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The Role of Artificial Intelligence in Shaping the Future of Education: Opportunities and Challenges

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Abstract: Artificial intelligence has become a booming technology whereas it brings numerous positive changes within the educational process. The aim of the research is to describe the role of artificial intelligence in education through the analysis of its opportunities and challenges. The study involved the integration of qualitative (interviews, focus groups, and classroom observations) and quantitative methods (survey and statistical analysis). All the research procedures were organized according to the ethical standards for data collection and analysis. Over 50 recent scientific works were selected to analyze the research problem from different perspectives and present its comprehensive overview. The study involved 56 participants representing instructors from different institutions of higher education in Ukraine. The inclusion criteria were based on subject specialization, institution type, curriculum accreditation, and experience with artificial intelligence technologies. It was found that the positive impacts of artificial intelligence include personalized and adaptive learning, automated administrative tasks, enhanced support, e-learning facilitation, inclusivity, data-driven decision making, gamification, increased engagement, behaviour and predictive analytics, improved assessment. The challenges concerned the data privacy, security, bias, lack of understanding, transparency, necessity for additional training. The findings showed that the implementation of artificial intelligence through personalized learning, predictive analytics, intelligent tutoring systems, content creation systems, Virtual Reality, automated administrative tasks, and chatbots can shape the educational process effectively in future and modernize the future specialists' training. The research results can be used within the educational institutions to increase the awareness of using artificial intelligence tools.

Keywords: artificial intelligence tools, automation, intelligent tutoring systems, personalized learning, Virtual Reality.

Introduction

Artificial intelligence (AI) is considered of significant importance in education today, revolutionizing traditional teaching and learning methods. Its tools and adaptive algorithms offer more personalized experiences and enhance the efficiency of educational process. AI-powered technologies facilitate interactive learning environments and promotes inclusivity within the diverse educational environment. AI is defined as the ability of a digital machine to perform tasks associated with human intelligent. These tasks involve computer vision, machine learning, natural language processing, recognizing patterns, solving problems, and making decisions (Chiu et al., 2023). At present, AI has become a booming technology whereas it brings numerous positive changes including enhanced productivity (Gao & Feng, 2023), improved healthcare (Davenport & Kalakota, 2019), and preventive maintenance in manufacturing (Rojek et al., 2023). AI opens up for new opportunities such as improvement of logistics and public transport (Jevinger et al., 2023). Other AI applications involve natural disaster prediction or response (Jain et al., 2023), precision agriculture (Gardezi et al., 2023). Kaur et al. (2023) admit that AI-based tools influence cybersecurity since they help detect cyber threats, indicate deviations and malicious activity, or improve user's authentication. Additionally, AI is increasingly being used in human resources management to automate the recruitment process and analyse employees' performance (Bujold et al., 2023).

The potential applications of AI-driven technologies in education include personalized learning and automated assessment (Lin et al., 2023). According to Kamalov et al. (2023), AI is used to enhance teacher-student collaboration and create flexible learning environment. Also, it provides adaptive learning promoting a more customized learning experience (Gligorea et al., 2023), and AI-powered tutoring systems provide real-time assistance (Lin et al., 2023). Ruiz-Rojas, Acosta-Vargas, De-Moreta-

Llovet, & Gonzalez-Rodriguez (2023) emphasize that AI facilitates virtual classrooms through attendance tracking, adaptive content delivery, and active engagement with the material. AI, using data analytics, helps make data-driven decisions, enhance teaching strategies, and optimize teaching resources (Rahmani et al., 2021). Besides, AI-based Learning Management Systems (LMS) are designed to streamline administrative tasks, create personalized learning paths, or provide instant feedback (Firat, 2023; George & Wooden, 2023). Tan & Cheah (2021) along with Yordanova (2020) found that AI has a significant impact on gamification as it makes educational games more personalized and engaging.

The special attention is paid towards using of Generative Pre-trained Transformer (ChatGPT) within the educational process. It has become a promising tool that promotes a students' active participation and cognitive advancement (Montenegro-Rueda et al., 2023). ChatGPT is used as a virtual tutor to provide students with instant assistance and explanations on a wide range of subjects (Memarian & Doleck, 2023a). ChatGPT helps students in solving problems, offering guidance on research, and providing explanations for challenging concepts (Fütterer et al., 2023). In addition, this language model is employed to create interactive learning experiences, practice and improve language skills (Kohnke et al., 2023). Montenegro-Rueda, Fernández-Cerero, Fernández-Batanero, & López-Meneses (2023) and Annuš (2023) explain the use of ChatGPT as an assistant for lesson planning and content creation. It's important to note that despite ChatGPT is a valuable educational tool, it can be used as a complement to traditional teaching and cannot replace a human (Memarian & Doleck, 2023a; Yu, 2024).

It is worth mentioning that AI-driven technologies played an important role in emergency education, especially in situations where traditional education systems are disrupted due to natural disasters, pandemics, war, or other crises. AI facilitates the implementation of remote learning platforms that deliver educational content to the students affected with emergencies (Bakhov et al., 2021). Kamruzzaman, Alanazi, Alruwaili, Alshammari, Elaiwat, Abu-Zanona, Innab, Mohammad Elzaghmouri, & Ahmed Alanazi (2023) describe positive affect of AI tools on providing personalized learning experiences which is particularly important in emergency education because students may have diverse learning requirements and different stress level. During the COVID-19 pandemic AI enabled access to education through virtual classrooms, educational apps, and content delivery mechanisms (Pantelimon et al., 2021). Danylchenko-Cherniak (2023) indicates that AI-based instruments contribute to building the "normal" educational process during the war in Ukraine. According to Chmyr & Bhinder (2023), AI is able to increase the efficiency of military training significantly.

At the same time, AI presents various challenges that need to be addressed for successful implementation. They include data privacy and security, bias and fairness, lack explainability (Nguyen et al., 2023). A number of findings concern ethical considerations that concern the use of AI in education, such as data collection, the use of personal information, and the potential impact on students' independent work (Akgun & Greenhow, 2022; Grubaugh et al., 2023). Foltyněk, Bjelobaba, Glendinning, Khan, Santos, Pavletic, & Kravjar (2023) insist that ethical framework must be established to guide the introduction of AI technologies within the educational process.

In the Ukrainian context, the special attention must be paid towards the study of Yuskovych-Zhukovska, Poplavska, Diachenko, Mishenina, Topolnyk, & Gurevych (2022) who explained the main principles of AI application in education and outlined the emerging problems and opportunities. Spivakovsky, Omelchuk, Kobets, Valko, & Malchykova (2023) revealed the institutional policies towards AI in university learning, teaching, and research. The findings show that AI-based tools are widely used within the process of formation of professional competencies at the Ukrainian institutions of higher education (Baranovska et al., 2023; Nosenko et al., 2019). The introduction of AI instruments like

ChatGPT to optimize teaching, learning and educational management was investigated by Stepanenko & Stupak (2023).

Therefore, it is necessary to admit that AI plays a significant role in shaping contemporary education by revolutionizing traditional teaching and learning methodologies. Understanding the opportunities of AI-driven technologies will facilitate harnessing its capabilities within the educational process, enhancement of teaching methodologies, and automating administrative tasks. Additionally, as AI becomes increasingly integrated into the educational system, it is necessary to identify its challenges in order to equip both teachers and students with the tools to navigate ethical considerations and ensure the responsible use of AI in shaping the future of education.

Research Problem

The findings show that AI is an important tool for the enhancement educational process through building positive teacher-student collaboration (Kamalov et al., 2023), personalized learning (Lin et al., 2023). Additionally, AI-based instruments facilitate virtual classrooms (Ruiz-Rojas et al., 2023) construct intelligent tutoring systems (Lin et al., 2023; Memarian & Doleck, 2023a). The use LMS ensure uninterrupted learning and students' engagement (Veluvali & Suriseti, 2022) as well as simplify administrative procedures (George & Wooden, 2023). According to Montenegro-Rueda, Fernández-Cerero, Fernández-Batanero, & López-Meneses (2023), AI is used as an assistant for creation of courseware and customize educational materials. At the same time, AI provides rapid and effective responses to educational challenges during crises (Kamruzzaman et al. 2023; Danylchenko-Cherniak, 2023). Given that education becomes increasingly digital, AI plays an important role in preparing future professionals for the dynamic challenges of work environment, fostering their critical thinking, problem-solving skills, and technological competencies.

The extensive use of AI-driven technologies helps make more informed decisions and streamline repetitive tasks but also it brings ethical, societal, and even philosophical concerns in the educational environment. Firstly, it deals with privacy issues because AI systems often process vast amounts of personal data (Nguyen et al., 2023). Also, AI-based algorithms used for decision-making require smooth functioning and transparency (Memarian & Doleck, 2023b; Zhao & Gómez Fariñas, 2023). Other concerns are related to a digital divide between AI-enhanced learning experiences and resource-limited classroom (Kamalov et al., 2023), assessment of students' emotions or behaviors (González-Calatayud et al., 2021; Leon et al., 2023). Grassini (2023) explained the potential long-term consequences of using AI in education. Therefore, the responsible implementation of AI demands the development of a legal framework (Chmyr & Bhinder, 2023). Currently, the Artificial Intelligence Act or AI Act, a proposed regulation on AI in the European Union (European Commission, 2021) has become the basis for the design of institution-specific AI regulations.

Since AI is a powerful tool for enhancing the educational process by offering personalized learning experiences, automating administrative tasks, and increasing the students' performance, it is of great importance to analyze vast amounts of data to understand the impact of AI in education for educators, researchers, and students. Harnessing the benefits of AI effectively, it is necessary to address the potential challenges and ensure that AI technologies are ethically deployed within the educational process.

Research Focus

The in-depth analysis of the role of AI in education is of critical importance since it offers a paradigm shift and modernization drive of the educational process. In such a way, understanding the

opportunities of AI-driven technologies can lead to the creation of improved educational environment, facilitation of complicated administrative operations and utilization of resources more efficiently. Obviously, AI enables the educational institutions to continually enhance their practices and introduce innovative strategies to meet the changing needs of a rapidly evolving world. Besides, the examination of the role of AI in education is not complete unless the challenges of AI implementation in education have taken into consideration. The results may be used for the development of applicable recommendations of introduction of AI tools for teaching, learning and research in order to legalize the interaction between AI, instructors, students, and administrators.

Research Aim and Research Questions

The aim of the research is to describe the impacts of AI in shaping the educational process through the analysis of its opportunities and challenges.

In doing so, the research will aim to answer the following questions:

- 1) How does AI-driven technologies impact education? What are the advantages of AI in shaping the educational process?
- 2) What challenges related to the use of AI-driven technologies do the participants of educational process face?
- 3) What are future possible applications of AI in education?

Materials and methods

General Background

The study the role of AI was conducted on the principles of flexibility, validity and reliability, and practical significance that are being placed on the research of this type. Also, the study suggests the integration of qualitative (interviews, focus groups, and classroom observations) and quantitative methods (survey and statistical analysis) that is called Q methodology. The combination of qualitative and quantitative techniques allows to gain a comprehensive understanding the opportunities and challenges of using AI-driven technologies. The mixed methodology had a number of advantages address comparing the findings from the qualitative and quantitative components and, therefore, provide a holistic perspective of the research problem. In additions, the research procedures were organized according to the ethical standards for data collection and analysis.

Sample / Participants / Group

The study involved 56 participants representing instructors from five different institutions of higher education in Ukraine. The respondents participated anonymously and voluntarily according to the ethical guidelines for education research to ensure their rights and confidentiality. Also, the guidelines dealt with the integrity of the research process and the responsibility for further dissemination of the findings. The inclusion criteria were based on the relevant characteristics such as subject specialization (Engineering, Information Technologies, Mathematics, Economics, Sociology, Foreign Language, Communication and Media Studies, Health, Law, and Education), institution type (higher education), curriculum accreditation (accredited by the State Service of Quality of Education of Ukraine), and experience with AI technologies (at least one academic year). it is worth stating that random sampling techniques were employed to enhance the generalizability of findings and reduce biases. Table 1 shows the profile characteristics of the participants.

Table 1. Participants' profiles

Profile characteristics		Number of participants
Education background	Master	16
	Doctoral students	1
	PhD	30
	Doctor of Science	9
	Totally	56
Experience with AI technologies	1 year	22
	2-3 years	14
	3-5 years	12
	over 5 years	8
	Totally	56
Frequency of using AI in the educational process	every lesson	3
	often (more than a half)	13
	sometimes	35
	rarely	5
	Totally	56
Position	Assistant instructor	5
	Instructor	13
	Senior instructor	14
	Associate professor	12
	Professor	8
	Head deputy of the department	2
	Head of the department	1
	Dean	1
	Totally	56
Subject specialization	Engineering	3
	Information Technologies	5
	Mathematics	2
	Economics	6
	Sociology	2
	Foreign Language	10
	Communication and Media Studies	4
	Health	6
	Law	7
	Education	11
	Totally	56

Source: based on the author's development.

Instrument and Procedures

The survey was carried out via an online questionnaire, consisting of both closed-ended and open-ended questions. The initial questionnaire was developed on the basis on the findings of the literature review on the role of AI-driven technology in education. To ensure the relevance of the survey, the pilot study was organized prior to the formal data collection that enabled to modify the questions and arrange the feedback procedures. The final questionnaire included 32 items ranging from "Completely agree" to

“Do not agree”. Also, it included 10 open-ended questions to collect the participants’ additional attitudes towards AI applications in the institutions of higher education.

Classroom observations involved purposeful observation of using AI in the educational environment and evaluating its effect on teaching and learning. Before conducting observations, an observation framework with specific indicators for the role of AI in education was developed. The indicators were ranked from “Positive impact” to “Adverse effect” and addressed the ethical concerns of using AI in the classroom (e.g. privacy, security, bias, and transparency). During the observation phase, the observer systematically monitored the frequency of using AI-based tools in the classroom and their educational value including teacher-student interactions, the efficiency of instructional strategies used for material delivery, classroom management, students’ engagement, the quality of instructional materials, and the objectivity of assessment. Following the observation, the post-observation conference was organized to share feedback among the participants, discuss the strengths and possible areas for improvement of AI applications in the educational process. The findings documented during the observations were included in the comprehensive research report.

Data Analysis

To analyse the data, the statistical analysis was used. It provided the summarizing the findings and presented a clear and concise overview of the collected survey data. The method involved creating frequency distributions to show how a trend occurs within the educational process. On the basis of the most common and less common responses it was possible to express the survey outcomes as percentages and to obtain the most interpretable representation of the data. The survey data was presented via charts or line graphs to convey the patterns clearly and make it more accessible to a target audience. The results of statistical analysis were used for further generation of conclusions. Moreover, Q methodology allowed to consider subjectivity of the research and to provide a specific understanding of the research problem. In the context of studying the role of AI in shaping future of education identified perspectives and their implications the shared viewpoints among participants were represented to assess possible opportunities of AI applications and challenges occurring within the educational process.

Results

The positive impacts of AI-driven technologies on the educational process

During the survey the authors found that the positive impacts of AI-driven technologies of the educational process include personalized learning, automation of administrative tasks, adaptive learning, enhanced instructor’s support, facilitation of e-learning, inclusivity, data-driven decision making, gamification, increased students’ engagement, introduction of behaviour analytics, efficient assessment and predictive analytics. The application of questionnaire and classroom observations demonstrated that there is no significant difference in the data. Thus, personalized learning was admitted by the most participants as the advantages of implementation of AI within the educational process (41,2 % and 50,3% respectively).

At the same time, the biggest difference was demonstrated through automated processes and AI-based assessment. 39,8 % of instructors said that automation enhances educational process and contribute to increasing its efficiency. But the positive use of automated platforms was noticed in 24,5 % of cases that proves it requires institution-specific adjustment and advanced training for instructors. Similarly, there was approximately 14 % difference between answers on the use of AI-based assessment tools. 20,6 % of participants decided that assessment conducted with the use of AI instruments is

effective. But much more effective use of assessment instruments was observed (34,5 %). This is due to objectivity of AI-based assessment, immediate feedback, customization of tasks, and their flexibility (It is possible to assess students' outcomes using various modalities such as text, images, audio, and video). Figure 1 shows the analysis of positive impacts of AI-driven technologies on the educational process based on questionnaire and classroom observations.

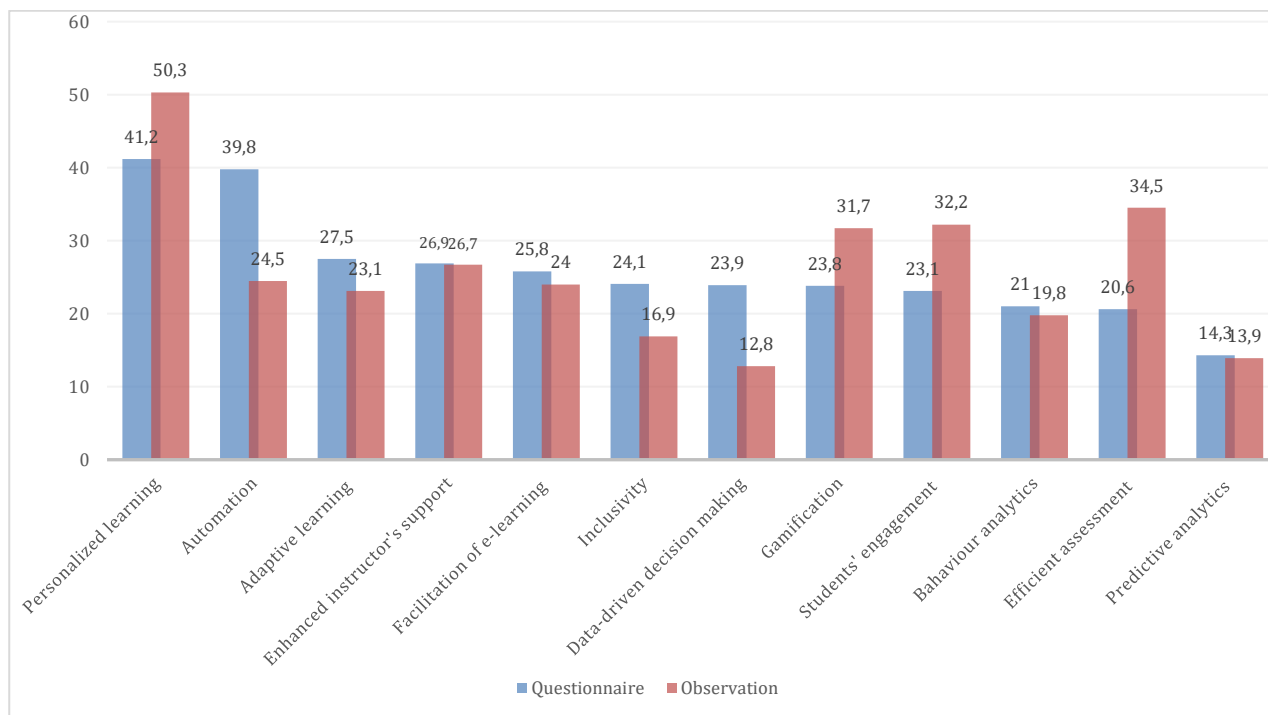


Figure 1. Positive impacts of AI-driven technologies on the educational process

Source: based on the author's development.

Challenges related to the use of AI in education

According to the survey conducted by the authors, the challenges facing the participants of the educational process include data privacy, security, bias, lack of understanding how to interpret AI outputs, transparency, necessity for additional training for instructors working with AI tools. Other challenges deal with resistance to change among the participants of the educational process, high costs of AI-based instruments, loss of human connection and risk of depersonalization. At the same time, the challenges are linked with legal and ethical considerations. Studying the integration of AI in education, the surveyors found that the most of instructors (78,4 % and 83,1 % respectively) consider data privacy and security as the biggest challenges. But during classroom observations it was concluded that the collection and analysis of student's data were adequately protected in more than half of these cases.

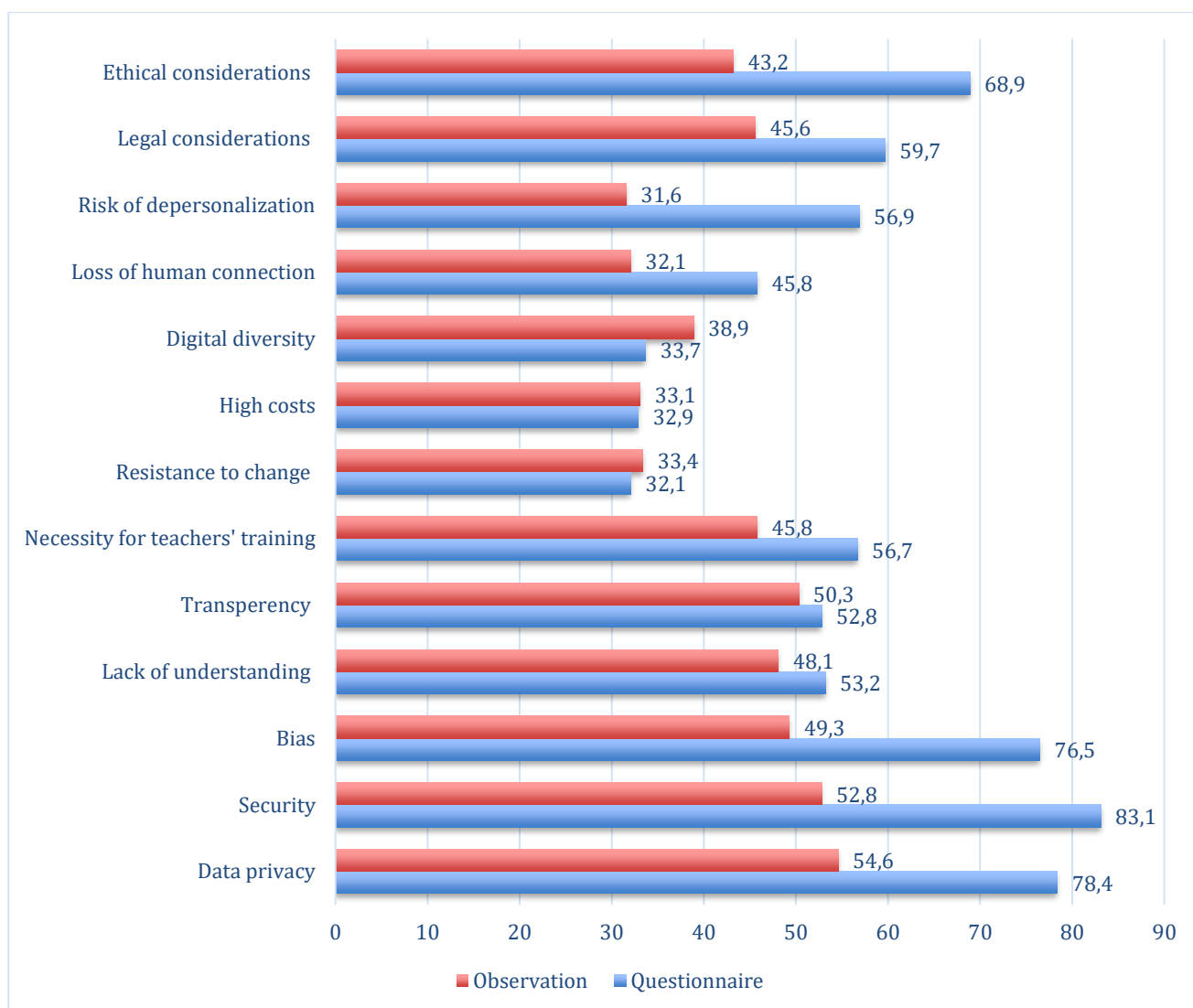


Figure 2. Challenges related to the use of AI in education

Source: based on the author's development.

Additionally, the authors proved that 76,5 % of respondents are worried about bias because if the data on educational process contains biases, AI may produce discriminatory results, affecting certain student groups unfairly. It is worth mentioning that 56,7 % of instructors considered that they lack the necessary training and professional development opportunities to effectively integrate AI into their teaching practices. In 45,8 % of cases it was found that instructors were able to work with AI tools effectively and turn the educational environment into an effective one. The findings prove that addressing these challenges requires a collaborative effort involving both instructors and students to ensure that AI is implemented responsibly and is focused on positive learning outcomes. Figure 2 shows the analysis of challenges related to the use of AI in education based on questionnaire and classroom observations.

Future possible applications of AI in education

The survey showed that most of participants insist on positive impact of AI-driven technologies. 23,5 % of instructors agreed that AI is highly efficient tools and in future they will revolutionize the educational process significantly. 31,4 % of participants stated that the use of AI within the educational process has average efficiency and enhance students' learning outcomes through the increasing of motivation, teacher-student collaboration, and improvements of assessment. According to them, the benefits in using AI-driven technologies exceed the negative impact their ethical and legal consideration. At the same time, it was revealed that 19,1 % of participants considered AI has a low efficiency and cause a number of challenges within the educational process. AI tools can be used sometimes or rarely as a complement to other teaching technologies. And 11,4 % of instructors are not aware of positive impact of AI instruments. They are sure that the use of AI-based techniques makes the educational process complicated and overloading. It testifies about the necessity of additional training for pedagogical staff oriented towards the explanation of AI possibilities in education. Figure 3 shows the efficiency of using AI technologies in education according to the survey participants.

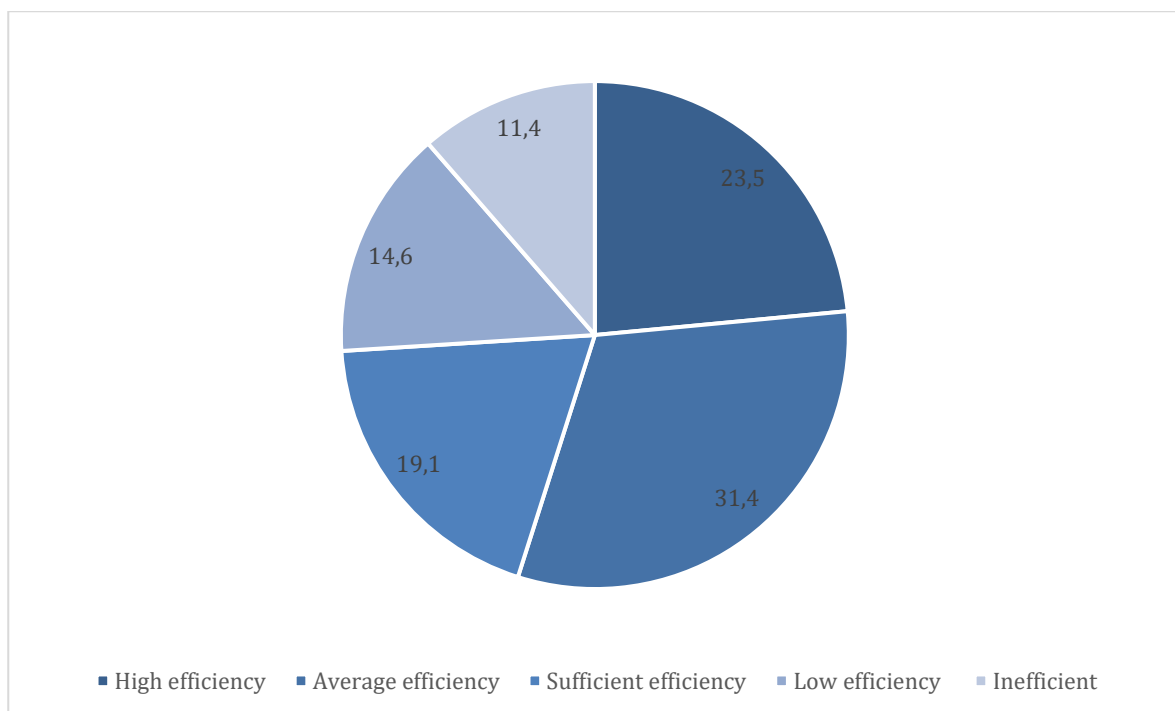


Figure 3. Efficiency of using AI technologies in education

Source: based on the author's development.

Studying the possible AI application in education it was revealed that in most cases AI-based tools can be used to implement personalized learning paths (54,2 %), predictive analytics (51,6 %), intelligent tutoring systems (46,7 %), and automated content creation (46,2 %). Virtual Reality (VR) (43,8 %), tools for automated administrative tasks (42,7 %), educational chatbots (41,7 %) have great potentials to enhance the educational process in future since they optimize the routine tasks and make the educational environment more comfortable. At the same time, the use of robotics (18,3 %) and blockchain technology (17,5 %) were found as the most complex and least understood among instructors because they can be used only at the specialized departments where future Information Technology or Engineering professional are trained. Table 2 shows possible AI applications in the educational process.

Table 2. Possible AI applications in the educational process

AI-driven tool	Use in educational process	Number of participants (%)
Personalized learning paths	creation of adaptive learning paths based on individual student needs; adjustment of the curriculum; optimization of students' learning outcomes.	54,2
Intelligent tutoring systems	real-time feedback; personalized assistance; objective assessment.	46,7
Automated content creation	creation of interactive learning materials; design of quizzes and assessment materials; courseware development; possibility for real time updates.	46,2
VR	creation of realistic educational environment; safe and controlled training; support of collaborative learning experience; building of customized learning experiences for students with special needs.	43,8
Emotion recognition	monitoring of students' engagement levels; real-time feedback; identification of students' learning difficulties; monitoring students' mental health and stress level.	39,3
Predictive analytics	development of early warning system; recommendations on the courses to students based on their performance and career objectives; admissions and enrollment planning; budget planning; curriculum planning.	51,6
Educational chatbots	assistance with common questions; personalized learning support; language learning assistance; study planning.	41,7
Blockchain	maintaining students' records; verification of digital identity.	17,5
Competency-based assessment	identification of specific competencies that require improvement; creation of competency mapping; skill gap analysis; designing of individual competency portfolios.	23,1
Automated administrative tasks	optimization of course scheduling; creation of attendance tracking system; collecting feedback from students and instructors.	42,7
Robotics	teaching STEM education; stimulation of innovations;	18,3

	development of interdisciplinary courses.	
Admission and enrollment processes	verification of the authenticity of documents; identity verification; creation of the system of automated notifications; automated admissions decision-making.	28,7
Gamified learning platforms	tracking user's engagement; incorporation of game elements; personalization of the learning experience.	39,9

Source: based on the author's development.

According to respondents' answers, AI is to revolutionize education further by introducing innovative applications incorporating personalized and adaptive learning, virtual tutors, intelligent assessment tools. The survey results prove that AI has the possibilities to improve administrative tasks through automation. As AI-driven technologies evolve, they contribute to students' collaboration, development of their creativity and critical skills, increase the inclusivity of the educational process. Thus, these potential applications of AI in education demonstrate the transformative impact of the technology on teaching and learning. The findings show that it is essential to apply these advancements with careful consideration of ethical and privacy implications to ensure responsible integration of AI-based tools within the educational environment.

Discussion

The research shows that, according to the respondents' answers, personalized learning, predictive analytics, intelligent tutoring systems, systems of automated content creation, VR, automation of administrative tasks, and educational chatbots have the greatest potentials. The implementation of these AI-powered tools will positively shape the educational process in future and enhance the efficiency of training of future specialists. It was found that these AI technologies are presently being used within the educational process but they are constantly evolving and showing more benefits when applied correctly and responsibly. To reveal the role of AI in shaping education, it is necessary to analyse these technologies in detail.

1) **Personalized learning paths.** According to Jiang, Li, Yang, Kong, Cheng, Hao, & Lin (2022), personalized learning is a teaching strategy that tailors the students' learning style to their specific needs. It includes learning objectives, teaching methodology, and educational content that can vary depending on the requirements of students. Personalized learning paths can effectively integrate high-quality learning resources, optimize the allocation of learning resources, and maximize their role (Ma et al., 2023). Shemshack & Spector (2020) admit that personalized learning is a complex activity approach that is generated from self-organization and self-assessment. The respondents found that personalized learning paths create the customized learning environment for students on the basis of their learning style and preferences. The educational content presented through personalized learning paths is often relevant and targeted to the students' interests, skill level, and learning objectives. At the same time, it was indicated that personalized learning paths improve assessment procedures significantly since they include real-time feedback. Choosing their learning paths students have a possibility to work interdependently and, therefore, they are getting ready to continuous professional development that is one of the requirements for future specialists in different fields. Moreover, using personalized learning paths increases motivation, engagement, and understanding of educational material.

2) **Predictive analytics** deals with statistical algorithms analyzing historical data to make predictions about future outcomes. In the context of education, predictive analytics creates forecasts for the future by analyzing past trends in learning experiences (Sghir et al., 2023). In the modern educational environment, it is very important to predict and understand students' performance whereas it provides instructors with valuable information about learning patterns and allows students to recognize areas for further improvement (Syed Mustapha, 2023). During the last ten years, efficient and sophisticated predictive models developed with machine and deep learning enabled to discover complex hidden characteristics in learning data and enhances the efficiency of the educational process (Sghir et al., 2023). The findings showed that predictive analytics in education provides early interventions and instructors can identify students at risk of academic challenges. At the same time, predictive analytics contribute to the development of personalized learning paths significantly understanding students' learning style, strengths, and weaknesses. The respondents described the following AI applications that can be widely used in future within the educational process: curriculum design based on future professionals' needs and learning objectives, admissions and enrollment planning, graduation rate improvement through analysis of academic performance, financial concerns, or social aspects the students face.

3) **Intelligent tutoring systems** are integrated educational tools for customizing formal education using intelligent instruction or feedback (Guo et al., 2021). Singh, Gunjan, Mishra, Mishra, & Nawaz (2022) mention that the intelligent tutoring system is a technique that offers the students the exclusive educational materials developed on the basis of learning styles and preferred media of learning. According to Akyuz (2020), the use of intelligent tutorial systems makes the educational process dynamic and flexible because the students are longer engaged, able to study at their own pace, and are provided with professional assistance. The survey demonstrated that the intelligent tutoring systems positively affect helps students' addressing their learning styles and unique needs. A number of respondents confirmed that the intelligent tutoring systems provide real-time feedback and, as a result, help the instructors to adapt the teaching strategies and tasks based on their performance. Besides, the systems create continuous assessment and contribute to students' performance tracking. The educational environment built via the intelligent tutoring systems, enhances students' engagement and motivation as well. It was also found that the intelligent tutoring systems can incorporate gamified elements, simulation-based activities, and interactive exercises. This makes the students' learning experience more stimulating.

4) **Automated content creation** is related to generation of educational materials without direct human intervention (Kamalov et al., 2023). This approach streamlines the content creation process significantly and increases its efficiency (Lee et al., 2023). Automated content is created through automatic question generation, text summarization or simplification, automated translation, or content recommendations according to students' preferences (Diwan et al., 2023; Ruiz-Rojas et al., 2023). On the basis of the survey results, it is obvious that automated content creation streamlines the process of generating educational materials, facilitates the creation of a large volume of educational materials, ensures the higher quality of educational content. Additionally, some respondents agreed that automated processes help to adhere to the defined standards and criteria, and develop the materials that are applicable to the students to learners with diverse needs, including those with limited learning abilities. Automated content creation facilitates the integration of innovative elements in the educational process including simulation-based activities, interactive multimedia, and games.

5) **VR** is defined a computer-generated simulation of a real-life environment that can be interacted with using different devices like headset, gaming console, motion sensors, audio equipment, and VR software (Zhao et al., 2023). Serin (2020) admits that VR is an important innovation for future

educational environment since VR applications the students to gain experiences that are dangerous or impossible for them to acquire in real life. Based on the findings of Santos Garduño et al. (2021), it is possible to state that using VR equipment with very realistic applications allowed students to have an immersive, interactive, and contextualized experience of the disciplinary contents. During the survey the instructors of the Ukrainian educational institutions enumerated a number of advantages related to the use of VR in education. They include: creation of realistic environments, providing simulations and virtual experiences according to real-world scenarios, increasing students' engagement and motivation, support of collaborative learning, and facilitation of e-learning especially when the traditional educational process is disrupted due to emergency situations.

6) Automating of administrative tasks. Currently, AI-powered systems can handle admissions, enrollment, and course scheduling resulted in reducing the workload for administrative staff (George & Wooden, 2023). Administrative tasks are automated using personalized assistance platforms or chatbots (Parycek et al., 2023). The automating of administrative tasks is oriented towards boosting administrative efficiency, handling admissions, managing students' applications, organizing appointments, and collecting students' feedback (Ahmad et al., 2022; George & Wooden, 2023). The respondents found the automated administrative tasks lead to time efficiency, minimization of the risk of human errors, costs savings, and data management. The educational process benefit from the automating of administrative tasks since assessment instruments and attendance tracking systems are introduced. In addition, automated administrative tasks are related to enhancement of security measures by controlling access to students' sensitive information.

7) Educational chatbots. AI-powered chatbots are designed to follow people's conversations using text or voice interaction, providing information in a conversational manner (Labadze et al., 2023). The recent findings show that generative AI tools such as educational chatbots have the great potential to facilitate self-regulated learning (Chang et al., 2023). According to Wu and Yu (2024) AI-based chatbots had a greater effect on students in higher education, compared to those in primary education and secondary education. The survey participants showed that AI-based chatbots deliver immediate responses to inquiries, providing instant support for common questions related to courses, schedules, or resources. Also, educational chatbots offer personalized assistance and, therefore, facilitate the educational process. The findings proved that educational chatbots engage the students through interactive and conversational interfaces, increase their motivation to learning activities. But a number of respondents admitted that the positive use of educational chatbots require additional training and application of clear communication algorithms.

At the same time, according to the survey results, the participants face a number of challenges related to the use of AI in educational process. They include data privacy, security, bias, lack of understanding, transparency, necessity for instructors' additional training, high costs of AI-based instruments, and risk of depersonalization. It was concluded that addressing these challenges requires the elaboration of applicable recommendations on the use of AI within the educational institutions to gain the most benefits.

Conclusions

The research on the role of AI in shaping education resulted in the following conclusions:

The survey findings demonstrated that the role of AI in education has increased in recent years and most of the instructors agree that the use of AI-driven technologies positively affects the educational

process. It was found that the potential benefits of AI include introduction of personalized learning and customization of the educational content, automation of administrative tasks and facilitation of routine processes, providing students with educational and psychological support, creation of high-quality teaching recourses and modernization of curriculum. Also, AI tools bring data-driven decision-making, create innovative learning environment through VR, simulation-based technologies, or interactive educational games. AI helps students prepare for future professional activities and contribute to formation of their professional competencies (critical thinking, creativity, communication skills, digital literacy, adaptability and flexibility, readiness to innovative activity, and ability to continuous learning in particular).

Also, the findings show that currently AI tools are used to training future professional from different specialists including Science (Engineering, Information Technologies, Mathematics, Economics) and the Humanities (Foreign Language, Communication and Media Studies, Law, and Education). In addition, AI is widely used to teach interdisciplinary specialities like Sociology and Health. Obviously, AI has the great potentials to enhance the training of future professionals in science across various disciplines. According to the respondents, AI-driven tools help to analyze and interpret big amount of data, create predictive models in scientific research based on various variables, solve repetitive tasks in the laboratory, simulate a risk-free environment for students to conduct experiments and explore scientific concepts. In the process of training of future specialists in the Humanities, AI may contribute to text analysis, literature review, translation and cross-cultural studies. Alsos, it was found that AI-powered instruments may help researchers identify various trends in the Humanities, tailor the educational materials to individual students' learning styles and preferences in the Humanities subjects, and facilitates collaboration. The special attention was paid towards the use of VR and simulation-based technologies in training future health professionals since they create real-life healthcare scenarios, allows students to practice their clinical skills and surgical procedures, and enable to apply theoretical knowledge in a risk-free environment

Since AI becomes increasingly integrated into the educational system, a number of challenges facing the participants of the educational process. According to the survey results they include data privacy, security, bias, lack of understanding how to interpret AI outputs, transparency, necessity for additional training for instructors working with AI tools. Other challenges deal with resistance to change among the participants of the educational process, high costs of AI-based instruments, loss of human connection and risk of depersonalization. At the same time, many challenges are linked with legal and ethical considerations and require the development of comprehensive framework on responsible use of AI-powered tools by the academic community for educational purposes as well as to conduct multifaced research. The study showed that personalized learning, predictive analytics, intelligent tutoring systems, systems of automated content creation, VR, automation of administrative tasks, and educational chatbots have the greatest potentials. The implementation of these AI-powered tools can shape the educational process effectively in future and modernize the training of future specialists. It was found that these AI technologies are presently being used within the educational process but they are constantly evolving and showing more benefits when applied correctly and responsibly.

The research results are to be introduced within the educational institutions to increase the awareness of using AI-based tools within the educational process. The findings will be useful for instructors working planning to work with AI-powered technologies and they can be implemented in the professional development curriculum for faculty staff oriented towards the extensive use of innovative technologies. Also, the ideas developed during the research can be applicable for improvement of educational programs within the Ukrainian educational institutions aimed at formation

of current professional competencies and training highly-skilled workforce for the country's economic growth.

Suggestions for Future Research

The research revealed the unique role of AI in enhancement educational process and the use AI-powered tools ensure uninterrupted learning and students' engagement, simplify administrative procedures, and provide rapid responses to educational challenges during crises. At the same time, it was found that the extensive use of AI technology brings ethical, societal, and even philosophical concerns in the educational environment. It is worth mentioning that the potential long-term consequences of using AI in education are not fully studied in the contemporary pedagogical literature. Definitely, future research must concern the potential long-term effect of AI-powered tools on the educational environment.

Moreover, in future the researchers must consider the development of approaches to responsible use of AI-powered tools within educational process and the design of comprehensive recommendations for the educational institutions. These recommendations must consider the AI potentials, algorithms for its using, and the methods to minimize the possible challenges. Further research must be oriented towards the institution-specific recommendations since learning objectives, infrastructure and technology readiness, students' population, curricula and educational programs may vary.

Also, the special attention of educational specialists must be paid towards exploration of the impact of AI on teacher professional development. Therefore, further research must concern the formation of instructor's AI competence and development of AI-specific methodology to cultivate the skills that are necessary for AI using. It is suggested creating the program for instructors' professional development related towards enhancement of digital literacy and formation of culture of innovation among pedagogical staff.

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The survey was conducted according to the ethical guidelines for educational research and designed on the principles of informed consent, voluntarily participation, confidentiality of participants' data. Also, the research was aimed at maximization of benefits for the educational process and oriented towards the accurate representation of all the findings.

References

- Ahmad, S. F, Alam, M. M, Rahmat, M. K, Mubarik, M.S., & Hyder, S. I. (2022). Academic and Administrative Role of Artificial Intelligence in Education. *Sustainability*, 14(3), 1101. <https://doi.org/10.3390/su14031101>.
- Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, 2(3), 431–440. <https://doi.org/10.1007/s43681-021-00096-7>.
- Akyuz, Y. (2020) Effects of Intelligent Tutoring Systems (ITS) on Personalized Learning (PL). *Creative Education*, 11, 953-978. <https://doi.org/10.4236/ce.2020.116069>.

- Annuš, N. (2023). Chatbots in Education: The impact of Artificial Intelligence based ChatGPT on Teachers and Students. *International Journal of Advanced Natural Sciences and Engineering Researches*, 7(4), 366–370. <https://doi.org/10.59287/ijanser.739>.
- Bakhov, I., Opolska, N., Bogus, M., Anishchenko, V., & Biryukova, Y. (2021). Emergency Distance Education in the Conditions of COVID-19 Pandemic: Experience of Ukrainian Universities. *Education Sciences*, 11(7), 364. <https://doi.org/10.3390/educsci11070364>.
- Baranovska, L., Simkova, I., Akilli, E., Tarnavska, T., & Glushanytsia, N. (2023). Development of digital competence of future philologists: case of Turkish and Ukrainian universities. *Advanced Education*, 23, 87-102. <https://doi.org/10.20535/2410-8286.295458>.
- Bujold, A., Roberge-Maltais, I., Parent-Rochelleau, X., Boasen, J., Sénécal, S., & Léger, P.-M. (2023). Responsible artificial intelligence in human resources management: A review of the empirical literature. *AI and Ethics*. <https://doi.org/10.1007/s43681-023-00325-1>
- Chang, D. H., Lin, M. P.-C., Hajian, S., & Wang, Q. Q. (2023). Educational Design Principles of Using AI Chatbot That Supports Self-Regulated Learning in Education: Goal Setting, Feedback, and Personalization. *Sustainability*, 15(17), article number 12921. <https://doi.org/10.3390/su151712921/>
- Chiu, T. K. F., Xia, Q., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 4, article number 100118. <https://doi.org/10.1016/j.caeai.2022.100118>.
- Chmyr, V. & Bhinder, N. (2023). AI in the Higher Military Institutions: Challenges and Perspectives for Military Engineering Training. *Rupkatha Journal*, 15(4). <https://doi.org/10.21659/rupkatha.v15n4.11>.
- Danylchenko-Cherniak, O. (2023). Creative and collaborative learning during Russian-Ukrainian war period: Philological aspects. *Philological Treatises*, 15(1), 51–61.
- Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare journal*, 6(2), 94–98. <https://doi.org/10.7861/futurehosp.6-2-94>.
- Diwan, C., Srinivasa, S., Suri, G., Agarwal, S., & Ram, P. (2023). AI-based learning content generation and learning pathway augmentation to increase learner engagement. *Computers and Education: Artificial Intelligence*, 4, article number 100110. <https://doi.org/10.1016/j.caeai.2022.100110>.
- European Commission. (2021). Proposal for a Regulation of the European Parliament and of the Council laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union legislative acts. Retrieved from: <https://artificialintelligenceact.eu/the-act>.
- Firat, M. (2023). Integrating AI Applications into Learning Management Systems to Enhance e-Learning. *Instructional Technology and Lifelong Learning*, 4(1), 1-14. <https://doi.org/10.52911/itall.1244453>.
- Foltynek, T., Bjelobaba, S., Glendinning, I., Khan, Z. R., Santos, R., Pavletic, P., & Kravjar, J. (2023). ENAI Recommendations on the ethical use of Artificial Intelligence in Education. *International Journal for Educational Integrity*, 19, 12. <https://doi.org/10.1007/s40979-023-00133-4>.

- Fütterer, T., Fischer, C., Alekseeva, A., Chen, X., Tate, T., Warschauer, M., & Gerjets, P. (2023). ChatGPT in education: global reactions to AI innovations. *Scientific Reports*, 13, article number 15310. <https://doi.org/10.1038/s41598-023-42227-6>.
- Gao, X., & Feng, H. (2023). AI-Driven Productivity Gains: Artificial Intelligence and Firm Productivity. *Sustainability*, 15(11), article number 8934. <https://doi.org/10.3390/su15118934>.
- Gardezi, M., Joshi, B., Rizzo, D. M., Ryan, M., Prutzer, E., Brugler, S., & Dadkhah, A. (2023). Artificial intelligence in farming: Challenges and opportunities for building trust. *Agronomy Journal*, 1–12. <https://doi.org/10.1002/agj2.21353>.
- George, B., & Wooden, O. (2023). Managing the Strategic Transformation of Higher Education through Artificial Intelligence. *Administrative Sciences*, 13(9), 196. <https://doi.org/10.3390/admsci13090196>.
- Gligorea, I., Cioca, M., Oancea, R., Gorski, A.-T., Gorski, H., & Tudorache, P. (2023). Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review. *Education Sciences*, 13(12), article number 1216. <https://doi.org/10.3390/educsci13121216>.
- González-Calatayud, V., Prendes-Espinosa, P., & Roig-Vila, R. (2021). Artificial Intelligence for Student Assessment: A Systematic Review. *Applied Sciences*, 11(12), article number 5467. <https://doi.org/10.3390/app11125467>.
- Grassini, S. (2023). Shaping the Future of Education: Exploring the Potential and Consequences of AI and ChatGPT in Educational Settings. *Education Sciences*, 13(7), 692. <https://doi.org/10.3390/educsci13070692>.
- Grubaugh, S., Levitt, G., & Deever, D. (2023). Harnessing AI to Power Constructivist Learning: An Evolution in Educational Methodologies. *EIKI Journal of Effective Teaching Methods*, 1(3). <https://doi.org/10.59652/jetm.v1i3.43>.
- Guo, L., Wang, D., Gu, F., Li, Y., Wang, Y., & Zhou, R. (2021). Evolution and trends in intelligent tutoring systems research: a multidisciplinary and scientometric view. *Asia Pacific Education Review*, 22(3), 441–461. <https://doi.org/10.1007/s12564-021-09697-7>.
- Jain, H., Dhupper, R., Shrivastava, A., Kumar, D., & Kumari, M. (2023). AI-enabled strategies for climate change adaptation: protecting communities, infrastructure, and businesses from the impacts of climate change. *Computational Urban Science*, 3, 25. <https://doi.org/10.1007/s43762-023-00100-2>.
- Jevinger, Å., Zhao, C., Persson, J. A., & Davidsson, P. (2023). Artificial intelligence for improving public transport: a mapping study. *Public Transport*. <https://doi.org/10.1007/s12469-023-00334-7>.
- Jiang, B., Li, X., Yang, S., Kong, Y., Cheng, W., Hao, C., & Lin, Q. (2022). Data-Driven Personalized Learning Path Planning Based on Cognitive Diagnostic Assessments in MOOCs. *Applied Sciences*, 12(8), article number 3982. <https://doi.org/10.3390/app12083982>.
- Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New Era of Artificial Intelligence in Education: Towards a Sustainable Multifaceted Revolution. *Sustainability*, 15(16), article number 12451. <https://doi.org/10.3390/su151612451>.

- Kamruzzaman, M. M., Alanazi, S., Alruwaili, M., Alshammari, N., Elaiwat, S., Abu-Zanona, M., Innab, N., Mohammad Elzaghmouri, B., & Ahmed Alanazi, B. (2023). AI- and IoT-Assisted Sustainable Education Systems during Pandemics, such as COVID-19, for Smart Cities. *Sustainability*, 15(10), article number 8354. <https://doi.org/10.3390/su15108354>.
- Kaur, R., Gabrijelčič, D., & Klobučar, T. (2023). Artificial intelligence for cybersecurity: Literature review and future research directions. *Information Fusion*, 97, article number 101804. <https://doi.org/10.1016/j.inffus.2023.101804>.
- Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for Language Teaching and Learning. *RELC Journal*, 54(2), 537-550. <https://doi.org/10.1177/00336882231162868>.
- Labadze, L., Grigolia, M., & Machaidze, L. (2023). Role of AI chatbots in education: systematic literature review. *International Journal of Educational Technology in Higher Education*, 20, 56. <https://doi.org/10.1186/s41239-023-00426-1>.
- Lee, J. H., Shin, D., & Noh, W. (2023). Artificial Intelligence-Based Content Generator Technology for Young English-as-a-Foreign-Language Learners' Reading Enjoyment. *RELC Journal*, 54(2), 508-516. <https://doi.org/10.1177/00336882231165060>.
- Leon, C. G. R. M. P., Mano, L. Y., Fernandes, D. D. S., Paula, R. A. P., Brasil, G. D. C., & Ribeiro, L. M. (2023). Artificial intelligence in the analysis of emotions of nursing students undergoing clinical simulation. *Revista brasileira de enfermagem*, 76(Suppl 4), article number e20210909. <https://doi.org/10.1590/0034-7167-2021-0909>.
- Lin, C. C., Huang, A. Y. Q., & Lu, O. H. T. (2023). Artificial intelligence in intelligent tutoring systems toward sustainable education: a systematic review. *Smart Learning Environments*, 10, 41. <https://doi.org/10.1186/s40561-023-00260-y>.
- Ma, Y., Wang, L., Zhang, J., Liu, F., & Jiang, Q. (2023). A Personalized Learning Path Recommendation Method Incorporating Multi-Algorithm. *Applied Sciences*, 13(10), 5946. <https://doi.org/10.3390/app13105946>.
- Memarian, B., & Doleck, T. (2023a). ChatGPT in education: Methods, potentials, and limitations. *Computers in Human Behavior: Artificial Humans*, 1(2), article number 100022. <https://doi.org/10.1016/j.chbah.2023.100022>.
- Memarian, B., & Doleck, T. (2023b). Fairness, Accountability, Transparency, and Ethics (FATE) in Artificial Intelligence (AI) and higher education: A systematic review. *Computers and Education: Artificial Intelligence*, 5, article number 100152. <https://doi.org/10.1016/j.caeai.2023.100152>.
- Montenegro-Rueda, M., Fernández-Cerero, J., Fernández-Batanero, J. M., & López-Meneses, E. (2023). Impact of the Implementation of ChatGPT in Education: A Systematic Review. *Computers*, 12(8), 153. <https://doi.org/10.3390/computers12080153>.
- Nguyen, A., Ngo, H. N., Hong, Y., Dang, B., & Nguye, B.-P. T. (2023). Ethical principles for artificial intelligence in education. *Education and Information Technologies*, 28, 4221-4241. <https://doi.org/10.1007/s10639-022-11316-w>.
- Nosenko, Y. H., Popel, M. V., & Shyshkina, M. P. (2019). The state of the art and perspectives of using adaptive cloud-based learning systems in higher education pedagogical institutions (the scope of Ukraine). *CTE Workshop Proceedings*, 6, 173-183. <https://doi.org/10.55056/cte.377>.

- Pantelimon, F.-V., Bologa, R., Toma, A., & Posedaru, B.-S. (2021). The Evolution of AI-Driven Educational Systems during the COVID-19 Pandemic. *Sustainability*, 13(23), article number 13501. <https://doi.org/10.3390/su132313501>.
- Parycek, P., Schmid, V., & Novak, A. S. (2023). Artificial Intelligence (AI) and Automation in Administrative Procedures: Potentials, Limitations, and Framework Conditions. *Journal of the Knowledge Economy*. <https://doi.org/10.1007/s13132-023-01433-3>.
- Rahmani, A. M., Azhir, E., Ali, S., Mohammadi, M., Ahmed, O. H., Yassin Ghafour, M., Hasan Ahmed, S., & Hosseinzadeh, M. (2021). Artificial intelligence approaches and mechanisms for big data analytics: a systematic study. *PeerJ. Computer science*, 7, article number e488. <https://doi.org/10.7717/peerj-cs.488>.
- Rojek, I., Jasiulewicz-Kaczmarek, M., Piechowski, M., & Mikołajewski, D. (2023). An Artificial Intelligence Approach for Improving Maintenance to Supervise Machine Failures and Support Their Repair. *Applied Sciences*, 13(8), 4971. <https://doi.org/10.3390/app13084971>.
- Ruiz-Rojas, L. I., Acosta-Vargas, P., De-Moreta-Llovet, J., & Gonzalez-Rodriguez, M. (2023). Empowering Education with Generative Artificial Intelligence Tools: Approach with an Instructional Design Matrix. *Sustainability*, 15(15), article number 11524. <https://doi.org/10.3390/su151511524>.
- Santos Garduño, H. A., Esparza Martínez, M. I., & Portuguese Castro, M. (2021). Impact of Virtual Reality on Student Motivation in a High School Science Course. *Applied Sciences*, 11(20), 9516. <https://doi.org/10.3390/app11209516>.
- Serin, H. (2020). Virtual Reality in Education from the Perspective of Teachers. *Amazonia Investiga*, 9(26), 291-303. <https://doi.org/10.34069/AI/2020.26.02.33>.
- Sghir, N., Adadi, A., & Lahmer, M. (2023). Recent advances in Predictive Learning Analytics: A decade systematic review (2012–2022). *Education and Information Technologies*, 28, 8299–8333. <https://doi.org/10.1007/s10639-022-11536-0>.
- Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. *Smart Learning Environments*, 7, 33. <https://doi.org/10.1186/s40561-020-00140-9>.
- Singh, N., Gunjan, V. K., Mishra, A. K., Mishra, R. K., & Nawaz, N. (2022). SeisTutor: A Custom-Tailored Intelligent Tutoring System and Sustainable Education. *Sustainability*, 14(7), 4167. <https://doi.org/10.3390/su14074167>.
- Spivakovsky, O. V., Omelchuk, S. A., Kobets, V. V., Valko, N. V., & Malchykova, D. S. (2023). Institutional policies of artificial intelligence in university learning, teaching, and research. *Information Technologies and Learning Tools*, 97(5), 181–202. <https://doi.org/10.33407/itlt.v97i5.5395>.
- Stepanenko, O., & Stupak, O. (2023). The use of GPT Chat among students in Ukrainian universities. *Scientific Journal of Polonia University*, 58(3), 202–207. <https://doi.org/10.23856/5828>.
- Syed Mustapha, S. M. F. D. (2023). Predictive Analysis of Students' Learning Performance Using Data Mining Techniques: A Comparative Study of Feature Selection Methods. *Applied System Innovation*, 6(5), 86. <https://doi.org/10.3390/asi6050086>.

- Tan, D. Y., & Cheah, C. W. (2021). Developing a gamified AI-enabled online learning application to improve students' perception of university physics. *Computers and Education: Artificial Intelligence*, 2, article number 100032. <https://doi.org/10.1016/j.caeai.2021.100032>.
- Veluvali, P., & Suriseti, J. (2022). Learning Management System for Greater Learner Engagement in Higher Education – A Review. *Higher Education for the Future*, 9(1), 107-121. <https://doi.org/10.1177/23476311211049855>.
- Wu, R., & Yu, Z. (2024). Do AI chatbots improve students learning outcomes? Evidence from a meta-analysis. *British Journal of Educational Technology*, 55(1), 10-33. <https://doi.org/10.1111/bjet.13334>.
- Yordanova, Z. (2020). Gamification as a Tool for Supporting Artificial Intelligence Development – State of Art. In: Botto-Tobar, M., Zambrano Vizuite, M., Torres-Carrión, P., Montes León, S., Pizarro Vásquez, G., Durakovic, B. (eds) *Applied Technologies. ICAT 2019. Communications in Computer and Information Science*. Springer, Cham. https://doi.org/10.1007/978-3-030-42517-3_24.
- Yu, H. (2024). The application and challenges of ChatGPT in educational transformation: New demands for teachers' roles. *Heliyon*, 10(2), article number e24289. <https://doi.org/10.1016/j.heliyon.2024.e24289>.
- Yuskovych-Zhukovska, V., Poplavska, T., Diachenko, O., Mishenina, T., Topolnyk, Y., & Gurevych, R. (2022). Application of Artificial Intelligence in Education. Problems and Opportunities for Sustainable Development. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, 13(1Sup1), 339-356. <https://doi.org/10.18662/brain/13.1Sup1/322>.
- Zhao, J., & Gómez Fariñas, B. (2023). Artificial Intelligence and Sustainable Decisions. *European Business Organization Law Review*, 24, 1–39. <https://doi.org/10.1007/s40804-022-00262-2>.
- Zhao, X., Ren, Y., & Cheah, K. S. L. (2023). Leading Virtual Reality (VR) and Augmented Reality (AR) in Education: Bibliometric and Content Analysis From the Web of Science (2018–2022). *SAGE Open*, 13(3). <https://doi.org/10.1177/21582440231190821>.