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ARTIFICIAL INTELLIGENCE IN EDUCATION: A REVOLUTIONARY TOOL WITH A DOUBLE-EDGED SWORD

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ABSTRACT

Today's educational institutions stand on the brink of a digital revolution that is fundamentally changing the way we teach and learn. Artificial intelligence and digital pedagogy have become indispensable elements of modern education, offering unprecedented opportunities while also presenting new challenges. While some advocate for their transformative power, others warn of the potential pitfalls of over-reliance on technology. This analysis explores the complex relationship between technological progress and educational values, emphasizing the need for a balanced approach.

The most intriguing paradox lies in the fact that while artificial intelligence facilitates access to information, it may simultaneously undermine fundamental educational values. For instance, automated essay grading and intelligent tutors, though efficient, gradually erode the crucial role of teachers as mentors and educators. The more algorithms enter the classroom, the less room there is for authentic human interaction – the very essence of education. The key wisdom lies not in rejecting technology but in using it strategically to preserve the human dimension of learning.

KEY WORDS

artificial intelligence, digital pedagogy, education

CLASSIFICATION

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INTRODUCTION

In recent decades, education systems around the world have undergone significant changes under the influence of digitalization and technological advancement. Digital pedagogy and artificial intelligence (AI) have become key tools in education, enabling the personalization of the learning process and the improvement of educational outcomes. Our students have changed radically. Today's learners are no longer the individuals for whom our education system was originally designed [1]. Since today's students are growing up in a digital environment, it is crucial to transform educational processes on multiple levels by implementing digitalization and AI in education. This article explores the role of digital pedagogy and AI in educational institutions, demonstrates how technology is transforming education, analyzes the advantages and challenges of digitalization, and proposes possible solutions for improving the education system and ensuring the effective application of technology.

Recent research highlights the growing role of AI in education, particularly in the areas of personalized learning, assessment, and student engagement [2, 3]. Studies indicate that AI-supported learning environments can enhance learning outcomes by adapting content to individual learner needs and providing immediate feedback [4].

At the same time, scholars warn of potential negative consequences, including reduced social interaction, increased dependency on technology, and ethical concerns related to data privacy and algorithmic bias [5]. These findings suggest that while AI holds significant promise, its educational implementation requires careful pedagogical and ethical consideration.

AIM AND RESEARCH QUESTIONS

The main aim of this article is to provide a critical overview of the role of artificial intelligence in education, with particular emphasis on both its pedagogical benefits and potential risks.

The article seeks to answer the following research questions:

RQ_1: In which ways does artificial intelligence contribute to the improvement of teaching and learning processes?
RQ_2: What are the main pedagogical, social, and ethical challenges associated with the use of artificial intelligence in education?
RQ_3: How can artificial intelligence tools, such as ChatGPT, be integrated into education in a responsible and balanced manner?

Given the conceptual nature of this article, no formal hypotheses are tested. Instead, the study is based on a critical analysis of existing literature.

METHODOLOGY

This article is based on a qualitative, non-empirical research design. A narrative literature review approach was employed to analyze relevant academic sources related to artificial intelligence in education.

The selection of sources included peer-reviewed journal articles, books, and conference papers published primarily between 2000 and 2024. Databases such as Google Scholar and Web of Science were consulted.

The analysis focused on identifying key themes related to the advantages, disadvantages, ethical challenges, and pedagogical implications of artificial intelligence in education, with particular attention given to the use of generative language models such as ChatGPT.

THE EMERGENCE OF ARTIFICIAL INTELLIGENCE

The Latin term intellectus has two basic meanings: “mind” and “the power of understanding”. The root of the modern concept of “intelligence” also lies in the Latin intellegere, with the basic meaning of “to understand” [6, p.27]. AI is defined as a computer system capable of performing tasks typically associated with intelligent beings [7]. The emergence of artificial intelligence is a process that began in the late 20th century and continues to this day. AI refers to systems that can perform interesting and useful activities usually carried out by humans, such as problem-solving, learning, and language comprehension. Although the development of AI actually began in the 20th century, the first significant step toward creating AI was the development of computers in the mid-20th century. The first computer, the Colossus, was built in 1943, followed by two other major computers: ENIAC (1946) and UNIVAC 1 (1951). These computing systems enabled the development of the first AI systems, such as PERCEPTRON (1957), ELIZA (1966), and MYCIN (1986). PERCEPTRON was the first automated learning machine, based on artificial neural networks [8]. ELIZA was the first AI capable of holding conversations with humans and simulating aspects of psychological therapy [9]. MYCIN was the first AI used in disease treatment, based on probabilistic logic [10].

The first real step toward the development of AI as a technological and scientific field was taken by British mathematician Alan Turing. Turing posed the question *Can machines think?* and proposed the “Turing Test” in 1950, which was a crucial step in defining AI [11]. Turing believed that thought was computational and that, given sufficiently complex infrastructure, machines could mimic human intelligence [11].

In 1956, John McCarthy, Marvin Minsky, Nathaniel Rochester, and Claude Shannon organized the Dartmouth Conference [12], considered the formal beginning of AI as an academic discipline. McCarthy defined AI as the scientific discipline concerned with creating programs that can perform tasks requiring human intelligence. McCarthy also developed the LISP programming language, which became key to further AI development.

After a period of stagnation in AI development during the 1970s and 1980s due to uncertainty about the capabilities of existing systems, the early 21st century saw renewed interest in AI. The development of deep learning, combined with the application of large datasets, significantly advanced AI capabilities. Geoffrey Hinton argued that if we want to create systems that can understand, recognize, and respond to their environment in a human-like manner, we must start from how the human brain processes information [13].

Today, AI is divided into three main classes: narrow AI, general AI and superintelligence.

Narrow AI (Specialized AI) refers to AI systems designed to perform specific tasks with a high level of precision. This type of AI is used in various applications, including speech and image recognition.

General AI refers to the ability of AI systems to learn and solve a wide range of problems in a manner similar to human intelligence. This type of AI remains a theoretical concept, as no current system can achieve such a level of autonomy and cognitive ability.

Superintelligence represents a hypothetical form of AI that would surpass human intelligence in nearly all aspects, including creativity, problem-solving, and social skills. This type of AI could solve problems beyond the reach of human intelligence.

These three classes of AI reflect the development and applications of AI technologies in today’s society. Narrow AI is already present in everyday life, General AI remains a challenge for the future, and Superintelligence raises ethical and safety concerns that will need to be addressed if and when it becomes a reality.

ADVANTAGES OF DIGITAL PEDAGOGY AND ARTIFICIAL INTELLIGENCE IN EDUCATION

AI has the potential to significantly enhance the educational process in various ways that can transform the learning experience. One of the key aspects is the personalization of learning. Personalized teaching, as an essential part of modern education, provides numerous opportunities for each student, fostering a more creative and active approach to learning and preparing them for future life challenges [14 p.14]. AI tools can analyze vast amounts of student data, including academic performance, learning styles, and emotional responses during lessons. Based on this information, systems can recommend additional resources, exercises, or teaching methods best suited to individual student needs.

For example, a system may recommend exercises focusing on students' weaknesses, enabling faster and more successful development. Additionally, the system may suggest different teaching methods proven effective for individual students, such as technology-assisted learning or hands-on learning. These approaches increase student motivation, facilitate engagement in the educational process, and improve content assimilation. Allowing students to learn at their own pace leads to deeper levels of understanding and concept mastery. AI can tailor education to individual student needs, enabling teachers to focus on areas requiring additional attention [2].

The integration of AI into the education system can facilitate access to education for all students, including those with special needs and gifted students. This approach certainly eases teachers' workload, as AI creates visualizations of individual student progress, allowing teachers to better understand and adapt lessons to individual needs.

Moreover, AI significantly reduces the burden on teaching staff by automating routine administrative tasks such as attendance records, exam grading, and schedule management. By freeing teachers from these tasks, they can dedicate more time to interacting with students, creative lesson planning, and evaluating teaching methods. Tools based on automation and artificial intelligence have the potential to support teachers in improving their pedagogical skills and increasing self-efficacy [15].

Intelligent tutors are software tools that use AI technologies to provide customized support to students in the learning process. These tutors can analyze students' knowledge and understanding, adapt content and learning pace, and offer feedback to improve learning outcomes. They feature interactive dialogue functions where students ask questions in real-time, and the AI system can respond quickly and explain concepts clearly. When students solve exercises or quizzes, tutors can immediately assess their answers and provide improvement suggestions. Based on performance analysis, tutors may recommend additional resources or materials to target areas needing more attention. Intelligent tutors are available 24/7, allowing students to learn and solve problems at their convenience. These tools facilitate the learning process, encourage independence and motivation among students, and enable them to take control of their education. With technological advancements, intelligent tutors are becoming increasingly efficient and accessible, providing significant support to educational institutions and students worldwide.

Digital pedagogy encourages collaboration among students. Access to digital resources and online tools for group work, such as virtual collaboration boards or idea-sharing platforms, enables students to work together on projects regardless of physical distance. This collaboration develops teamwork and communication skills, which are crucial in today's globalized society. Additionally, this inclusivity helps reduce educational disparities and provides equal learning opportunities for all [16].

Overall, digital pedagogy and AI represent revolutionary tools in education, enabling personalized learning tailored to each student's needs, fostering creativity, and promoting a

culture of collaboration. This approach is not just a trend but a crucial step toward an educational future that recognizes the importance of each student as an individual.

DISADVANTAGES OF DIGITAL PEDAGOGY AND ARTIFICIAL INTELLIGENCE IN EDUCATION

Alongside the many advantages of digital technology and AI in education, there are also significant drawbacks and challenges associated with their use.

Loss of social skills is one of the biggest challenges linked to the digitalization of education. Overreliance on digital technologies can diminish the development of social skills, which are an essential part of educational processes [5]. While technology can provide quick and efficient responses for gathering information, it reduces the development of crucial human communication and interaction skills. Technology should not entirely replace the important social and emotional aspects of human communication, though it already does to some extent. When students excessively use automated systems, they risk developing limited abilities to establish deeper, personal relationships. Automated systems cannot fully replicate the complex emotional responses and social intelligence that form the basis of human relationships. The vast majority of real human communication relies on nonverbal cues, tone of voice, facial expressions, and emotional expression – elements that digital technology cannot replicate. Excessive use of digital technology causes students to miss opportunities to build social resilience and empathy, key skills for facing today's challenges and stresses [17]. Only a balanced approach that includes both technology and real human interaction will enable young people to develop the comprehensive skills needed for success in modern society.

Lack of infrastructure as a barrier to the widespread use of AI technologies in education has a particularly negative impact on educational inequality. Technical limitations, such as the lack of fast internet connectivity or computer equipment, can reduce the effectiveness of AI in education [5]. In countries or regions with significant socio-economic disparities or remote rural communities, access to basic digital infrastructure like the internet and computers is often limited. This creates a significant gap between those who have access to modern technological tools and those who do not. Digital technologies can further widen educational disparities between different regions and social strata [5].

This inequality can have far-reaching consequences for the education system and society as a whole. Students without access to AI tools and other digital technologies may be at a disadvantage compared to their peers who have easier access to these resources, potentially resulting in lower academic achievement and reduced employment opportunities. Additionally, the lack of access to technology and AI tools in education limits teachers' ability to develop personalized educational plans and programs, as well as to monitor and support students with special needs or gifted students. This can lead to further segregation and restrict opportunities for social and economic development for individuals and communities.

Addressing this issue requires a joint effort by governments, educational institutions, and the private sector to invest in digital infrastructure, as well as in teacher training for the effective integration of AI tools into the educational process. Furthermore, strategies must be developed to include all students in the digital world, regardless of their socio-economic conditions or geographic location. This may successfully reduce inequalities in access to education and enable all students to leverage the potential of digital technologies and AI tools for better academic results and personal development.

The use of AI digital tools in education can lead to the collection of vast amounts of student data, including personal information, behavior, learning outcomes, and activities conducted in digital spaces. This raises concerns about privacy and data security [5]. A significant amount

of personal data must be managed and protected. In such cases, risks such as data breaches, security attacks, and even identity theft are common.

To mitigate these risks, schools and educational institutions must implement responsible data management procedures, such as:

- Guidelines and policies – Schools and institutions must define guidelines and policies for the use of AI and digital tools in education, as well as for privacy protection and data security.
- Education and counseling – Students and school staff must be educated and advised on the importance of privacy and data security, as well as on procedures to protect them.
- Use of security protocols – Schools and institutions must implement security protocols for storing and processing large amounts of data, such as cryptographic techniques and identity verification.
- Reports and monitoring – Schools and institutions must keep track of the use of AI and digital tools in education, including their results, as well as the use and protection of data [5].

Through the implementation of these procedures, schools and educational institutions can overcome the risks associated with privacy and data security when using AI and digital tools in education.

Overreliance on automated systems in education can have numerous negative effects on the development of creativity and critical thinking. Critical thinking is essential in education because it enables students to understand and evaluate information in the context of various perspectives. Creativity is crucial because it allows students to adapt knowledge and information to their individual needs and learning styles. Technology can reduce the need for thinking and problem-solving skills [18]. AI can automate many tasks but cannot replace human creativity, which is key to the educational process [3]. Students who rely too heavily on AI use their own high-quality analysis, creative abilities, and information assessment less frequently. They are aware that someone – or something – else will complete their tasks for them. The use of AI programs to assess their own or others' creations can lead to lazy work habits [18]. It is essential to issue guidelines on the rational use of technology in education to continue fostering students' creativity and critical thinking.

Students who overuse digital tools and AI may struggle with self-sufficiency and develop a dependency on technology. Their ability for critical and analytical thinking diminishes. The use of automated tools for grammar checking, translation, or solving math problems can make students reliant on these tools while reducing their ability to develop problem-solving skills independently. Using technology as a substitute for independent thinking can decrease their capacity for creativity and autonomous decision-making. Additionally, students who excessively depend on automated systems may experience reduced self-confidence [17]. If they frequently rely on technology for learning assistance, they may feel insecure when the system is unavailable or when faced with a task that cannot be solved using digital tools. This insecurity can lead to diminished self-efficacy and personal development, with long-term consequences for their academic and professional paths.

To reduce technology dependency, it is important to encourage students to develop independent thinking, problem-solving, and collaboration skills without constant technological assistance. The use of technology in education should be balanced and purposeful, emphasizing its role as a tool to help students advance their knowledge and skills, not as a replacement for their active role in learning. In this sense, educational systems should guide students to use technology as support, not as the primary means of achieving educational goals.

The immediacy and speed offered by automated systems can create the illusion that solutions are simple and quickly accessible. Students who rely on algorithms to solve math problems or use online tools for writing and editing texts may learn how to obtain correct answers but lack

an understanding of the processes and steps leading to those answers. This approach can limit students in developing their ability to assess more complex information.

In real-life situations, problems are not always as clear and simple as in digital tools, where answers are often predetermined. Quick solutions provided by automated systems can reduce students' ability to cope with uncertainties and ambiguities common in real life. Automated systems typically do not allow students to learn from their mistakes or provide opportunities to consider alternative approaches or solutions. As a result, students may develop an inaccurate perception of how to solve complex problems. This can lead to imprecise assessments of information, which is particularly dangerous in a world where data accuracy is crucial for educational decision-making. Reliance on speed and immediacy can diminish students' ability to recognize the importance of thorough research and deep thinking [19].

In many situations, speed is not the most important factor – rather, it is the process leading to the solution. Deeper understanding, careful consideration of options, and adaptability are keys to effective problem-solving. Students should be encouraged to think critically and reflectively, to develop skills for analyzing complex situations, and to understand how to make informed decisions based on sources and perspectives.

To counteract this disadvantage of digital systems in education, it is important to incorporate strategies that encourage students to think, problem-solve, and evaluate options rather than merely seek quick answers. Teachers can encourage students to engage in discussion and collaboration, design tasks involving multiple solutions where students must select information from various sources, test hypotheses, and draw conclusions.

It is necessary to make students who use technology only for quick answers aware that they may neglect the importance of asking critical questions, analyzing information sources, and verifying data accuracy.

Electromagnetic radiation emitted by technological devices such as smartphones, tablets, and computers has become a topic of intense debate in recent years, particularly regarding potential health risks associated with prolonged use of these devices. Parents and teachers often express concerns about children and adolescents' long-term exposure to this form of radiation, given that young organisms undergo critical developmental phases. Although research in this area often yields mixed results, there are concerns that prolonged exposure to electromagnetic radiation may affect health, particularly the brain and reproductive system.

Recent studies have begun to explore the relationship between artificial intelligence-driven technologies and electromagnetic radiation exposure. Lal et al. [20] demonstrate that AI methods can be used to optimize electromagnetic radiation assessment in GSM base stations, indicating a direct connection between AI systems and EMR environments.

Furthermore, Prekodravac Filipović et al. [21] emphasize that modern technological ecosystems, increasingly shaped by AI-based systems, contribute to complex electromagnetic interference patterns that require interdisciplinary monitoring and regulation. These findings suggest that discussions of electromagnetic radiation in education should not be limited to device usage alone but should also consider the broader AI-supported digital infrastructure.

According to findings from the World Health Organization (WHO), through the International Agency for Research on Cancer (IARC), electromagnetic radiation has been classified as possibly carcinogenic to humans – Group 2B. Excessive use of digital devices may affect attention, memory, and general cognitive function. Exposure to blue light from screens can disrupt natural sleep cycles, leading to sleep problems, which further impact emotional and physical health. Prolonged use of digital devices can cause vision problems, dry eye syndrome, and musculoskeletal issues such as neck and back pain [22].

To reduce radiation exposure, WHO recommends several measures, such as:

- limiting duration of digital device use: Children should be restricted to short intervals of smartphone and other device use – no more than 1-2 hours per day.
- outdoor social activities – encouraging children to spend more time outdoors can reduce screen time and improve overall health.
- creating screen-free zones – introducing rules for screen-free zones in homes and schools can help reduce exposure. For example, dining rooms and bedrooms should be device-free areas.
- using hands-free technology – when possible, using headphones or speakers can help reduce levels of electromagnetic radiation.
- educating on technology use – promoting awareness among children and young people about safe and responsible technology use can encourage a more mindful approach to digital devices. Incorporating these topics into curricula can be beneficial.

Understanding the potential risks of electromagnetic radiation, along with active measures to mitigate them, can help preserve the health and well-being of younger generations.

CHATGPT – ARTIFICIAL INTELLIGENCE LANGUAGE MODEL

ChatGPT, Generative Pre-trained Transformer, is one of the more popular AI tools. ChatGPT is a large language model [23] developed by OpenAI and capable of generating human-like text responses. It was launched in November 2022 and gained popularity at a record pace, reaching one million users in just five days [24]. ChatGPT was developed using machine learning algorithms trained on comprehensive text datasets consisting of books, news articles, and websites [25]. Its development continued until March 2023, when the new ChatGPT-4 was introduced, offering even better performance and accuracy in assisting users, along with additional capabilities for creative writing and problem-solving.

ChatGPT was selected as a representative example of generative artificial intelligence due to its widespread adoption, accessibility, and significant impact on educational practice since its release. Unlike some alternative models, such as DeepSeek, ChatGPT has been extensively studied in educational contexts and is commonly used by students and educators worldwide, making it particularly relevant for pedagogical analysis.

Key Characteristics of ChatGPT [26]:

- core Technology – ChatGPT is based on the transformer architecture, a deep learning model that has become standard in many natural language processing tasks. The latest version of this model uses advanced variants of Generative Pre-trained Transformer.
- training – ChatGPT was trained using unsupervised learning methodologies, meaning the model was trained on vast amounts of data without direct human supervision. The model uses textual data to predict the next word in a sentence, and through massive datasets, it acquires the ability to generate coherent and meaningful responses.
- functionalities – ChatGPT can perform various tasks, including;
  - answering questions,
  - writing essays, articles, and creative texts,
  - assisting with coding,
  - explaining complex topics,
  - assisting with language translation,
  - and much more, depending on the user's specific query.
- interactivity – ChatGPT is designed to be interactive and respond in real-time, taking into account previous inputs in the conversation. This allows users to ask questions, hold conversations, or use the model for various professional or educational purposes.

- versions and updates – since its launch, ChatGPT has undergone several versions. For example, GPT-3, which was a significant step in development, served as the foundation for the first versions of ChatGPT, while newer iterations use improved training and optimization techniques.

Mogavi et al. [26] conducted research on the perception and application of ChatGPT among early users in education. Their study relied on content analysis from social media and focused on the use of ChatGPT across all educational levels. The results reveal that in higher education, ChatGPT is used for content generation, data analysis, and student performance assessment. In practical learning, ChatGPT serves as a tool to facilitate problem-solving and skill development. The study presents ChatGPT as an excellent tool in education, highlighting its advantages in personalized learning. However, challenges such as reduced social skills in students and their dependency on digital technology are also noted. The importance of moderate application of AI tools in educational systems is emphasized, along with the need for further research to develop guidelines for such integration.

Ahmad et al. [27] consider ChatGPT a disruptive force that will fundamentally transform the education sector. The ability of ChatGPT, and now GPT-4, to generate coherent and contextually appropriate responses to complex queries is seen as a significant breakthrough in conversational AI.

Additionally, there is a high potential for plagiarism, which is not easy to detect. ChatGPT can be considered a high-risk technological tool for cheating [28]. Fortunately, programs such as ChatGPT Detector can identify plagiarized documents or detect whether students have presented their own thoughts or if the content was machine-generated.

Despite its advantages, ChatGPT is known to occasionally generate inaccurate information or fabricated references. This limitation raises concerns regarding the reliability of AI-generated content, particularly in academic contexts. Users must therefore approach AI-generated responses critically and verify information using credible academic sources. The role of educators is crucial in guiding students toward responsible and ethical use of such tools.

Memarian and Doleck [29] concluded, based on their research, that ChatGPT offers benefits such as the development of personalized and complex learning in students, specific teaching and learning activities, assessment, asynchronous communication and feedback, and cognitive offloading. However, several challenge areas that ChatGPT faces or will encounter in education are also presented. Examples include, but are not limited to, deception through plagiarism, misuse, lack of learning, accountability, and privacy. The authors recommend that future research be more empirically based rather than relying on personal opinions and that the use of ChatGPT in education be explored in greater detail.

CONCLUSION

Digitalization and AI in education offer significant potential for improving education. They enable learning to be more efficient, faster, more accessible, and more personalized. Digital pedagogy represents a significant step toward modernizing educational practices by creating dynamic and interactive classrooms that better meet the needs of today's students. With the right supportive frameworks, training, and resources, digital pedagogy can enhance the quality of education and help students better prepare for future challenges.

However, alongside these advantages, the challenges of digital pedagogy must not be overlooked. Concerns exist regarding student data security, the risk of losing social skills in society, potential health consequences, and most importantly – the loss of the learning process itself, which is crucial for developing critical thinking.

Ultimately, considering both the advantages and disadvantages, educational institutions should develop clear guidelines for the optimal use of technology in the educational process while ensuring high standards of academic ethics and teaching quality.

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