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The Impact of Digital Technology on Educational Reform: The Role of Artificial Intelligence in Education

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Abstract: *The significance of this study lies in the inevitability with which the challenges of digitalisation have impacted the educational sector. As a consequence of the globalising tendencies characteristic of postmodern society, technologies facilitating the integration of information resources have increasingly permeated educational systems. Within the context of postmodernism, a prevailing global trend in education is the transition of pedagogical practices to a technologically advanced framework, necessitating the systematic incorporation of information technologies. The vector of change in education points to the need to expand the scope of innovation. In today's rapidly evolving world, education is undergoing significant changes influenced by digital technologies. This article explores how new technologies, in particular artificial intelligence, are transforming traditional teaching methods, making them more interactive, effective, and accessible. The author analyses the advantages of personalised learning, which allows to adapt the educational process to the individual needs of each student. In addition, the role of e-learning in ensuring flexibility and accessibility of education is discussed. Explored the potential of artificial intelligence in education, its ability to analyse large amounts of data, adapt learning materials, and provide individualised support to students.*

Keywords: *digital transformation; education; artificial intelligence; personalisation; e-learning; interactivity; accessibility.*

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1. Introduction

The tendencies to change the general situation of education coincide with the general principles of its reform in the world. The main factors behind the change of the traditional paradigm in education include: acceleration of society development, expansion of socio-political diversification, expansion of intercultural interaction, profound structural changes in employment, etc.

The global education system plays a pivotal role in securing a nation's position among the leading countries within the international community, serving as a key indicator of its advancement in science, culture, and educational development.

Digital technologies are revolutionising education by providing students with unprecedented opportunities for learning and development. This transformation manifests itself in two key ways: firstly, by providing students with the digital skill sets necessary for a successful career in today's digital world; and secondly, by using digital tools to improve teaching methods and enhance learning.

In the works of domestic and foreign scholars, several studies have assessed the impact of new technologies on education reform in today's developmental conditions (Nerubasska, Palshkov, & Maksymchuk, 2020; Melnyk et al., 2019; Melnyk et al., 2021; Sheremet et al., 2019). The scientific works of A. Katashov (2001) and Kosynskyy & Shvets (2012) revealed the essence of the concept of "information technology of education" and highlighted the problems of the current process of informatisation, in comparison with other European countries. N. Razina (2009) proved that in the era of postmodern society, teachers and students must learn the basic concepts necessary to master ICTs, and drew attention to the need to borrow foreign experience from the perspective of informatisation. Demyanenko, Bykov, & Lapinskyi (2012) advocated for expanding the experience of e-learning in elementary school. Foreign researchers, Vlasova et al. (2020), stressed the need to implement e-learning to improve the educational process in today's society.

The purpose of the article is to reflect the impact of the latest technologies on the reform of education in the present world; to describe the role of digital education in a society, the innovativeness of personalised learning, and the effectiveness of electronic education; to prove the effectiveness and importance of artificial intelligence, and provide its main characteristics.

The article methodology includes:

- formulation of the research question;
- information sources and search strategies - databases;
- the process of selection and quality assessment of research; - methods for assessing the relevance and credibility of selected publications;
- methods of data analysis;
- main results and conclusions - generalised conclusions drawn from the analysed data.

2. Digital Education in Today's Society

The term "digital education" in a postmodern society is the process of organising the interaction between students and learners, during the movement from goal to result in a digital environment, the main means of which are digital technologies, digital tools and digital traces as digital learning and professional activity results (Petko, Mitzlaff, & Knüsel, 2007).

Digital technologies are gradually redefining today's school classrooms and student classrooms. Elementary school students are using tablets to complete classroom and homework assignments, and teachers are increasingly using interactive whiteboards to explain and illustrate the content of their lessons. Students design objects via computer-aided design platforms (CAD) and print them on 3D printers. Paper textbooks are being replaced by interactive Internet services that provide more modern and in-depth content and allow students to learn at their own pace (Kepser, 2009).

The positive role of digital technology is enormous. Tasks that once required extensive time in physical libraries, searching for relevant books and journals, are now efficiently performed through digital platforms, significantly enhancing access to scholarly resources. Digitised academic

publications and e-books are downloaded to laptops, tablets, e-readers, and smartphones. Classroom note-taking has evolved markedly. External forces, such as the needs of society and employers, influence how and when students (learners) in each age group learn, how they interact with instructors and each other, and how instructors assign, receive, and evaluate their work. In both educational and corporate contexts, digital learning has emerged as an optimal approach for staff training, knowledge dissemination, and personal development. Activities that once necessitated physical attendance at extended courses and seminars have largely transitioned to remote learning modalities (Barakhsanova et al., 2018).

Acquiring new professional skills or autonomous personal growth is now possible outside the traditional learning environment. The emergence of massive open online learning platforms, many of which are online versions of popular school and university courses, means that anyone can learn almost anything on their own. There are far fewer constraints to lifelong learning today than at any other time in human history. The only obstacle is the lack of a habit of continuous learning (Judrups, 2016).

The educational environment of an educational institution, college, or university in the era of postmodernism can become a generator, conductor, and integrator of knowledge, only if it has the properties of adaptive flexibility, saturation, desire for evolution, and ability to respond to external and internal changes. Therefore, educational institutions are rapidly expanding their educational space with many promising digital technologies (cloud technologies, webinars, interactive technologies, etc.). The traditional model of "team of teachers (teachers) - a group of students (students)" is expanding through the inclusion of additional distance communities (Demyanenko, Bykov, & Lapinskyi, 2012).

Digital education implies an active expansion of educational communication platforms: opportunities to attract external lecturers, practitioners, and consultants appear.

The digital transformation of education can be represented as a movement towards personalisation and customisation of the educational process based on the use of new pedagogical models of organising and conducting individual educational work.

3. Innovativeness and Efficiency of E-learning

Based on the challenges of today's society in the education process, innovation, responsiveness, mobility, quality, and accessibility of smart education systems allow you to quickly solve problems in educational activities.

Smart learning (SMART-education) - flexible learning in an interactive educational environment that is freely accessible. It allows you to make the learning process the most effective as a result of the transfer of the educational process to an electronic environment, making it available everywhere and always.

E-education, being a democratic form of learning, combines economy, mobility, high technology, and accessibility. The system of mobile time updating of information and methods of delivery of knowledge ensures the permanence of the learning process and information exchange, without loss of relevance and novelty.

Distance technology allows for increasing the number of students, individualising the pace of learning, improving the quality, comfort, and shortening the period of study (Kibik et al., 2022).

The success of using distance technologies in e-learning for students in the postmodern period is dependent on the criteria identified by Kosynskyy & Shvets (2012):

- technical skills in computer control;
- availability of Internet resources;
- motivation of the learning process;
- self-organisation and self-control;
- setting clear goals and objectives;
- supervision by a tutor;
- mastery of the norms and skills of communication in the social network and the Internet;
- objectivity of knowledge control.

The role of the teacher changes significantly in this type of learning, significantly expanding its functions - tutor, organiser, and coordinator of the learning process, mentor, and consultant.

SMART technology is an integral part of the educational continuum, the interaction between the teacher and the student, divided geographically.

The role of the computer is a priority at the initial stage of training. During the adaptation period (the first semester of training), students develop special skills and abilities necessary for e-learning (technical skills in operating the computer, the ability to competently use electronic resources, independence, organisation, structured learning behaviour).

Moodle is an e-learning management system, also known as a learning management system or virtual learning environment. Communication media are reshaping societal interaction and daily routines (Melnyk et al., 2021).

New ways to intensify the learning process through e-learning management system methods and tools are new, innovative ways to change education.

The Moodle system contains resources, assignments, surveys, chats, tests, and files (Katashova, 2001).

Resources are the information that is intended for integration in our course. Resources also support any content in electronic form. They can be uploaded by the instructor or stored on the server.

When completing assignments, the instructor can ask questions and then receive the students' responses as a file uploaded to the server. The system allows the instructor to assign points for the answer received (in a specified format) to the server, where the report time is automatically recorded (the instructor can see which papers were submitted after the deadline).

The survey allows the teacher to ask questions and collect feedback from their students. In the survey, the teacher independently asks one question and presents multiple response options.

The survey can be used to organise individual student work. The teacher sees the results in the form of a table, the student sees an individual grade and qualitative feedback (Boltuc, 2017).

Forums are a service for organising discussions. There are different forum settings ("Teachers Only", "News", etc.).

Chat allows students to have a real-time discussion within a virtual space. When discussing any question and getting answers to it, chat is a convenient and useful tool.

The test allows you to create a database of questions both for independent testing of students and for organising interim and final examinations. There are different types of tests: with several answers, choosing right/wrong, or providing a short text answer (Sorochinsky et al., 2020).

The Moodle system is based on a new way of presenting educational material in electronic form and using web-based technologies to deliver e-learning materials to students. Distance learning technologies can be successfully used not only in educational institutions of various types, but also in corporate training.

We believe that this system contributes to the prestige of the educational institution and its indirect online advertising. It also attracts highly qualified teachers regardless of their place of residence, helps them participate in the infrastructure of the educational complex across the country, and integrates them into the global educational space. Teachers get the opportunity to automate the evaluation of student learning outcomes and a wide range of assessment scales. They also get the opportunity to use current multimedia technologies and incorporate additional learning materials from the Internet.

4. Artificial Intelligence (AI): Basic Characteristics

Today, it is clear that the digital educational space is the result of a long evolution of teaching methods and techniques (a kind of educational "intermediaries" between the subjects of education) - from educational and methodological literature to specially equipped spaces.

There are many definitions of AI circulating in contemporary scientific and social discourse, including this one (Khan & Lulwani, 2023):

- "the property of intelligent systems," their ability to perform human creative functions;

- "the science and development of creating intelligent machines" and programs;
- "a system of software products and their algorithms" capable of performing the specific functions of human intelligence;
- intelligent systems, the key task of which is to model mental, cognitive, and educational processes;
- "modelling of human intelligence processes by computer systems", including the processes of "learning" (receiving and processing information), "thinking" (formulation of certain conclusions, identification of patterns), "self-correction", recognition of verbal (language) and nonverbal signs ("machine vision");
- in the educational context, "augmented (amplified) intelligence", the application of which allows all subjects of education to receive and process additional information necessary to make more "informed" decisions;
- a tool to improve the methods and ways of learning, accelerating and simplifying the training, production, and communication processes;

AI, according to domestic experts, claims to perform the following functions in the educational space:

- a) the ability to distinguish and identify visually and images of acoustically perceived objects;
- b) the skill to formulate and solve professional tasks;
- c) the ability to search for, process, and use all types of information and knowledge;
- d) "the ability to understand the meaning of individual acts of socio-cultural human activity and language".

AI is a composite system, comprising the following elements (Uzwyszyn, 2023):

- a) an information retrieval system that allows the formation of a database based on various resources and sources for educational processes;
- b) an automated library of electronic educational and methodical materials
- c) a digital system for monitoring the level of knowledge, progress, and activity of students
- d) an automated database of control tasks, taking into account the performance of each subject of education;
- e) an automated system of distribution of teaching and educational workload;
- f) a communication system serving the interaction of all subjects of education.

The application of AI technologies in education plays an important role in human lifelong learning and development. These technologies include: the Internet of Things (distance learning laboratories); additive manufacturing (3D printers, 3D modelling, making robotic parts and devices); machine learning ("using avatars and chatbots in the educational process for counseling, testing and designing individualised educational paths"); big data, blockchain and cloud computing (building secure portfolios of students and teachers; recording the formation of educational and professional competencies); virtual and augmented reality (using different installations with elements of augmented reality in the educational process).

Based on the above definitions, features, and characteristics of AI, its relevance in the present educational space becomes obvious. The use of these technologies allows not only to overcome the limitations and consequences of the COVID-19 crisis, but also to ensure the effective development of the educational system, as well as the high quality of its results in the form of intellectual capital in the "post-COVID" period.

At the same time, new opportunities and prospects of AI in the educational space are quite obvious, in particular in the formats of adaptive and personalised learning.

The AI allows effective implementation of adaptive learning models based on the following educational technologies: applied software learning, method of expert evaluations, multi-agent approach, generation of complex educational systems (for example, BiGOR, WebCT, Moodle, etc.).

Adaptive educational AI-technologies allow timely monitoring of progress, selecting the order of demonstration of educational material according to the interests and needs of the subjects of education. However, the experimental practices of implementing adaptive technologies in the

educational space are mainly carried out in the commercial units of HR2 projects such as Competentum, Ispring, E-MBA, etc (Khan & Lulwani, 2023).

Adaptive learning is inextricably linked to the theory and practice of personalised learning techniques, the importance of which is recognised by about 80% of education professionals. Personalised learning is an effective tool for engaging and communicating with all participants in educational processes, contributing to their performance. These formats allow for maximum optimisation and differentiation of learning objectives and paces, teaching methods, and approaches depending on the needs, abilities, and competencies of specific educational participants.

Experts develop the following approaches to personalised learning: individual (pace adjustment); differentiated (approach adjustment); learning based on the competences of the subjects of the educational process. The following functions are distinguished: development of socio-emotional competencies in accordance with the established educational standards; real-time feedback; ample opportunities to adjust various aspects of educational processes based on the needs and interests of educational subjects, etc.

Prospects for the use of AI in personalised learning are as follows: automation of the main types of educational activities (presence, certification, etc.); adaptation of software educational space to the interests of specific subjects of education; timely support of feedback and communication in the educational process; teaching disciplinary patterns (but not creativity and thinking); transformation of the teacher in a facilitator; the possibility of applying the method of "trial and error".

Adaptive-personalised format of learning on the basis of AI-technologies promotes the formation and development of skills of "cognitive independence" (CI) of subjects of education, which imply their intellectual abilities and the ability to "independently isolate the essential and secondary features of objects, phenomena and processes, through abstraction and generalisation to reveal the essence of new concepts" (Uzwyshyn, 2023).

In this perspective, the main components of CI include: the ability of the subject of education to independently acquire, master, analyse new knowledge, abilities, skills (KAS), through various methods of independent learning (from "memorisation" to "scientific discovery"); the ability to competently and effectively apply KAS for self-education in the future; preparedness to apply KAS in practical educational and work activity.

The empirical study of the effectiveness of artificial intelligence in personalising learning was conducted on the basis of the National University of Bioresources and Nature Management. The respondents were the control group (20 people), who studied traditionally, and the experimental group (20 people), who studied with AI-personalisation. The comparative results are presented in Table 1.

Table 1. Empirical study of the effectiveness of artificial intelligence in personalising learning

Parameter	Control group (traditional learning)	Experimental group (AI-personalisation)	Change (%)
Average test score	75	85	13
Student engagement level (%)	60	82	37
Time of task fulfilment (min)	45	35	22
Satisfaction with the learning process (%)	65	88	35
Number of repeated explanations of the material	12	6	50

These data illustrate that using artificial intelligence to personalise learning can increase student achievement, engagement, and satisfaction, as well as reduce time on task and the need for additional explanations.

5. The Main Areas of Use of Artificial Intelligence

Artificial intelligence or machine learning is now being actively applied in education, from administering and reviewing exams, to automatically selecting material for students in areas where they have learning difficulties, suggesting that the student more consciously delve into the topic, enhancing cognitive outcomes and skill acquisition. By analysing the learner's success and performance, the system can personalise the learning trajectory with the constant and loyal supervision of an "indifferent" machine (Tkachuk et al., 2021).

Artificial intelligence will be actively implemented in the learning process, and it becomes obvious that the scale of use of these end-to-end technologies will only increase annually.

Let us consider the main directions of using artificial intelligence in education at the moment.

Teachers have always had a great deal of responsibility and workload with students, monitoring grades, checking standardised tasks, knowledge level, and preparation for classes. Such routine tasks take a lot of time away from the valuable learning process in the classroom. To improve the efficiency and quality of education, it is now possible to delegate such routine work to artificial intelligence. It is widely acknowledged that a human will never be able to process the amount of text and other information that can be processed by artificial intelligence. Human errors that artificial intelligence will make can be significantly minimised. Considerable attention is currently about personalising learning. By introducing artificial intelligence technologies into the educational environment, it is possible to realise the creation of personalised plans for the study of each discipline in the training of specialists, and then to control students' activities. This application of artificial intelligence in education becomes possible due to the development by teachers and psychologists of methods for determining the abilities, motivation, willpower, and other indicators of students, based on which an individual training program is built.

Creating educational applications and specialised content for students also helps to personalise the learning process. This functionality is widely utilised by both students and educators. For instance, a single digital platform can facilitate foreign language instruction across multiple formats. Such technology is capable of recognising the learner's language, analysing sentence structure, vocabulary usage, and grammatical accuracy, and subsequently generating tailored exercises to reinforce the material and support deeper learning. These programs are widely adopted because they are becoming a routine activity in personal digital devices for many people. Apart from foreign language learning, the technology applies to all subjects, and they are already starting to gain success with both students and teachers (Markova et al., 2021).

Personalised learning is a way of developing an educational plan and its implementation, in which the student is the subject of the educational process, taking into account his or her personal characteristics. To increase the effectiveness of the educational process from the point of view of personalisation, it is necessary to resort to the capabilities of artificial intelligence both for teachers and students themselves.

Artificial intelligence can collect and analyse large arrays of heterogeneous data sets, and subsequently extract the overall picture of the situation. In addition, artificial intelligence can forecast a learning trajectory based on the starting point and offer options for its adjustment depending on the request. As far as the educational process is concerned, artificial intelligence is able to identify certain disciplines, areas of these disciplines where students have problems. This helps to analyse the situation at the moment and highlight where the student needs additional help. Moreover, at each subsequent point in the development of time, there may be a need to decrease or increase the amount of this help. This concept can help to create a personalised learning trajectory, taking into account such parameters as interest in the topic, psychological state, ability to perceive specific types of information at a certain point in time, etc.

In the digital age, in addition to mastering professional competencies (hard skills), it is necessary to develop soft skills. The ever-increasing amount of information and knowledge has significant cognitive implications for the human brain. It is impossible to learn all the information, but artificial intelligence can help in executing diverse cognitive operations, allowing students to

develop critical thinking and creativity. Today, end-to-end technologies can be effective in aggregating and curating information that can help students learn more effectively and teachers improve the quality of learning.

Neurosystems are rapidly gaining interest from educational institutions and platforms that analyse the activities of students. Artificial intelligence can systematically detect weaknesses in their performance in certain disciplines, which in turn means teachers need additional intervention and help in addressing the performance of the student. The concept of implementing artificial intelligence in the education process is aimed at personalising the system, adapting it to the abilities of students, as well as monitoring the social component, convenience, and usability (Markova et al., 2020).

Artificial intelligence is able to analyse students' interests and offer them programs and courses, matching them. Individual approach allows students to be interested in the learning process, as well as to control the independence of assignments during the period of distance or independent learning.

The digital world is a massive volume of information that a person cannot process and analyse, so let technology delegate such tasks to technological systems for them. Neurosystems will help to cope with the routine of teachers, checking tests, term papers, and voluminous homework. The ability to identify different errors in writing, solving tests, and solving mathematical equations up to complex, is a significant advancement for education and a very useful tool in the hands of a teacher.

Another problem of today's education can be solved with the help of neural networks - it is vocational guidance, which is aimed not only at preparing for the choice of profession, but also at helping graduates in self-determination and further employment. Analysing the answers to diverse questions regarding the constructed logical chain by the machine, the result is a detailed picture of a person's abilities and interests.

The process functions as follows: a standardised suite of tests, developed by subject-matter experts, is administered to students, and the resulting data serve as input for the neural network. The question is selected and formulated according to clear requirements, reflecting the level of professionalism and awareness in certain areas of education. After entering the data, the code, with the help of a machine learning model, produces a result, then there are multiple developmental pathways in which the test taker should continue to develop.

Artificial Intelligence is showing significant potential in improving the efficiency of the educational process. The results of recent research conducted by the University of the Basque Country and the University of Pau showed that AI can approximate with 70% accuracy the grades provided by prospective teachers when checking the work of elementary school students. This shows that AI can be used to automate assessment, allowing teachers to focus on other important aspects of learning, such as personalising the educational process and improving classroom interaction.

British researchers have found that using AI can save teachers up to 8% of their time, particularly by automating assessment and lesson planning. This allows educators to spend more time directly interacting with students, which has a positive impact on learning outcomes. In addition, AI-powered personalised learning bots can improve students' ability to learn by mimicking the effect of having a private tutor present (*Education built by AI*, 2024).

An All-Ukrainian survey conducted in 2023 showed that 76% of teachers surveyed had used AI services at least once, and 37% had engaged students in their use. Pupils use AI to prepare for lessons, do homework, and independent work, which indicates the integration of AI into the educational process and its potential to improve learning outcomes (Results of an all-Ukrainian survey, 2023).

These examples highlight the potential of AI to improve the efficiency of education by automating routine tasks, saving teachers' time, and personalising learning for students.

The introduction of artificial intelligence (AI) in education has significant potential, but also comes with certain risks and moral challenges.

The risks are as follows: students and teachers may become overly dependent on AI, which may reduce critical thinking and independent learning skills, and AI algorithms may contain algorithmic biases, which may affect equal access to knowledge and assessment. The use of AI in education involves the collection of large amounts of personal data from students, which poses risks of information leakage or misuse. While AI helps in teaching, its mass adoption could diminish the role of teachers or cause job cuts. AI may also generate inaccurate or insufficiently customised information for students.

A major ethical concern is the compromise of academic integrity, as automated services can facilitate cheating (e.g., using AI to write papers instead of the student). The use of AI for personalised learning may raise the risk of manipulating or controlling student behaviour, and access to advanced AI solutions may be uneven due to financial or technical constraints. The implementation of AI may reduce interpersonal communication between students and teachers, which is important for social development (Soroichinsky et al., 2020).

AI can be a powerful tool in education, but its implementation must be accompanied by clear moral standards, quality control, and safety guarantees. It is important to maintain a balance between automation and human interaction, so that AI complements, rather than replaces, traditional learning.

6. Conclusions

The significance of this material lies in its examination of the influence of emerging technologies on contemporary educational reform. The article explores the role of digital education within postmodern society, highlights the innovation of personalised learning, and assesses the effectiveness of electronic education modalities.

The article also proves the importance of artificial intelligence, as it claims to perform the following functions in the educational space: the ability to distinguish and identify visually and figuratively acoustically perceived objects; the skill to formulate and solve professional problems; the ability to search, process and appropriately use all types of information and knowledge; "the ability to understand the meaning of individual acts of socio-cultural activity and language".

Evidence suggests that the integration of end-to-end technologies, including artificial intelligence and neural networks, can lead to a significant improvement in the effectiveness of learning, the formation of the digital and information culture of students, and will allow personalising the learning process. In addition, the use of end-to-end technologies will make it possible to monitor and adjust the educational process, which is more in line with the requirements of today's digital society. Now it is much easier for prospective students to choose a profession when entering educational institutions, because machine devices analyse only the input information given by students themselves, without imposing the opinion of society, parents, and peers. Artificial intelligence helps to optimise approaches to learning depending on the needs and characteristics of each learner. This is the necessity of using this educational technology to personalise education to achieve effective personalisation. It should also be understood that artificial intelligence is not the only current technology, it is closely intertwined with other cross-cutting technologies (big data, robotics and sensorics, Internet of Things, cloud technologies, augmented and virtual reality technologies, quantum technologies, new production technologies), which are a guarantee of successful professional activity of all participants of the educational process.

The latest technologies significantly change the educational process, making it more flexible, accessible, and effective. Personalisation of learning, use of electronic resources, and artificial intelligence open new opportunities for educational development. Further research can focus on optimising personalisation algorithms, improving knowledge assessment methods, and studying the impact of AI on students' cognitive processes.

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