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The Role of Artificial Intelligence in Improving the Quality of Education and Research

Liudmila Perminova*

Doctor of Philosophy in Pedagogical Sciences, Professor, Head of the Department of Pedagogy, Psychology and Educational Management named after Professor E. Petukhov, Faculty of Pedagogy, Kherson State University, <https://orcid.org/0000-0002-6818-3179>

Svitlana Vasylyuk-Zaitseva

MPhil in Physics, Senior Lecturer, Computer Science department, Information Technologies Faculty, National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine, <https://orcid.org/0000-0002-0875-462X>

Iryna Shapka

Senior Lecturer, Department of Higher Mathematics, Faculty of Computer Sciences and Engineering, Ukrainian State University of Chemistry and Technology, Dnipro, Ukraine, <https://orcid.org/0000-0003-1171-6445>

Nataliia Savastru

Assistant Professor, Assistant Director for scientific and methodical work, Department of theoretical disciplines, Serge Lifar Kyiv Municipal Academy of Dance, Kyiv, Ukraine, <https://orcid.org/0000-0002-0845-3763>

***Correspondence email:** lperminova@ksu.ks.ua.

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Abstract: The purpose of the study is to determine the role of artificial intelligence in improving the quality of education and research. To achieve this goal, a content analysis was used. Of note is the SWOT analysis method, which was used to identify the positive and negative aspects of the integration of artificial intelligence into scientific and pedagogical life. The results show that the use of artificial intelligence technologies in the field of education is a promising and promising area for further development. The analysis conducted in this context revealed that innovative technologies have become an essential component of modern education. The use of artificial intelligence (AI) is becoming more widespread and. However, for the further development of this area, it is important to improve the level of digital literacy among users. Based on the results of the study, both positive aspects and disadvantages in the use of these technologies can be identified. Among the advantages are the high adaptability of AI, the possibility of individualised learning, accessibility, and a wide range of applications, from primary school to higher education and research. It is important to note that these technologies can be used to achieve learning success regardless of geographical region, making them global in nature. The scientific novelty lies in the consideration of certain shortcomings, among which the issue of security is particularly relevant, especially in the context of global hybrid threats and the overall process of digitalisation. The conclusions note that to overcome the identified negative aspects of the use of AI in research and teaching, it is important to focus on the ethical aspects of using digital tools in general. It is also recommended to consider the possibility of organising additional online courses.

Keywords: artificial intelligence, educational activity, science, digitalisation, prospects, threats.

Introduction

The origins of artificial intelligence (AI) can be traced back to the mid-20th century when the field of computer science began to explore the possibility of creating machines that could simulate human intelligence. The term "artificial intelligence" was coined by John McCarthy in 1956 when he organized the Dartmouth Workshop, which is often considered the birth of AI as a formal field of study. Early AI researchers were primarily focused on developing programs that could mimic human thought processes, such as problem-solving and logical reasoning. The extent to which AI is used varies widely depending on the level of education and geographical region. Access to resources, funding, and infrastructure also play a significant role in determining the extent of AI adoption in different areas.

Modern social demands shape the requirements for specialists of a new level. In particular, the global penetration of digitalisation into all spheres of social life demonstrates the need to find new methods of training specialists in various fields, both natural and humanitarian. The integration of distance education into learning, which occurred as a result of the spread of the COVID-19 pandemic and related quarantine restrictions, has demonstrated the relevance of using the latest technologies. Although the disease has receded globally, the resulting realities demonstrate the need for reflection and further improvement. Among the new tools that are being actively introduced into the educational process are artificial intelligence technologies, which contain considerable innovative potential that is still important for pedagogical science.

Research Problem

Artificial intelligence is a field of scientific and technological developments that deals with the creation of systems that are capable of performing certain tasks that have long required the use of human intelligence (Ridley, 2019). In particular, artificial intelligence includes certain algorithms and models that enable computer systems to analyse, understand, and solve certain tasks using methods

that resemble human thinking (Miller, 2019). Such systems are already quite popular in education today, especially due to their ability to perform tasks, recognise certain images and words, and make independent decisions, organise preliminary planning, or process large amounts of information (Laird et al., 2017). Artificial intelligence is usually used to operate a variety of systems. In general, its potential is important for machine learning, neural networks, linguistics, etc. (Holzinger et al., 2019; Lee & Lee, 2021). However, this system does not have a separate consciousness – its algorithms and programs are created by humans. For this reason, the use of artificial intelligence in education (as well as further vectors of this use) requires special attention from researchers.

Research Focus

Artificial intelligence has become a remarkable force that is changing the way we work, learn, and explore the world around us (Oluniyo, 2020). In this context, it is important to track the role that AI plays in improving the quality of education and research. With the growth of data and the power of computing, this technology has become a key tool in solving complex problems facing education and research. Artificial intelligence helps to improve data analysis, forecasting, recommendation, and task automation, and it is important to identify specific use cases for its application in education and research and to characterise the benefits it brings in improving outcomes and optimising processes. The growing availability of digital tools makes it more accessible for use in a variety of fields, from education to medicine and engineering. It is important to understand how to use these opportunities properly and effectively to achieve maximum results. The focus will also be on the problems of identifying positive and negative episodes in the use of artificial intelligence against the background of its further integration into educational and scientific life and development prospects.

Research Aim and Research Questions

The purpose of the study is to analyse the role of artificial intelligence in improving the quality of education and research. The realisation of this goal involves the disclosure of additional tasks:

1. Determining the current state of AI integration into scientific and pedagogical processes.
2. Analyse the positive and negative elements of its use in scientific, research and educational practice.

Literature Review

In modern literature, the investigated problem is partially presented. However, certain aspects were of interest to many scientists. Modern researchers argue that conceptual elements relevant to learning, such as open science, big data, open data, SMART data, FAIR data, etc. are usually directly related to the use of artificial intelligence (Vasudevan et al., 2019). In particular, the recent evolution of its application (primarily in the period 2017-2022) has demonstrated significant progress and achievements in analytical computational tools and related innovations (Zuroff & Chapados, 2023). This is especially true for the use of those methodologies for which the connection with new areas of artificial intelligence is particularly relevant. The application of machine learning, deep learning, and further work on the development of neural networks have demonstrated certain possibilities for profound transformations of the paradigms of modern learning and science. These achievements range from computer vision (the effect of recognising faces or any other objects), natural language processing (the ability to recognise speech and turn it into texts or translations) to countering cyber fraud (detecting digital intruders and attackers). Other important advances include conversational chatbots, robotic agents, and strategic thinking (Gruson et al., 2019; Pilon, 2023). The functioning of such complex

systems has become possible due to significant improvements in the combination of software algorithms, much greater computing power, more accurate metadata schemes, accessible online datasets, and, most importantly, open repositories and systems with research. It should be noted that in Ukrainian realities, such changes are still hardly noticeable. According to Darwish (2022) artificial Intelligence (AI) has surfaced as a field brimming with advanced methodologies and innovative applications. The swift progression of AI concepts and technologies has given rise to a discernible trend—the integration of interpretability and explainability into this paradigm.

The study by Drach et al. (2023) delves into the theoretical underpinnings of incorporating artificial intelligence (AI) within the realm of higher education. It elucidates how AI, as a strategic technological advancement, bestows numerous advantages upon individuals and society as a whole. Furthermore, it signifies a transformative milestone not only in the history of digital technology but also on a global scale in the evolution of modern civilization. Ceccaroni et al. (2019) offers an insightful overview of the policies formulated by prominent European and global entities, including but not limited to the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the European Union, the Organisation for Economic Cooperation and Development, and the European University Association. These policies pertain to the effective integration of AI into everyday life, with a specific focus on its application within the sphere of education. At the same time, Cohen (2021) researched the issue of the evolution of machine learning. The paper by Yuskovych-Zhukovska et al. (2022) focuses on the application of artificial intelligence in education, shedding light on both opportunities and challenges in the context of sustainable development. It begins by assessing the current state of implementing AI technologies within the educational sphere. These AI technologies are categorized into four main groups: cognitive services, virtual, mixed, and augmented reality, the Internet of Things and peripheral computing, and metacognitive scaffolding (Yuskovych-Zhukovska et al., 2022).

In addition, the article by Pendy (2023) engages in a discussion regarding issues related to the confidentiality and depersonalization of students' data when processed by artificial intelligence during the educational process. It recommends a differentiation of responsibilities concerning access, storage, and utilization of personal and confidential data by educational institutions. Lampou (2023) believed that artificial Intelligence has seamlessly woven itself into the fabric of our daily lives, manifesting in automated systems within vehicles and personalized online advertisements. Within the domain of education, AI holds the potential to elevate the teaching and learning experience. According to Lee and Lee (2021) its objective is not to supplant educators but rather to enrich their role by rendering the learning process more captivating and streamlined. AI systems possess the capacity to offer feedback on students' performance, pinpointing areas for enhancement, and fostering inclusivity, especially for students facing special needs or language barriers. Moreover, AI can automate numerous administrative tasks, affording educators additional time for crafting lesson plans and refining their instructional methods (Ridley, 2019). In summary, the current literature highlights a wide range of aspects related to the development and use of artificial intelligence in education, including technological development, social impact and future prospects.

Research Methodology

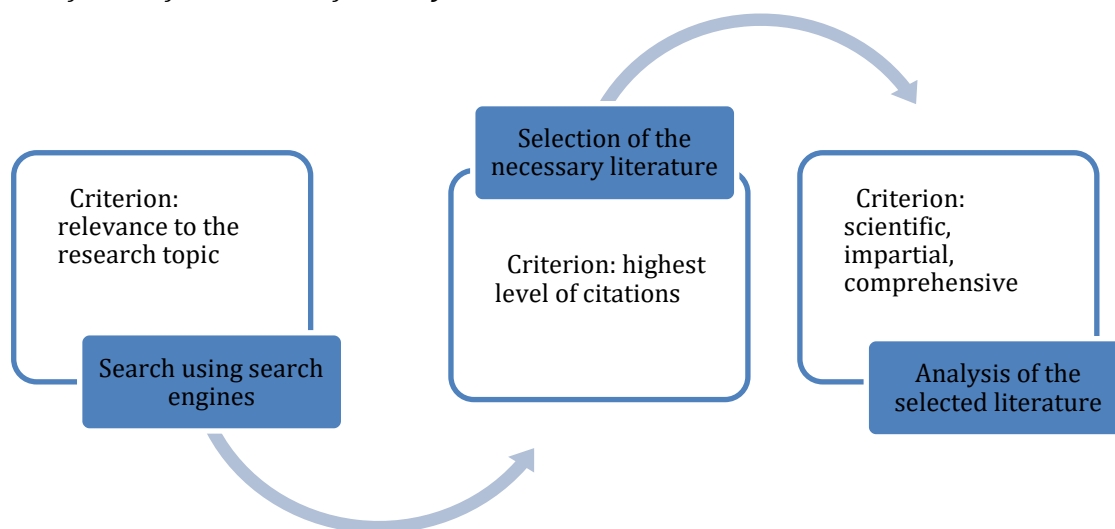
General Background

The method of content analysis was used to study the scientific professional literature that addresses the problem of using AI. Content analysis is the systematic study of textual scientific information in order to identify and analyse patterns, trends, and patterns in a large volume of documents or texts. This method was very useful for studying scientific professional literature, as it allows you to systematise and extract insights from a large number of scientific texts. As a result of the

search using search engines of the texts, more than 140 articles were found on the given topic. In order of appearance of the results, 50 of them were selected (Figure 1).

Figure 1

Selection of Scientific Literature for Analysis



Source: Compiled by the authors.

Based on the study of these publications, the SWOT analysis method was also applied to highlight the prospects for the application of AI in science and education. SWOT analysis is a popular tool in strategic management that helps to assess the current state of affairs and develop a strategy to achieve the set goals. The SWOT acronym reflects four main aspects. Strengths are the internal positive characteristics that define advantages. Weaknesses are also internal factors, but they are negative. Weaknesses indicate limitations, shortcomings, or vulnerabilities. Opportunities - these external factors indicate potential opportunities for the development of AI. Threats - these are also external factors that may have a negative impact in the future. A SWOT analysis helps to identify how AI's strengths can be leveraged to exploit opportunities and reduce the impact of weaknesses and threats in the future. This analysis resulted in recommendations aimed at achieving success and improving the state of affairs. The comparison method was important: it allowed us to compare the data obtained with the results of other researchers. The typological method was used for qualitative processing and grouping of the information obtained. The basics of comparativism were used to compare the strengths and weaknesses of the use of artificial intelligence in education and science.

Data Analysis

The research was conducted in several stages. The first stage involved the collection of materials and content analysis of professional scientific publications. The main search was carried out in computer databases among publications using content analysis, and the most relevant and most cited research studies were selected (50 most relevant and cited works were selected in total). Since they formed the theoretical basis for the study, special attention was paid to this procedure, since the objectivity and impartiality of the coverage of future results depended on the breadth of the sample of materials. By using the methods of analysis and synthesis, the collected material was subjected to critical scrutiny. Certain conclusions were also drawn, which were reflected in the overall findings. The SWOT analysis was used at the third stage of the research to organise and present the collected material, and to identify prospects for further research. At the last stage, the typological method was used to summarise the research.

Research Results

AI Opportunities in Education and Research: The Current State of the Art

Machine learning capabilities using artificial intelligence are also effectively applied due to the pre-training of algorithms and the use of relevant datasets of familiar sizes (Joshi et al., 2021). New opportunities in education have also opened up as a result of a combination of effective research data repositories and the willingness of researchers and educators to share their results and datasets in the open.

This allows educators and researchers to use algorithmic machine learning functions globally, all over the world, justifying their results both by using previous models and by accessing new online research data (Giró Gràcia & Sancho-Gil, 2021; Pendy, 2023). Due to the extensive development of software, huge amounts of images, data, and metadata can be easily and conveniently downloaded, archived, and used for further training of neural networks.

In recent years, many new digital mechanisms have also emerged that make it possible to change the lives of users and students and guarantee convenient work with artificial intelligence products. For example, the world-famous Google Translate service, which allows you to read and translate texts from more than 100 languages, works through any modern browser and automatically provides extremely accurate translations. In addition, digital tools such as Siri and Google Assistant, which allow users to ask questions and receive answers, have become an integral part of smartphones. A tool such as ChatGPT (and similar artificial intelligence programs) has the ability to quickly generate answers to any questions asked, provide justifications, give examples, create poems or narratives, summarise research materials, etc. The possibilities for processing and working with images have also evolved (Xue & Wang, 2022). Visual services based on user-generated texts expressed in natural language are also extremely developed at the current stage of development. Examples of tools that allow you to set textual conditions during training in order to get a realistic image, as result, include Stable Diffusion, Midjourney, or Imagen: Text-to-Image Diffusion Models.

Several types of artificial intelligence can be distinguished (Ouyang & Jiao, 2021). First of all, we are talking about rule-based artificial intelligence and machine-learning artificial intelligence. Rule-based artificial intelligence uses decision-making rules to generate or recommend a proposed solution to a query posed by a learner (Alam, 2021). An example of such a system is intelligent tutoring software that can explain grammar or provide specific feedback to learners. Artificial intelligence based on machine learning is much more powerful because machines (computer-oriented) can actually learn and will likely get much better over time, especially if they are constantly working with large volumes of multi-layered data sets. In education, AI tools based on machine learning are commonly used to solve a variety of problems, including monitoring the activity of students and creating models that accurately predict the consequences of student behaviour.

As part of the further use of artificial intelligence in education, there is another subfield - natural language processing, i.e., the use of software that will allow to understand, predict, translate, and record the textual content of voice commands (Chen et al., 2020). Researchers continue to study methods of using voice artificial intelligence to improve the ability to diagnose reading or other academic and pedagogical work. In particular, the use of machine artificial intelligence in the field of education can now be considered quite commonplace (Malik, 2021). Some testing companies (e.g., Pearson) use natural language processing in the assessment of students' written work. Obviously, the further development of such technologies has considerable scientific and pedagogical potential for further evolution.

Advantages and disadvantages of using AI

Using the SWOT analysis method of professional scientific literature, it is possible to identify the main advantages and disadvantages of using AI in education and research processes. This comparison will allow us to characterise the main prospects for the future use of this digital tool in education and research. In general, researchers positively assess the possibilities of using artificial intelligence in education (Luan et al., 2020), highlighting the following advantages when actively used in pedagogical experience (See Table 1).

Table 1

Advantages of Using AI in Education and Science

Advantages	Characteristics
Fast adaptation	Artificial intelligence systems are able to adapt to the individual learning needs of each student, to achieve learning goals in accordance with the identification of their strengths and weaknesses.
Technological progress	Already at the current stage, artificial intelligence systems are able to analyse and observe the current progress and learning style of the student, their abilities, and inclinations, providing a certain customised template to support learning in the future. Artificial intelligence can systematically track the progress of students by collecting data on their achievements and mistakes. This allows teachers and students to receive feedback on task performance and identify areas that require additional attention.
A variety of functions	Artificial intelligence systems have the ability to evaluate not only closed answers efficiently and quickly (presented in the format of answers to test tasks) but also descriptive answers, which is an important help for teachers today. Through this process, students do not hesitate to make mistakes (because mistakes are part of any real learning) and subsequently receive real-time feedback to apply the necessary corrections
Convenience	Artificial intelligence models offer a gradual transition from simple to complex processes: adaptive learning is applied to students at the first levels, followed by a gradual transition to the next stages with the mandatory completion of the previous one.
Inclusion	AI can make education more accessible to people with disabilities, regardless of physical or cognitive limitations. It can provide adapted materials, support, and tools to help expand learning opportunities for all learners. For example, artificial intelligence can provide learners with access to education according to their needs, by providing text-to-speech for the visually impaired.
Versatility	Artificial intelligence can be used in a dosed manner even in pre-school education (in particular, in the form of special interactive games that teach and develop the necessary basic skills in children). There are opportunities for creating educational content using artificial intelligence: researchers believe that apps that can convert voice to text are already in demand.

Increasing opportunities

Artificial intelligence can provide access to a wealth of information and resources that enhance learning opportunities. It can provide access to up-to-date data, online courses, interactive materials, and other resources to help learners deepen their knowledge.

Source: Compiled by the authors based on Baker et al. (2019), Bilanych and Bokotei (2013), Casas-Ortiz et al. (2023), Darwish (2022), Górriz et al. (2020), Panigrahi (2020).

There are already significant benefits to using AI for the education and science of the future, but these benefits could be transformed and expanded further by the rapid development of this technology. For example, in the future, AI may become a learning partner that can adapt learning material to the individual needs of each student. This will make it possible to more effectively take into account the level of knowledge, learning style, and other personal characteristics of each student (Balat & Bahşi, 2023). Virtual assistants, online courses, and other AI applications can provide access to learning and scientific information to a wider audience. In the field of science, AI can significantly contribute to the automation of research processes. From literature searches to data analysis, AI can perform many routine tasks, freeing up researchers for more creative work. The processes of solving complex tasks and problems may increase significantly. This is especially important in science, where some research can take a lot of time and resources. This will be based on machine learning and data analytics, which can help predict and analyse scientific and educational trends. They can identify patterns that would not always be visible using traditional methods of analysis. Additionally, AI can provide ideas for new research and teaching approaches (Cohen, 2021). Algorithms that are able to generate ideas and solve problems can inspire innovation in science and education (Hosny & Aerts, 2019). Overall, the benefits of using AI in education and science may be transformed in the future due to the continuous development of technology and the new opportunities it will bring. This can contribute to more intelligent, efficient, and accessible learning and research.

At the same time, based on the content analysis of other researchers' studies, we can identify the most common disadvantages of using AI (Table 2). They are being actively discussed, and tentative ways to overcome them are also proposed, although a broader discussion is needed to finally resolve these issues (Hutson, 2018; Joshi, 2019).

Table 2

Disadvantages of Using AI in Education and Science

Disadvantages	Characteristics
Limited ability to understand the context	AI may have limited ability to understand complex contexts, especially when it comes to deep or intuitive aspects of learning and research. It can generate answers to questions but is not always able to adequately interpret or analyse more complex concepts.
Impact on data privacy and security	The use of AI requires a large amount of data, including personal and sensitive data. This can lead to data privacy and security breaches if appropriate protection measures are not taken.
Focus on specific tasks	AI is often developed to solve specific tasks and may be inefficient or incapable of performing other types of tasks. This can limit its versatility and applicability across industries

Support for technical staff	Introducing AI into education and research processes can require significant effort and resources to train and support technical staff with the necessary skills. Also, the development and implementation of AI systems can be expensive, and this can make it difficult for all educational and research institutions to access these technologies
The risk of addiction	Relying on AI can lead to a loss of human competence in certain areas. If the AI system breaks down or receives incorrect information, this can lead to serious problems.
Ethical issues	The use of AI in education and research raises ethical issues such as transparency, equity, and fairness. For example, AI systems may reflect stereotypes or be used to manipulate information

Source: Compiled by the authors based on Ceccaroni et al. (2019), Drach et al. (2023), Knox (2020), Mohammed and 'Nell' Watson (2019), Silva and Janes (2023).

The risks associated with the utilization of artificial intelligence (AI) in education and research are subject to evolution and change in the future, owing to the continuous advancement of this technology and shifts in the socio-cultural and ethical landscape. As AI becomes more prevalent, the volume of personal data collected and processed is likely to expand. This heightened data exposure may elevate the risks of privacy breaches and the potential for misuse, necessitating more robust security and compliance measures. Simultaneously, the emergence of increasingly sophisticated and autonomous AI systems in the future could introduce new uncertainties, as these systems make decisions based on their own analyses. This may give rise to novel risks associated with the unpredictability of such AI behavior in educational and research contexts.

Furthermore, there is a risk of anthropomorphization, where individuals start perceiving digital systems as if they were human (Li et al., 2020). This can result in incorrect expectations and interactions with these systems. Ethical concerns related to AI's usage are expected to intensify or emerge in the future, including debates about its ethical application in scientific research, its impact on the development of intellectual morality, and the responsibility of AI systems, among other issues.

Additionally, AI's influence on the labor market will be profound. The evolution of AI may lead to changes in job roles, potentially automating certain tasks and causing job displacement for some workers. This shift can engender social and economic risks, as professions such as education or science may face the possibility of obsolescence (Vilim & Ibarra, 2022). Therefore, a thorough examination of the advantages and challenges of AI adoption necessitates further discussion, as the perspectives of scholars often diverge on key points. In light of these considerations, there is a need for ongoing dialogue to assess and determine the future prospects of deploying this digital tool.

Discussion

Data storage and the capabilities of digital scholarly systems support the academic cycle of research, knowledge development, and discovery. Data is accessible through the capabilities of networked communication systems and content control tools. We can agree with researchers that this exchange between researchers on a global level contributes to transparency in guaranteeing the knowledge gained (Shrivastava, 2023; Yuskovych-Zhukovska et al., 2022). Artificial intelligence, as Nguyen et al. (2022) rightly point out, has a direct connection with open science. This is especially noticeable when working with large amounts of data, SMART data, and FAIR information, as AI systems and services are able to quickly process, find, analyse, and compare them (Ajami & Karimi, 2023). Its

use is important only as an element of digitalisation. These actions contribute to the further development of artificial intelligence services and systems and better reproduction of results according to the set algorithms. Artificial intelligence is thus becoming a reliable assistant to teachers, providing opportunities to complement the formation of individual learning paths and the ability to provide quick feedback to students. However, certain possibilities of this potential can be harmful (Sadiku et al., 2021; Shi et al., 2021). Among these possible negative consequences of using artificial intelligence in education are the risk of reducing the role of the teacher, increasing negative creativity and uncritical thinking of students (opportunities for cheating and passing off AI work as their own achievements), and the risk of widening the gap between students with different socioeconomic status. In fact, the element of integrity in the use of AI capabilities is much less emphasised (Renz et al., 2020; Taddeo et al., 2021). In general, academic integrity is a core component of academic culture and guarantees high-quality education and research, maintains trust in the academic environment, and promotes the development of science and education. Obviously, this aspect will require further development. Adherence to ethical norms and standards in research and education today requires researchers to be cautious about human experimentation, data confidentiality, and other ethical principles. All this forms the elements of trust in the activities of educational and research institutions.

The current importance of trust in teaching and research is often underestimated as results take centre stage (Lampou, 2023; Schiff, 2020). At the same time, the very mechanics of AI functioning pose threats to trust (Koos, 2018). To be successful, AI must also use only reliable data to draw the right conclusions at the end of a query. If incorrect information is included in the overall dataset, it can lead to incorrect results. In fact, there is no such thing as absolutely objective information, and some digital algorithms can even make information even more subjective. For this reason, it is important to develop digital competence among teachers and researchers, which would allow them to use truly proven capabilities and be able to distinguish between false or biased information, which can be used in AI algorithmic work, among other things. Therefore, actualising the development of digital competencies among teachers, researchers, and students will make it possible to use the potential of AI to its fullest, to counter hybrid threats and other challenges related to the functioning of digital information sources. In order to actively implement such systems, it is proposed to set up a system of free online courses, during which experts will introduce students to the basics of information hygiene and work with the capabilities of the digital environment. As the courses offered will be made publicly available, this will allow us to reach the maximum interested audience, highlight and emphasise the importance of working with AI algorithms and further improve it, bringing it to a new level of efficiency.

Conclusions and Implications

The analysis has shown that innovative technologies have become an indispensable companion to teaching in modern circumstances, AI is used very often, and motivation for learning activities is growing. However, further use of AI requires improvement of digital literacy. Based on the results of the study, the main advantages and disadvantages of using these technologies were identified. Among the advantages are high adaptability, the possibility of forming an individual learning path, accessibility, and a wide range of applications (from primary school to university education, research, etc.). As a result, it is also pointed out, that there is tangible progress in learning that does not depend on the geographical region, i.e., is global in nature. There are also shortcomings, including an important security challenge, which is especially relevant in times of global hybrid threats against the backdrop of the global spread of digitalisation. To overcome the negative effects of AI in research and teaching, it is proposed to emphasise the importance of ethical views on the use of the potential of digital tools in general. The organisation of additional online courses that would form the basis for the development of digital competencies is recommended for use in the near future.

Suggestions for Future Research

An important aspect for further research is to address the formation of new ethics of teachers, students, and researchers, which would be aimed at taking due account of the role of digitalization in modern educational and scientific processes. The development of technologies, including AI capabilities, indicates that constant updating of the “moral codes” of teaching and research, etc. is necessary to meet the challenges of our time. It is important to explore the ethical implications of using AI in education. It is important to address issues such as data privacy, AI algorithm bias, and the ethical use of student data, with a focus on developing guidelines and policies to ensure the responsible implementation of AI in education. At the same time, we consider the study of the relationship between the use of artificial intelligence and the development of education during life to be a separate important aspect. The following studies should be devoted to analyzing the potential of AI to support lifelong learning. For example, it is important to investigate how AI-powered platforms can help people of all ages learn new skills and knowledge throughout their lives. In addition, the use of AI should be reflected in regulations. As the further integration of this tool into public life is evident, there is a need to develop norms for its regulation. An important problem for further research is the integration of the capabilities of artificial intelligence into the training of humanitarian education students. Therefore, this problem of studying the features of using artificial intelligence in the education system will continue to be relevant and will require a thorough research, especially considering modern digitization trends.

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