THE ROLE OF ARTIFICIAL INTELLIGENCE IN THE DEVELOPMENT OF INNOVATIVE METHODS AND APPROACHES IN EDUCATION

O PAPEL DA INTELIGÊNCIA ARTIFICIAL NO DESENVOLVIMENTO DE MÉTODOS E ABORDAGENS INOVADORES NO DOMÍNIO DA EDUCAÇÃO

EL PAPEL DE LA INTELIGENCIA ARTIFICIAL EN EL DESARROLLO DE MÉTODOS Y ENFOQUES INNOVADORES EN LA EDUCACIÓN

Victoriya NICHYSHYNA[1]
e-mail: vika.nichishina@ukr.net

Oleksandr BORDIUK[2]
e-mail: bbsanb@gmail.com

Tetiana SLABOSHEVSKA[3]
e-mail: btm-77@ukr.net

Kateryna HESELEVA[4]
e-mail: heseleva@kpnu.edu.ua

Liudmyla TKACHENKO[5]
e-mail: l.a.kulish@npu.edu.ua

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[1] Central Ukrainian State University named after Volodymyr Vinnichenko, Kropyvnytskyi – Ukraine. Associate Professor of the Department of Mathematics and Digital Technologies, Faculty of Mathematics. Natural Sciences and Technologies. PhD in Pedagogy. Researcher ID: IAM-7845-2023

[2] Ukrainian State Dragomanov University, Kyiv – Ukraine. Assistant professor. Department of Information Systems and Technologies. Faculty of Technologies and Design. PhD in Pedagogy. Researcher ID: JCO-1342-2023.

[3] Ukrainian State Dragomanov University, Kyiv – Ukraine. Associate Professor. Department of Information Systems and Technologies. Faculty of technologies and design. PhD in Pedagogy. Researcher ID: GLN-3420-2022.

[4] Kamianets-Podilskyi Ivan Ohiienko National University, Kamianets-Podilskyi – Ukraine. Senior Teacher. Department of Mathematics, Faculty of Physics and Mathematics. PhD in Physics and Mathematics.

[5] Ukrainian State Dragomanov University, Kyiv – Ukraine. Associate Professor.

ABSTRACT: The article aims to analyze the scientific and educational discourse on the expediency of using artificial intelligence in the educational process. About 50 scientific papers have been studied, devoted to various elements of AI in the educational system, and structured into two main clusters: target and functional. The research methodology is based on general scientific analysis and philosophical and synergistic methodological approaches. The study's results indicate the actualization of AI in the education system and the dominance of the functional aspect of using this tool in the practical and pragmatic dimension of the educational process. Thus, the functionality of AI tools does not raise any objections in the scientific and educational community. The situation is different with the positioning of artificial intelligence in the intuitive and targeted dimension of education.

KEYWORDS: Artificial intelligence. Educational innovations. ICT. Educational paradigm.

RESUMO: *O propósito deste artigo é analisar o discurso científico e pedagógico sobre a viabilidade da utilização da inteligência artificial no processo educacional. Foram examinados aproximadamente 50 artigos científicos, abordando diversos elementos da inteligência artificial no sistema educativo e categorizados em dois amplos grupos: objetivo e funcional. A metodologia de pesquisa fundamenta-se em uma análise científica abrangente, incorporando abordagens metodológicas filosóficas e sinérgicas. Os resultados da investigação apontam para a integração atualizada da inteligência artificial no sistema educacional, com uma predominância evidente do aspecto funcional no uso dessa ferramenta na dimensão prática e pragmática do processo educativo. Nesse contexto, a funcionalidade das ferramentas de inteligência artificial não suscita objeções na comunidade científica e educacional. No entanto, a situação difere quando se trata do posicionamento da inteligência artificial na dimensão intuitiva e direcionada da educação.*

PALAVRAS-CHAVE: *Inteligência artificial. Inovações educativas. TIC. Paradigma educativo.*

RESUMEN: *El propósito del artículo es analizar el discurso científico y educativo sobre la conveniencia de utilizar la inteligencia artificial en el proceso educativo. Se han estudiado unos 50 artículos científicos dedicados a diversos elementos de la IA en el sistema educativo y estructurados en dos grandes grupos: objetivo y funcional. La metodología de la investigación se basa en el análisis científico general y en enfoques metodológicos filosóficos y sinérgicos. Los resultados del estudio indican la actualización de la IA en el sistema educativo y el predominio del aspecto funcional del uso de esta herramienta en la dimensión práctica y pragmática del proceso educativo. Así, la funcionalidad de las herramientas de IA no suscita objeciones en la comunidad científica y educativa. La situación es diferente con el posicionamiento de la inteligencia artificial en la dimensión intuitiva y dirigida de la educación.*

PALABRAS CLAVE: *Inteligencia artificial. Innovaciones educativas. TIC. Paradigma educativo.*

Victoriya NICHYSHYNA; Oleksandr BORDIUK; Tetiana SLABOSHEVSKA; Kateryna HESELEVA and Liudmyla TKACHENKO

Introduction

The accelerated development of artificial intelligence has resulted in its incorporation into all spheres of social activity, garnering widely diverse assessments. Education, traditionally characterized by principles of sustainability, foundation, and, to some extent, conservatism, has also been impacted by the influence of the technological and digital sectors. On the one hand, the technologization of education constitutes an integral part of global trends in sociocultural development, so these processes do not contradict the general principles of social and civilizational progress. On the other hand, the extent and intensity of innovative elements lead to the loss of educational identity within the global paradigm.

Artificial intelligence can potentially replace educational effectiveness at the technological level; however, contradictions arise regarding the technology's ability to provide balanced educational services, encompassing moral, spiritual, ethical, and other values inherent in the classical educational system. These values have also demonstrated their relevance in existing paradigms of civilizational development over the centuries. The crucial question that arises is whether society is prepared, either in the present or the future, to replace traditional social foundations with innovations, resulting in a transformation in the format of education but also a redefinition of its meanings and existential contents. As an element of technological and digital progress, will artificial intelligence become a functional aid within the educational system? Formulating answers to these questions as imperatives is still premature, but axiological changes in the priority of key educational segments in the educational discourse are already becoming evident.

Literature Review

Contemporary scientific and educational discourse actively investigates the challenges of implementing artificial intelligence in the educational system. The practical and functional implications of the impact of AI on the educational process and the potential transformations in education resulting from the adoption of technological and digital innovations are relevant research topics. Current scientific research indicates a prevalence of practical and specific topics on the subject in studies over the last five years. In particular, out of the 47 articles analyzed, 42 focus on the purely functional dimensions of AI in education without significantly addressing the theoretical and methodological dimensions of these tools in educational strategies.

Notably, in a second group of 47 articles, the institutional and goal-oriented dimension of AI in education was not defined as a self-sufficient strategic dimension but was positioned as an interdisciplinary factor in educational transformations. When analyzing works on AI in education over the last five years, the predominance of functional topics in these studies stands out (Figure 1).

Figure 1 – Topics of scientific papers on AI in modern education
(in the context of the last 5 years)
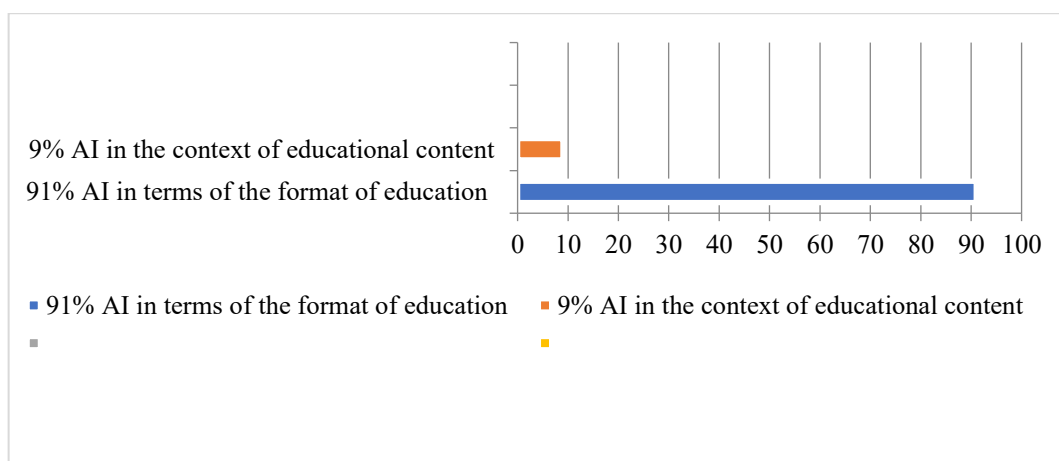
Source: Prepared by the authors

Previously, similar studies were conducted that analyzed various data on the manifestations of artificial intelligence in the educational paradigm. This included a comprehensive overview of the use of artificial intelligence in STEM education, conflicts between critics and supporters of AIEd (SCHIFF, 2021, p. 331); the uniqueness of technological influences due to artificial intelligence in educational programs of specific areas of social activity, such as medicine (VAN DER NIET; BLEAKLEY, 2020, p. 30), healthcare (CHEN *et al*., 2023, p. 161), defense and technology (CLANCEY, HOFFMAN, 2021), public administration, and business activities (SALTMAN, 2020, p. 196); the fundamentals of literacy in the potential of artificial intelligence (LAUPICHLER *et al*., 2022); peculiarities of artificial intelligence in the local (national) education system (VASYLYUK-ZAITSEVA *et al*., 2023, p. 77) and international global educational projects (VOROPAYEVA *et al*., 2022, p. 294); as well as the principles of value in the use of artificial intelligence in education (ZAWACKI-RICHTER *et al*., 2019).

Research on the use of artificial intelligence in education is diversified regarding the chronology of studies, with Zhai *et al.* (2021) exploring ten years of artificial intelligence usage

(2010-2020). Chiu *et al.* (2023) point out the dispersion and lack of conceptual concentration of artificial intelligence principles in education. Lorenzo and Gallon (2019) position artificial intelligence as an intelligent agent in the smart educational system of the future. Hodgson *et al.* (2022, p. 1878) emphasize the socio-historical mission of artificial intelligence in education as driving the ideas of the Industrial Revolution from format 4.0 to standard 5.0. Artificial intelligence and other technological and digital elements form a holistic educational and innovative paradigm of the future (KRYVOSHEIN *et al.*, 2022, p. 45).

It is observed that the initial conclusions of scientific and educational research on artificial intelligence (AI) in education were predominantly negative regarding these technological innovations. This was because of the excess of computational indicators in educational activities (COPE; KALANTZIS; SEARSMITH, 2021, p. 1229). The role of the teacher was practically leveled, encountering natural resistance from the educational community. Subsequently, the integration of AI was carried out considering the human dimensional status in education, namely: personalization of the technological space (SONG; WANG, 2020, p. 474), competency assessment (GONZÁLEZ-CALATAYUD; PRENDES-ESPINOSA; ROIG-VILA, 2021), ethics of artificial intelligence (LEWIS; STOYANOVICH, 2022, p. 783), digital environment in the pedagogical process (AL HASHIMI *et al.,* 2023, p. 176).

The purpose of this article is to analyze innovative approaches in the educational context implemented through the use of AI, leading to transformations in the educational process. The article aims to examine the initial results of introducing AI elements in education and highlight promising areas of its use.

Research Methodology

The methodological basis for scientific research was the general scientific methodological conglomerate, primarily focused on analyzing studies on the use of AI in education. The introduction of artificial intelligence occurred in a heterogeneous educational space and under the specific conditions of different educational systems (national, local, sectoral), becoming a necessary factor in attributing elements of comparative analysis to the study. System analysis was used to structure the technological and digital education segment's conceptual characteristics.

To develop perspectives on AI in the educational system, the article updates the methodology of modeling and prediction. In addition to the general scientific methods, the article incorporates philosophical principles of the synergistic dimension. In particular, interdisciplinary principles allow for the analysis of the effectiveness of AI in the context of various scientific and disciplinary models (technical, natural, humanitarian, etc.). Synergetic elements of self-organization assist in defining the human context of artificial intelligence. The current study is based on the analysis of scientific research on the use of AI in the educational process, encompassing 47 scientific articles that highlight the functional and institutional-target dimensions of education undergoing transformations and being influenced by artificial intelligence.

Results

This study actively analyzes the introduction of artificial intelligence (AI) into the educational process, considering it as a functional conglomerate. Most scientific research is dedicated to AI tools that shape new elements of pedagogical activity. Additionally, technological and digital characteristics are progressively permeating the organizational sector of education, exerting a comprehensive impact in this area.

The last stronghold that AI has not strongly influenced is the human dimensional segment of education. Participants in the educational process are currently using AI as an auxiliary or accompanying element. However, as the intensity and scale of AI usage in daily life increase, preconditions will be established for a more active introduction of these technologies into the educational process.

The human dimension of education implies various options for the subject of the educational process to respond to the impact of AI, including adaptation to new educational conditions associated with a change in the learning format (BOZKURT *et al*., 2021); proactive use of AI in the educational process by teachers and students (CHOI; JANG,;KIM, 2023, p. 910); correlation of AI with the fundamental principles of the worldview and ethics of education (CELIK, 2023); mandatory controllability of AI tools in the process of their integration into the educational system (LAMERAS; ARNAB, 2022); increased individual indicators of the relevance of education and personal motivation for its perception and dissemination (SANUSI; OYELERE, 2020, p. 1–2); AI as an element of initiative and leadership development (KONIARI; RAFTOULIS, 2023, p. 144); civic responsibility and updating the socially

significant potential of participants in the educational process (SADOVYI *et al.*, 2022, p. 213); individual level of knowledge acquisition through AI (DIYER; ACHTAICH; NAJIB, 2020, p. 1–3).

In these conditions, the question arises about the alteration of the content of the educational system, not just the format. In this case, innovative transformations in education will have dramatic consequences not only for the educational process's format but also for education's purpose. A change in the position of educational actors is likely expected, leading to a complete reset of the fundamental principles of education.

When considering the specific educational characteristics of AI, it is relevant to focus on the synergy of this technological tool with other innovations: the concept of deep learning (GUAN; MOU; JIANG, 2020, p. 134), blended learning (SEREDA, 2022, p. 239), intelligent learning systems (KOCHMAR *et al.*, 2022, p. 323), adaptive learning (HOW; HUNG, 2019), cloud technologies (HUMENIUK; ROMANIUK, 2023, p. 32).

The article proposes positioning Artificial Intelligence in two key dimensions that determine the practical use of technologies in the educational process and the changes in worldview and existential aspects in education in general (see Figure 2).

Figure 2 – Fundamental dimensions of AI in education

practical and functional	institutional and targeted

Source: Prepared by the authors

Artificial intelligence is bringing about significant changes in the technological structures of the educational system at an impressive rate, although its capacity to impact software elements is not equally prominent (XU; BABAIAN, 2021). The complete integration of the technological component into the educational system requires a transformation in the conception of educational services. It becomes evident that even among the most technologically advanced communities, society is not yet ready for a comprehensive reinterpretation of the educational space.

These realities relegate artificial intelligence to the role of a tool in educational activities. The transition to a systemic set of elements in education demands not only the potential already formed by technology but also an adequate understanding of these innovations on individual and societal levels. One possible approach for AI to achieve a systemic status in education is

its utilization of literacy (DAVY *et al.,* 2022). In this context, it refers to the concept of digital literacy, which is coordinated and employed to achieve a specific overall literacy level. Another advantage of AI lies in the accessibility and openness of education, grounded in technological and digital principles (BEARMAN; RYAN; AJJAWI, 2023, p. 369).

There is heterogeneity in the use of AI in different disciplinary segments of education. It is evident that in computer-based educational programs, especially in the K-12 education format (TEDRE *et al*., 2021, p. 110558) or in the educational informatics paradigm (MURAINA, 2023, p. 151), the technological aspect presents more opportunities to implement its practical guidelines. Practical examples of the predominant integration of AI in the educational process include educational and gaming activities. The combination of artificial intelligence and machine learning creates the synergy necessary to ensure the effectiveness of learning and teaching (ALAM, 2022, p. 69).

One of the few studies that focuses on characterizing AI as an autonomous and self-sufficient format is identified by Garg and Sharma (2020). The article restricts the usage aspect to the inclusive education cluster, allowing for an understanding of the broader impact of AI on the educational process in a more specific sense, extrapolating this data to the general dimension of education. It is observed that AI has demonstrated the ability to operate autonomously. This can be interpreted as a sign of its capacity to be self-sufficient in the theoretical and methodological dimensions of the educational program. Dai and Ke (2022) also focused on the target elements of AI usage in education.

According to the researchers, the key to institutional transformations in education through innovative development is the use of AI in preparing programs, plans, and strategies for educational development. According to this idea, AI can address various issues related to academic levels and qualifications and update key educational process aspects, such as differentiating between fundamental and flexible skills and introducing new elements in education, such as digital and creative skills.

Discussion

The presence of artificial intelligence in the educational environment is shaping a unique status for itself. Given that the educational paradigm has never encountered a model as advanced in terms of intellectual and organizational design, the specific role of AI in education is currently in the process of definition and will largely depend on external sociocultural factors.

The consolidation of AI's position in the educational environment will depend on its demonstrated efficiency in economy, production, information space, and daily life.

Simultaneously, all threats and contradictions arising from using AI will have immediate reflections in the educational sphere. Contemporary worldviews and mental images of the world face an ethical crisis, a condition not necessarily linked to the use of AI but influenced by other factors in social life. However, all threats stemming from the technological and digital dimensions are promptly classified as ethical and moral challenges of social development. This example highlights the vulnerability of AI to human and social evaluation, regardless of its nature. Therefore, the use of AI in education, as in any other field, will be intrinsically linked to potential ethical threats (RAJI; SCHEUERMAN, 2021, p. 515).

In the educational dimension, AI ensures that participants in the educational process play the role of "creators of intelligent solutions" (MARTINS; VON WANGENHEIM, 2023, p. 421). A notable and debated example of AI usage in educational activities is ChatGPT. The scientific and educational community immediately discussed the methodological characteristics of such technological applications in education (COOPER, 2023, p. 444).

If this AI tool is endowed with generative content, it will be a relevant element in cognitive activity. However, by reducing the activity of AI to a translational model, questions arise about its effectiveness in the educational dimension. A coherent manifestation of ChatGPT's use is its application in formulating educational programs and strategies (KEIPER, 2023). One strategy to make AI relevant to education is the ability to foster critical thinking through informative and algorithmic activities (MARKHAM, 2020, p. 227). The primary task of education is to dispel doubts through acquired knowledge and experience. Therefore, AI's ability to ensure critical thinking for participants in the educational process constitutes a defining perspective characteristic.

Loftus and Madden (2020, p. 457), in analyzing the informative component of artificial intelligence, note that the data structures provided by these technologies can confuse and complicate the perception of educational information. While such data presentation can be optimized through methodological algorithms for the engineering or technical disciplines, for the humanities, for example, this becomes a real issue.

Since information and communication are considered substantially enhanced by AI, there is an evident contradiction between expectations regarding AI outcomes and its actual performance in scientific and practical fields, especially in the humanities-oriented segment. One way to resolve this contradiction is the introduction of interdisciplinary approaches in

educational practices, allowing for the effective application of technological advantages in various educational clusters.

Every innovative initiative in the educational realm must be integrated into a holistic educational system, whether assuming a dominant position or remaining a supporting component. Incorporating new tools in education must be grounded in appropriate didactic foundations (VÁZQUEZ-CANO, 2021, p. 7) aimed at their subsequent use in pedagogical activities. This consideration represents one of the fundamental contradictions in the systemic and organizational aspects related to the integration of Artificial Intelligence (AI) into the educational paradigm.

The technological dimension, rapidly penetrating the contemporary sociocultural reality on a large scale, sometimes compromises the systemic organization of processes and systems. While revolutionary changes are common in culture and do not represent an existential threat to this field of activity, for education, destabilization would mean the annulment of the integral educational system. Even without intentions of a destructive nature, technologies can inadvertently cause such destabilization in education due to their nature and distribution algorithms.

Final considerations

Contemporary scientific and educational discourse closely monitors emerging trends with the introduction of innovations in education. The analysis of AI usage in education at this stage highlights the predominance of the practical and functional dimensions of the technological and digital elements in the educational system. Artificial intelligence is becoming a tool that substantially enhances the educational process's informative and communicative clusters, organizational and logistical aspects, and practical aspects.

However, institutional and targeted characteristics (and, consequently, theoretical and methodological orientations) of educational activity maintain their fundamental existential and axiological lines, preventing, at this stage, a transformation in the content of education. The analysis of scientific research reveals a notable imbalance in research themes, favoring the functional characteristics of AI in education. Such findings, confirmed by research characteristics, reinforce the auxiliary role of AI in the contemporary educational paradigm. Nevertheless, trends in the evolution of the technological and digital world in everyday life will contribute to a more rapid alteration of AI's status in education.

The next stage of AI development in education presupposes acquiring an alternative status coexisting with fundamental traditional educational elements. In the long term, as suggested by some studies, AI may contend for the status of a dominant factor in the educational paradigm, bringing about all the inherent implications of this transformation, including changes in the institutional and objective dimensions of education.

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