ensure a sustainable improvement in the quality of education and the alignment of specialist training with the requirements of the digital economy.*

Key Word: *artificial intelligence, digital instructional materials, digitalization of education, adaptive learning, personalized learning path, intelligent tutoring systems, machine learning, learning analytics, automated assessment, digital learning environment, higher education, pedagogical technology, teacher digital competence, ethics of artificial intelligence.*

I. Introduction

In 2025-2026, digital teaching materials ceased to be simple electronic versions of printed textbooks and became multi-component interactive educational environments. Their fundamental difference from traditional aids lies in their high degree of adaptability: modern platforms rely on artificial intelligence algorithms that analyze the dynamics of a student's learning activities and automatically adjust the level of difficulty and format of content presentation. Electronic learning modules include integrated 3D models, audio and video materials, as well as hyperlinks to relevant scientific databases and digital resources.

The integration of machine learning algorithms, intelligent data analysis, and natural language processing technologies makes it possible to adapt content to the individual educational needs of students, automate the checking of assignments, generate recommendations, and predict academic results.

The interaction of the education system with artificial intelligence and its adaptation to its tools is not just a technical modernization, but also a transformation that will affect all aspects of the educational process. This will require a rethinking of the goals, methods, and tools of education. There is a need to develop new pedagogical approaches, as existing methods may prove ineffective when working with AI tools. New approaches need to be developed that integrate AI into the learning process in such a way that its tools complement rather than replace human interaction [4].

II. Material And Methods

Summary of the main content of the article. AI integration enables materials to respond to the user's so-called "digital footprint." Using unsupervised machine learning methods such as clustering and principal component analysis, the system identifies hidden behavioral and cognitive patterns. If difficulties are detected at a certain stage of content mastery, digital teaching materials automatically modify the structure of the module, offering alternative ways of assimilating information, such as replacing text explanations with interactive simulations or visualizations.

The introduction of artificial intelligence technologies into the educational process allows for the creation of a more flexible and adaptive learning system capable of considering these nuances. This can increase students' motivation and interest in learning, and in the future will contribute to the more effective training of specialists [3].

Artificial intelligence can also assist in the management of higher education institutions, freeing up faculty and staff to focus on more important tasks[5].

Artificial intelligence plays an important role in improving the quality of the educational process. One of its main advantages is that it allows for personalized learning. Modern platforms can analyze student performance data and create individualized learning plans that take into account the pace of learning, level of preparation, and interests of students. Artificial intelligence can also help automate routine tasks such as checking homework, scheduling, and managing the learning process. This allows teachers to focus on more complex aspects of teaching, such as developing critical thinking and maintaining student motivation [2].

Among the factors influencing the specifics of modern higher education, digitalization should be highlighted first and foremost. The widespread use of information and communication technologies is leading to the emergence of new formats for the educational process and the introduction of new innovative methods and models of pedagogical interaction. In addition, the introduction of modern information technologies is changing the very process of work, new professions are emerging, and new jobs are being created that require specialists to have new knowledge and skills and new educational outcomes. In this regard, there is a need to introduce the latest scientific achievements, including artificial intelligence, into the educational process.

In 2025, in order to study the degree of penetration of artificial intelligence into the lives of students, to find out what tools students prefer, for what purposes they use them, and what their views are on the use of artificial intelligence, a survey on the use of AI was conducted among students of the Agricultural and Technical Faculty of Naryn State University. The survey results showed that the use of AI by students for learning has already become a habit and is radically changing students' attitudes towards education. The survey was conducted in Kyrgyz and Russian, according to the students' preferences.

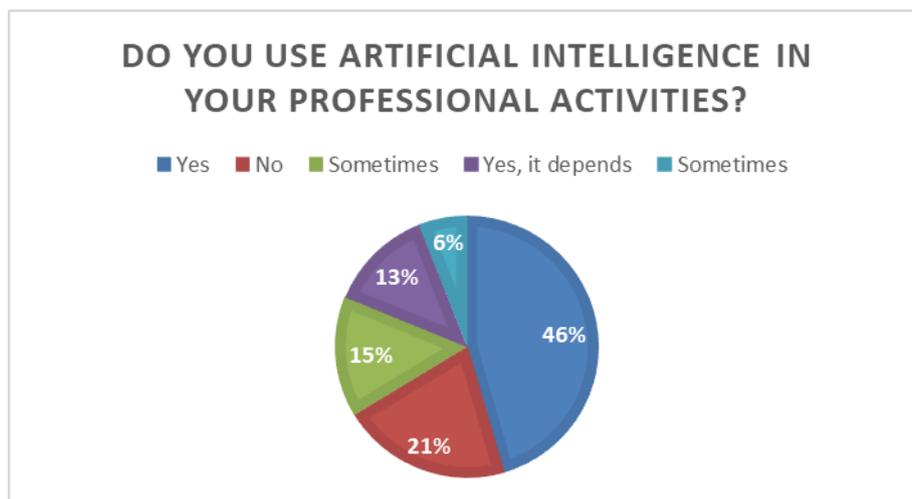Almost 50 percent of the 101 students surveyed said they use artificial intelligence.

Fig. 1. Overview of AI usage

When asked what they use it for, most students responded that they use it to create presentations and write texts.
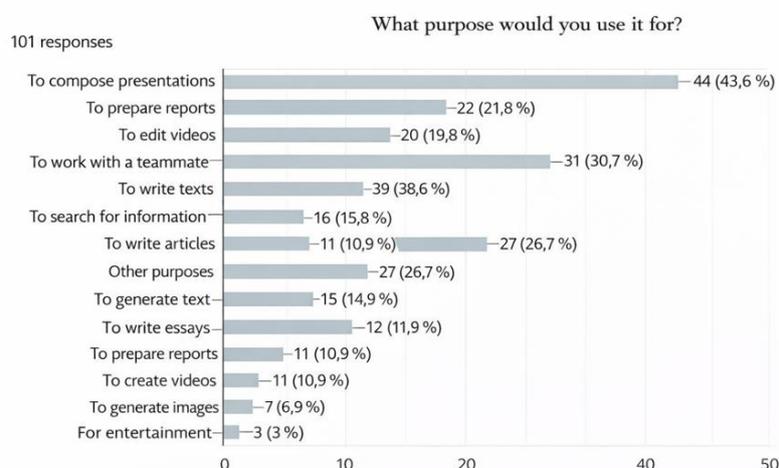

Fig. 2. Purpose of AI use

The diagram shows that almost 70 percent of the students surveyed use AI to create presentations, which may mean that they prefer to create presentations quickly so as not to waste time searching for information on the Internet.

As can be seen from the diagram below, the most popular tool among students is Chat GPT, a tool from Open AI known for its simplicity, ease of use, and partial free access.
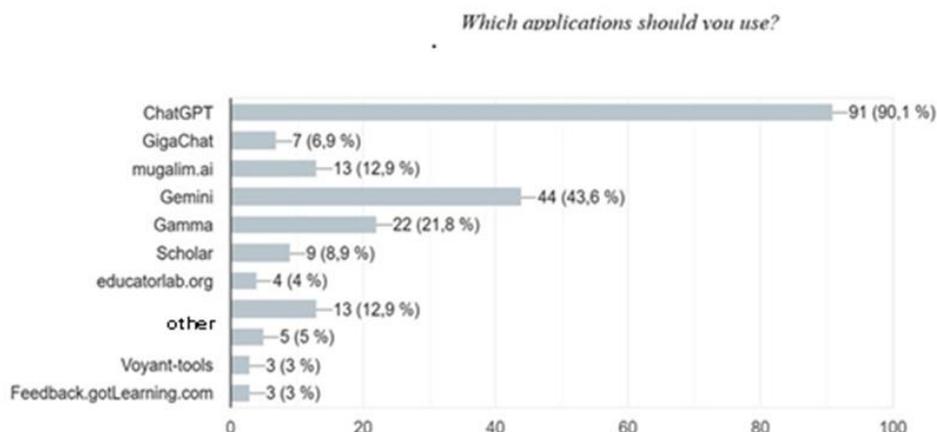

Which applications should you use?

ChatGPT	91 (90,1 %)
GigaChat	7 (6,9 %)
mugalim.ai	13 (12,9 %)
Gemini	44 (43,6 %)
Gamma	22 (21,8 %)
Scholar	9 (8,9 %)
educatorlab.org	4 (4 %)
other	13 (12,9 %)
	5 (5 %)
Voyant-tools	3 (3 %)
Feedback.gotLearning.com	3 (3 %)

Fig. 3. Students' use of applications

At the end of the survey, students were asked whether AI could completely replace humans. According to their responses, AI cannot replace humans, but it can help analyze information, structure it, and save time. As the survey shows, students understand that artificial intelligence cannot completely replace humans, but the question of whether the next generation will accept such a decision remains open.

Artificial intelligence in education is seen as a set of algorithms and software solutions that can analyze educational data, model-learning activities, and adapt learning content to the individual characteristics of learners.

In an educational context, AI performs the following functions:
• Adaptive management of educational content;
• Intelligent support for learners;
• Automated assessment of knowledge;
• Analysis of educational data (learning analytics);
• Prediction of educational outcomes.
AI can be integrated into each of these components, ensuring the intellectualization of the entire system.

Adaptive learning is one of the key mechanisms for AI integration. Based on an analysis of the learner's responses, the system:
• changes the level of difficulty of the tasks;
• offers additional explanations;
• creates an individual learning path.

Machine learning algorithms analyze the pace of work, frequency of errors, and style of interaction with the material. The result is a personalized educational environment. Intelligent Tutoring Systems simulate the functions of a teacher. They are capable of:
• giving hints;
• explaining mistakes;
• forming recommendations for reviewing material;
• maintaining a dialogue with the student.

AI enables automation of:
• test assignment checking;
• open-ended response analysis;
• essay evaluation based on NLP;
• proctoring (integrity control).
Analytical dashboards allow teachers to see the dynamics of competency development in real time.

The effectiveness of AI implementation in digital teaching materials depends on the following conditions:
1. Methodological soundness - AI should reinforce pedagogical strategy, not replace it.
2. Teacher digital competence - proficiency in data analysis and adaptive design tools.
3. Ethical standards - protection of students' personal data.
4. Transparency of algorithms - understanding the principles of AI.

III.   Result

During the study, work was carried out on modeling students' academic performance using a machine learning logistic regression model.
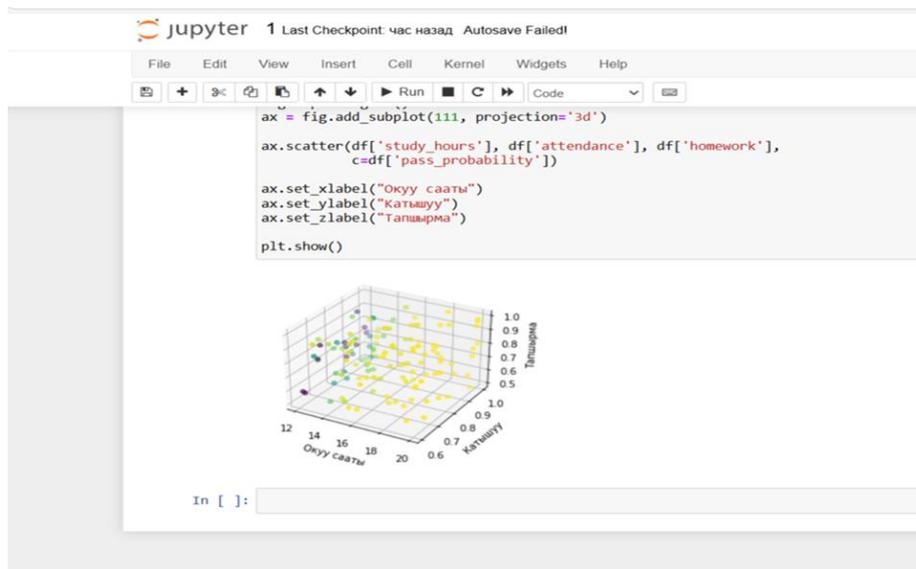

Figure 4. Analysis of student performance

Fig. 5. Data analysis was performed in the Jupyter Notebook web application

The experimental study allowed us to draw the following conclusions:
• Machine learning has high potential for predicting student performance;
• Quantitative assessment of the impact of learning factors contributes to improving the quality of education;
• Digital analytics is an innovative tool for managing the education system.

This study confirms that the use of machine learning in the educational process is scientifically sound and has practical significance.

IV.   Conclusion

The analysis showed that integrating artificial intelligence into modern digital teaching materials is a strategic direction for higher education development in the context of global digital transformation. AI is not an auxiliary tool, but a system-forming component of the digital educational environment, ensuring its adaptability, analytically, and personalized focus.

The introduction of machine learning algorithms, natural language processing technologies, and educational analytics tools contributes to the formation of individual educational trajectories, increased objectivity of assessment, and prompt feedback. The intellectualization of the theoretical, practical, assessment, analytical, and methodological modules of digital teaching materials enables continuous monitoring of educational outcomes and timely pedagogical correction.

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Thus, artificial intelligence transforms the structure of digital teaching materials, turning them into dynamic intelligent educational systems. Prospects for further research are linked to the development of models for the pedagogically appropriate integration of AI, criteria for evaluating the effectiveness of adaptive digital environments, and mechanisms for ensuring the ethical sustainability of educational technologies. The implementation of these areas will ensure a sustainable improvement in the quality of education and the alignment of specialist training with the requirements of the digital economy.

References

[1]. Russell, Stuart J.; Norvig, Peter (2021). Artificial Intelligence: A Modern Approach (4th Ed.). Hoboken: Pearson. ISBN 978-0-1346-1099-3. LCCN 20190474
[2]. Vyugin, V. V. Mathematical Foundations Of Machine Learning And Forecasting [Text] / V. V. Vyugin. - Moscow: Moscow Center For Continuous Mathematical Education (MCCME) Publishing House, 2013. - 305 P.
[3]. Radkevich A. S., Radkevich K. A., Ryabinin N. S. Artificial Intelligence In Modern Education / Https://Libeldoc.Bsuir.By/Bitstream/123456789/58509/1/Radkevich_Iskusstvennyj.Pdf
[4]. Khabarova N.D. Integration Of Artificial Intelligence And Neuroimaging Technologies For Personalization Of Learning / Information And Communication Technologies In Teacher Education, 2025. No. 4 (97)
[5]. Shestakova N. N., Dzhanelidze M. G. Artificial Intelligence: Impact On The Education-Labor Market System / MANAGEMENT CONSULTING. No. 5. 2025, Pp. 91-105 / Https://Www.Acjournal.Ru/Jour/Article/Viewfile/2829/2068
[6]. Strunin, D. A. Artificial Intelligence In The Field Of Education / D. A. Strunin. — Text: Direct // Molodoy Uchenyy. — 2023. — No. 6 (453). — P. 15–16. — URL: Https://Moluch.Ru/Archive/453/99921
[7]. Kaplan, Andreas; Haenlein, Michael (2019). "Siri, Siri, In My Hand: Who's The Fairest In The Land? On The Interpretations, Illustrations, And Implications Of Artificial Intelligence". Business Horizons. 62: 15–25.
[8]. Second AI Winter: Russell & Norvig (2021, P. 24), Mccorduck (2004, Pp. 430–435), Crevier (1993, Pp. 209–210), NRC (1999, Pp. 214–216), Newquist (1994, Pp. 301–318)
[9]. Problem-Solving, Puzzle Solving, Game Playing, And Deduction: Russell & Norvig (2021, Chpt. 3–5), Russell & Norvig (2021, Chpt. 6) (Constraint Satisfaction), Poole, Mackworth & Goebel (1998, Chpt. 2, 3, 7, 9), Luger & Stubblefield (2004, Chpt. 3, 4, 6, 8), Nilsson (1998, Chpt. 7–12)
[10]. Uncertain Reasoning: Russell & Norvig (2021, Chpt. 12–18), Poole, Mackworth & Goebel (1998, Pp. 345–395), Luger & Stubblefield (2004, Pp. 333–381), Nilsson (1998, Chpt. 7–12)
[11]. Intractability And Efficiency And The Combinatorial Explosion: Russell & Norvig (2021, P. 21)
[12]. Psychological Evidence Of The Prevalence Of Sub-Symbolic Reasoning And Knowledge: Kahneman (2011), Dreyfus & Dreyfus (1986), Wason & Shapiro (1966), Kahneman, Slovic & Tversky (1982)
[13]. Knowledge Representation And Knowledge Engineering: Russell & Norvig (2021, Chpt. 10), Poole, Mackworth & Goebel (1998, Pp. 23–46, 69–81, 169–233, 235–277, 281–298, 319–345), Luger & Stubblefield (2004, Pp. 227–243), Nilsson (1998, Chpt. 17.1–17.4, 18)
[14]. Smoliar, Stephen W.; Zhang, Hongjiang (1994). "Content Based Video Indexing And Retrieval". IEEE Multimedia. 1 (2): 62–72. Doi:10.1109/93.311653.
[15]. Poole, David; Mackworth, Alan; Goebel, Randy (1998). Computational Intelligence: A Logical Approach. New York: Oxford University Press. ISBN 978-0-1951-0270-3. Archived From The Original On 26 July 2020. Retrieved 22 August 2020.