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ORIGINAL

Utilising artificial intelligence in education: current trends, challenges, and future directions

Utilización de la inteligencia artificial en la educación: tendencias actuales, retos y orientaciones futuras

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ABSTRACT

Introduction: the article is dedicated to studying the main capabilities and effectiveness of using AI in the modern education system and the impact of neural networks on developing analytical skills in learners.
Method: the research is based on the comprehensive application of analysis, comparative methods, forecasting and data analysis, pedagogical observation, and generalisation methods.
Results: the article establishes that AI began actively integrating into the education system in November 2022 with access to the ChatGPT service. It also identifies that the use of artificial intelligence in the education system at various levels is founded on the integration of three primary skills: learning (collection and analysis of information), thinking (analytics, choosing optimal action algorithms), and self-correction (improving setting algorithms to achieve more accurate results). It is established that there are two main directions for using AI to enhance the efficiency of the educational process: the application of generative AI (generating texts, plans, annotations, presentations, images) and predictive AI (automation of educational processes). The use of AI in the education system occurs in three main areas: implementing personalised learning, automating essential educational functions (checking tests, problems, equations, even evaluating creative works), and improving the process of distance education and self-education.
Conclusions: it is determined that the main disadvantage of using AI in education is the reduction in the level of socialisation and critical thinking among learners. Therefore, it is crucial to balance using neural networks in the learning process and the presence of the teacher's personality in this process.

Keywords: Artificial Intelligence (AI); Neural Network; Education System; Intellectual Technologies; Adaptation of The Educational Process; Automation of the Educational Process.

RESUMEN

Introducción: el artículo está dedicado a estudiar las principales capacidades y la eficacia del uso de la IA en

el sistema educativo moderno y el impacto de las redes neuronales en el desarrollo de la capacidad analítica de los alumnos.
Método: la investigación se basa en la aplicación exhaustiva de análisis, métodos comparativos, previsión y análisis de datos, observación pedagógica y métodos de generalización.
Resultados: el artículo establece que la IA comenzó a integrarse activamente en el sistema educativo en noviembre de 2022 con el acceso al servicio ChatGPT. También identifica que el uso de la inteligencia artificial en el sistema educativo a varios niveles se fundamenta en la integración de tres habilidades principales: aprendizaje (recopilación y análisis de información), pensamiento (análisis, elección de algoritmos de acción óptimos) y autocorrección (mejora de los algoritmos de ajuste para lograr resultados más precisos). Se establece que hay dos direcciones principales para utilizar la IA con el fin de mejorar la eficacia del proceso educativo: la aplicación de la IA generativa (generación de textos, planes, anotaciones, presentaciones, imágenes) y la IA predictiva (automatización de los procesos educativos). El uso de la IA en el sistema educativo se produce en tres ámbitos principales: la aplicación del aprendizaje personalizado, la automatización de funciones educativas esenciales (comprobación de exámenes, problemas, ecuaciones, incluso evaluación de trabajos creativos) y la mejora del proceso de educación a distancia y autoeducación.
Conclusiones: se ha determinado que la principal desventaja del uso de la IA en la educación es la reducción del nivel de socialización y pensamiento crítico de los alumnos. Por lo tanto, es crucial equilibrar el uso de redes neuronales en el proceso de aprendizaje y la presencia de la personalidad del profesor en este proceso.

Palabras clave: Inteligencia Artificial (IA); Red Neuronal; Sistema Educativo; Tecnologías Intelectuales; Adaptación del Proceso Educativo; Automatización del Proceso Educativo.

INTRODUCTION

In recent years, there has been a period of active implementation of artificial intelligence (AI) in the education system, driven by the rapid development of society, where the integration of intellectual technologies with the educational sector is critical. Despite science fiction writers painting apocalyptic pictures of AI entering everyday life, it happened unobtrusively and naturally instead.

"Artificial intelligence" refers to a wide range of tools and machine learning algorithms that enable working with large text corpora, obtaining and processing information, tracking patterns, forecasting, and optimising the educational process. The term was first introduced into scientific circulation by Turing[1] in the scientific work "Computing Machinery and Intelligence." Neural networks work by identifying patterns that predict specific events. This principle of system analysis underlies the work of the extremely popular chatbots today.

The use of AI in the Ukrainian education system has changed over the past two years. Compared to the USA, where two-thirds of teachers encountered AI usage among students, Ukraine entered the group of countries with the lowest AI usage rates in the international ranking in 2023 (along with Guatemala, Paraguay, El Salvador, and other countries). However, in September 2024, the Minor Academy of Sciences of Ukraine assessed the prospects of AI in school education, which resulted in a significant increase in AI usage levels in modern Ukrainian schools at all levels. According to this study, 76 % of teachers used AI at least once, and half of the respondents had a positive experience. Additionally, every second Ukrainian teacher believes AI will change the education system in the coming years. The study also established an inversely proportional relationship between AI usage and teachers' pedagogical experience. The less pedagogical experience, the more frequently teachers used AI in lesson preparation. Most teachers/lecturers at all educational levels are sceptical about AI's potential, noting service imperfections and the presence of numerous logical and factual errors. Therefore, it is unsurprising that 39 % of Ukrainian teachers do not plan to recommend AI to students, whereas most students see only benefits from using AI in the learning process.

The article aims to explore the main capabilities and effectiveness of using AI in the modern education system and the impact of neural networks on the development of analytical skills in learners.

The primary research tasks include studying the genesis and essence of the concepts "artificial intelligence," "machine learning," "neural networks," and "deep learning," the relation of these concepts to AI, outlining the advantages and disadvantages of using AI in education, the modification of the teacher's role, identifying the primary skills that the use of AI can help develop, and outlining the main perspective lines for AI implementation in the educational process.

UNESCO, a world leader in education, published a comprehensive study in 2022 titled "Artificial Intelligence Technologies in Education: Recommendations for Policymakers." This publication was released as part of the Beijing Consensus. The document provided recommendations for the most effective use of AI capabilities and included guidelines for mitigating the risks associated with using AI in education. It addressed the financial

aspects, noting that the AI technology budget in education would reach approximately $6 billion by 2024. The preface to this study stated that the application of AI in education should promote equal and inclusive access to AI, be based on principles of fairness and inclusivity, and empower girls and women in accessing education.

The latest vision of education in the context of rapid technological development, particularly AI-based technologies, became the subject of scientific discussions among scholars in Geneva in 2016. The discussion's main focus was providing emotional and social learning through AI models.[2] The World Forum in the United Arab Emirates discussed AI strategies.[3]

Researchers Zheng, Liu, and Chen[4] noted the complex and often highly variable interaction between AI and humans, proposing to change the status of AI by renaming it "augmented intelligence." According to the researchers, this renaming implies using AI to expand rather than supplant human capabilities, enhancing ways of collaborative work between humans and machines. This position is echoed by researcher Mulgan,[5] who suggests that only an intelligent combination of AI and collective human intelligence can solve humanity's global problems. Researchers Smith and Neupane[6] also consider AI in the context of humanity's civilisational progress, while researchers Seldon and Abidoye[7] regard the AI era as the fourth revolution in education since the existence of humankind. In his monograph, Researcher Bostrom Nik[8] examines the benefits and dangers of "intelligent machines," including the educational process. The safety levels and potential risks of using AI-based technologies were also studied by Chi Jiancheng et al.[9]

Researchers du Boulay, Poulovassilis, Holmes, and Mavrikis[10] assert that AI technologies are most helpful in scientific, technological, engineering, and mathematical subjects (STEM), emphasising that they are not intended to replace teachers but to act as "assistants" that help free up time for individual student support. Zhong[11] explored the cognitive approach to studying AI technologies. Scientist Adams[12] researched AI in the context of gender issues. Ukrainian researchers Kotkova, Prykhodko, Lytvynska, Tsyhanok, Lushchyk,[13] after studying the features of scientific communication in the conditions of digital transformation of social processes, concluded that the integration of communicative, intercultural, and informational-digital competencies, considering the trends of integration processes in the scientific space towards the European community, is positioned as a priority direction for the development of scientific-communicative interaction aimed at improving the creation of unique texts.

Many contemporary studies are related to the use of AI in specific scientific fields rather than education or science in general. For instance, scientist Jackson[14] described the role and technologies of AI in studying foreign languages. Aalt D. J. van Dijk, Shin-Han Shiu, Dick de Ridder,[15] and Stavness, Giuffrida, and Scharr[16] investigated the possibility of using AI in areas such as genomics and breeding, as AI can conduct automated analysis of large plant sample conglomerates. AI technologies also power virtual patient simulators (Body Interact, operating on the Body Interact Studio platform), which are gaining popularity in the training of future doctors. This issue has been addressed by Ukrainian researchers Kudria, Kulishov, and Tretiak,[17] as well as medical scientists Kuchyn, Kaniura, Melnyk, Stuchynska, and Mykytenko.[18] The concept of AI is closely related to notions such as machine learning, artificial neural networks, and deep learning, which are also being implemented in the educational system as components or separate methods of AI. Today, machine learning is often equated with AI, but it is only a subset of AI that does not learn independently like humans do. Machine learning is entirely dependent on humans who perform data selection, classify data, interpret results, and form evaluations.[19]

AI's role in Ukraine's educational paradigm is hard to overestimate, as AI-based technologies can compensate for educational losses caused first by the epidemiological situation and then by war. In light of this, a collective monograph, "AI Development Strategies in Ukraine,"[20] was published in Ukraine in 2023. Ukrainian researchers Androshchuk and Maliuha,[21] after studying the impact of AI on the higher education system, concluded that "AI will undoubtedly transform higher education but cannot fully replace teachers, mentors, supervisors, etc.

The literature review reveals that the role and ethical component of AI, particularly the issue of academic integrity, have yet to be studied in education, highlighting the relevance of the chosen research topic.

METHOD

The article is a theoretical exploratory and descriptive study of the potential of using AI in the process of obtaining formal and informal education.

The aim and research tasks set out in the article have led to a comprehensive combination of the following scientific methods:

- the method of analysis and the method of synthesis for the critical review of scientific literature, clarifying the essence of the concept of "artificial intelligence";
- comparative method and method of pedagogical observation, which allows to highlight positive and negative aspects of AI use in the education system, studying the relationship between artificial intelligence, machine learning, neural networks and deep learning;
- the method of forecasting and method of statistical data analysis to form a future picture of

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the further implementation of AI in the educational system, to analyse the data from the survey of students and teachers on the benefits of using AI in education, to outline the main promising lines of AI implementation in the educational process;

- the ethical method, initiated by Aristotle, was used by us when discussing issues of academic integrity in the context of the use of AI, as well as when modeling the role of the teacher in the educational process, in particular the evolution of this role.
- use the generalisation method to formulate the scientific and theoretical conclusions of the study and describe the prospects for further research on the stated problem.

RESULTS

Artificial neural networks are a method of AI inspired by the structure of biological neural networks, particularly the brains of animals. Deep learning is an integrated part of artificial neural networks. Thus, new deep learning models include so-called "deep neural networks." The relationship between these concepts is best represented in a diagram.

The study established that the use of artificial intelligence in the education system at different levels is based on the integration of three primary skills:

1. Learning (collecting and analysing information, creating algorithms for further use).
2. Thinking (choosing optimal action algorithms).
3. Self-correction (improving setting algorithms to achieve more accurate results).

Using the method of pedagogical observation, we can assume that the main promising areas for AI application in education may include:

1. AI can adapt educational software to learners' needs. AI can influence by applying high levels of personalised learning and creating adaptive learning programs.
2. AI can analyse large corpora of texts, such as lecture materials of specific courses. For instance, Coursera (one of the largest open online course platforms) already uses AI to improve its courses.
3. AI can automate some technical aspects of the educational process, such as assessment or translation from one language to another, which use AI to analyse a broad context, thus forming the most accurate translation possible. These include translators like Grammarly, DeepL, Help Me Write, and UBOS.[22]
4. AI can create specific tutoring programs for studying basic grammar, mathematics, etc.
5. AI can modify the role of the teacher in the modern education system. While the role of the teacher will always remain central and system-forming, AI systems can be programmed to provide expert knowledge, replacing the teacher's role with that of a facilitator. This teacher role became dominant during online learning and implementing the flipped classroom model.

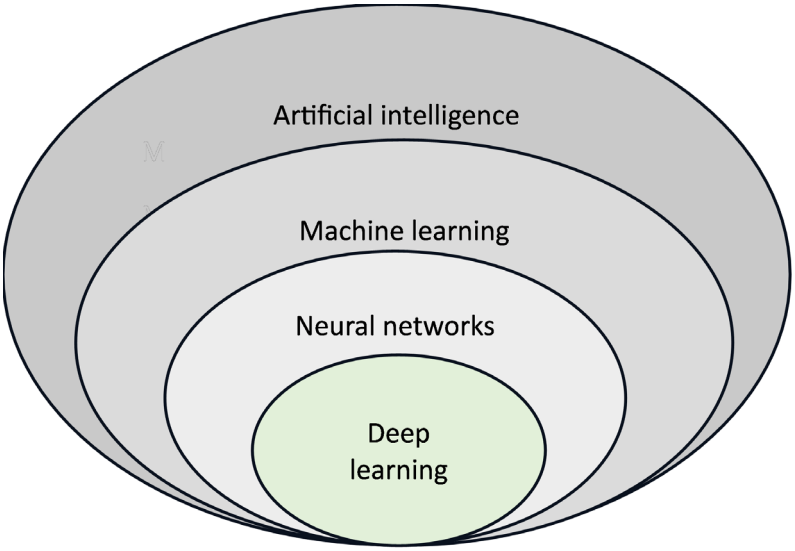

Figure 1. The Relationship between Artificial Intelligence, Machine Learning, Neural Networks and Deep Learning

Comparing the role of the teacher in the traditional education model with the role and functionality of the teacher in the modern educational process using AI, their features can be represented through the following models:

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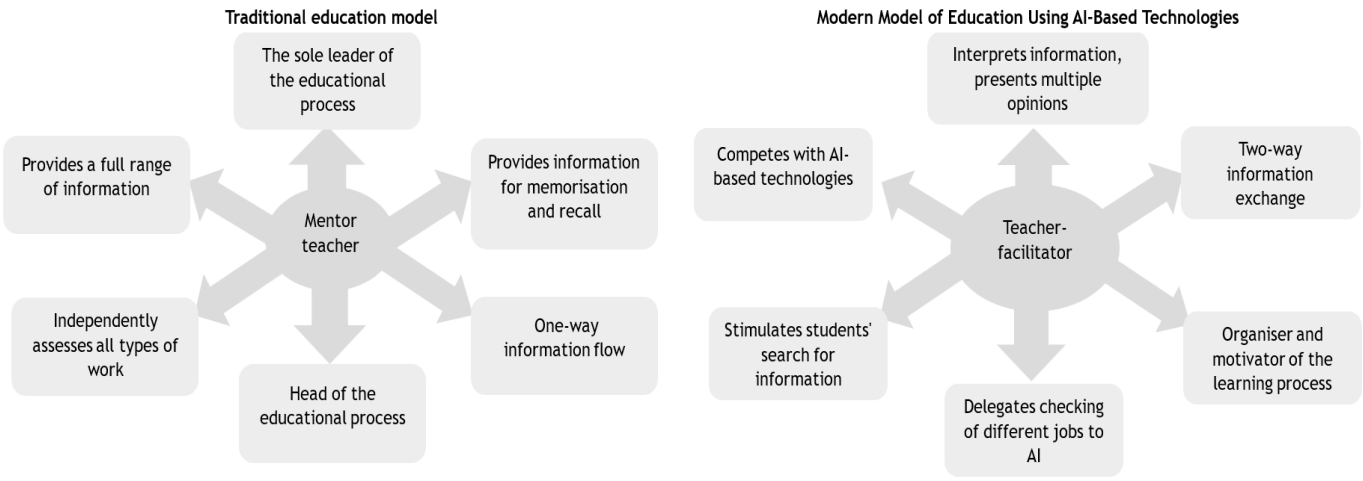

Figure 2. Comparison of the Role of the Teacher in the Traditional Education Model and the Education Model Using AI-Based Technologies

It is worth noting that AI affects the organisation of time and space for learning, as remote access programs enable learning from any corner of the world with internet access. By analysing user search parameters, AI also influences the recruitment system for higher education institutions and the choice of courses according to the students' target requests. It is facilitated by intelligent data analysis systems, which have significantly transformed the modern educational landscape. In some schools, AI-led learning facilitates the transition from college to higher education.

Artificial intelligence consists of several technologies actively used in medicine and automotive autopilot systems. Thus, not all of these technologies are suitable for use in education. In our opinion, the following AI technologies can be used in education:

1. Emotional Artificial Intelligence: This can be applied in literary studies to analyse tones and moods in texts, search for authors' intentions, and analyse the human behaviour of certain literary characters.
2. Machine Creativity: This AI technology is most commonly used in the study of design, architecture, and urban planning, as well as in history and archaeology for reconstructing entire artefacts based on found remains, retrospection of photographs of historical figures or cultural figures, and generating works of musical, visual, or literary creativity.
3. Speech Recognition Technology is appropriate for learning foreign languages, simultaneous translation, creating personalised assistants and chatbots, and organising various educational courses, projects, and startups. It is also effective for developing listening skills in learning foreign languages.
4. Data Analysis Technology for Forecasting: This technology is most suitable for medical use, particularly in diagnosing diseases, predicting their progression, and prescribing treatment. Based on this technology, a teacher can assess medical students' knowledge or compare their forecasts with AI's predictions in each specific medical case for further classroom discussion.
5. Autonomous Intermediaries Technology: This can be used in teaching computer engineering and programming, for instance, using AI in avatars for computer games, virtual guides, etc.
6. Natural Language Processing Technology: This technology is most relevant for linguistics and literary studies, as well as interdisciplinary fields such as psycholinguistics, neurolinguistics, and semiotics for automatic text interpretation, semantic analysis, and text generation. Besides linguistics, semantic analysis can be used in providing legal services and translating from foreign languages. Text generation is gaining popularity in automated journalism, which involves working with large conglomerates of texts, primarily of a new nature.

The implementation of the above technologies is present in specific service programs that we consider the most optimal for the educational system. It is crucial to take a closer look at the cognitive and didactic potential of each of these services:

1. DeepAI and Paintbytext: These offer practical tools for generating images from corresponding texts. These can be adequate auxiliary resources for visualising material and creating visual aids for educational materials, presentations, and digital educational resources.
2. Bedtimestory / MakeMyTale / Tome: AI-based programs that generate stories, fairy tales, and narratives, where the genre and style of the generated text can be predetermined and character names specified. With the help of good prompts, a teacher can generate a story about the class with specific classmates as characters, which will be particularly interesting for primary school students.

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3. Talk to Books: A neural network that answers profound philosophical questions with quotes from famous books. The neural network can select quote content on a relevant topic, find an apt epigraph for a lesson or essay, and be used in foreign language classes.

4. Mubert: A neural network for creating musical content.

5. Kaiber: A neural network that can generate animated videos based on a given image.

6. Pictory: A service that summarises teaching content from webinar recordings, Zoom or Teams, which can model video content for summarising or reviewing material, for quizzes, or as an educational product advertisement on social networks.

DISCUSSION

We agree with the researcher that the use of AI significantly eases the process of implementing the trial-and-error method, which is an integral part of any educational process. The human factor, present as the teacher, often makes this process less tolerant. In contrast, AI allows learners to experiment and learn in a relatively free environment, as AI systems improve through the trial-and-error method.

AI usage can also transform teaching methods by implementing personalized learning. However, it simultaneously limits students' social interaction and critical thinking development, which can be considered one of the main drawbacks of AI's impact on the educational system. Therefore, finding a balance between using technologies and developing interpersonal skills is crucial.[23]

Discussing the disadvantages and dangers of using AI in education is also necessary. These include, primarily, the reduction of socialisation among learners in both the "student-teacher" and "student-student" models. Another issue is the decline in critical thinking among learners, making it increasingly difficult for them to make their own decisions. Therefore, at all levels of education, it is crucial to balance the use of neural networks in the learning process and the presence of "live" people, particularly teachers.

Researcher Vizniuk Kai-Fu[24, 25] is correct in noting that the penetration of AI into the education sector has heightened the issue of academic integrity, as it is challenging to draw a clear line between violating the basic principles of academic integrity and using AI as an assistant for students. More students have been using AI to complete their homework in recent years. To aid teachers, external services such as ZeroGPT, WinstonAI, and GPTZero can help determine whether AI-generated a text. However, it is worth noting that none of these services can absolutely, 100% accurately determine whether AI-generated a text.

As we can see, the issue of AI integration into the education system is closely linked to the computer literacy of teachers and learners. For an AI system to provide the most accurate response, it is essential to correctly formulate the prompt (Prompt engineering), which can significantly improve the quality of the response. Optimising prompts is closely related to four aspects: context, task, constraints, and the format of the response output (table, code, charts, images). Optimising prompts can be achieved by following these main recommendations:

1. Write a general introduction to the question that is planned to be asked of the AI.
2. Provide context for the AI.
3. Formulate the question (task, objective) precisely.
4. Predefine the constraints the model should consider when generating the response.

For creating large projects, it is appropriate for users to formulate a system prompt, essentially a kind of instruction that gives the model guidelines for completing the task.

In our opinion, AI can significantly facilitate the evaluation process for teachers. It is clear that a number of objective and subjective factors are taken into account during evaluation, but some types of control, such as testing, require only an objective approach to evaluation, so the verification of such tasks can be fully delegated to AI. Evaluating creative works, especially essays, requires a combination of objective and subjective approaches to evaluation, so in this case it is difficult for AI to compete with the teacher, but in recent years the evaluation of creative works has also improved significantly.

CONCLUSION

Therefore, there are two main directions for using AI to enhance the efficiency of the educational process: the application of generative AI (generating texts, plans, annotations, presentations, images) and predictive AI (automating educational processes).

AI began integrating actively into the education system in November 2022 with access to the ChatGPT service. This service made it possible to obtain plans for various events or projects, write tests, annotate articles, and create lesson summaries, illustrations, and presentations. Each user received a unique product. The educational system responded to the emergence of AI-generated texts and projects with a complete ban on using this technology. However, this cannot be considered a successful strategy, as it is more important to find a balance between needs and tools to meet these needs, between tradition and innovation.

The use of AI in the education system occurs in three main areas: firstly, AI implements the concept of

personalised learning by creating individual learning programs according to the needs of each learner; secondly, the process of automating some essential educational functions has become possible, such as checking tests, problems, equations, and even evaluating creative works, which helps to prevent errors in evaluation and promotes objectivity and unbiased results; thirdly, the process of distance education and self-education is being improved.

Prospects for further research include multidisciplinary studies at the intersection of computer science, pedagogy, neurolinguistics, and psycholinguistics, which will detail the algorithms for using neural networks to solve typical educational tasks and challenges.

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