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The Role of Artificial Intelligence in Creation of Future Education: Possibilities and Challenges

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Abstract: Artificial intelligence has significant potentials in revolutionizing education by enhancing teaching methods, personalizing learning experiences, and improving educational outcomes.

The aim of the research is to specify the role of AI in creation of future education and to outline the potentials and challenges artificial intelligence can bring within the educational process. To answer the research questions the case study on the role of AI in the creation of future education was conducted. The methods included structured interviews among institutions administrators, faculty members, students, and AI developers; survey among students and faculty to collect quantitative data on their use of and attitudes towards AI technologies; classroom observations. Over 50 recent scientific works were selected to evaluate the role of artificial intelligence in education and to conduct the comparative educational analysis. The research was conducted among 56 participants, in particularly 9 institutions administrators, 19 faculty members, 24 students, and 4 artificial intelligence developers. The results showed that artificial intelligence integrated in the educational process are used to design simulation-based activities, organize personalized learning, form specific skills among students, and automate the administrative process. artificial intelligence leads to enhancement of learning outcomes among students, increased efficiency, and greater accessibility of education, during war in particularly when the educational process can be disrupted. Using artificial intelligence in education presents several challenges that need to be addressed for its effective implementation. Also, it was found that efficient using artificial intelligence tools within the educational process will lead to the creation of positive artificial intelligence based learning landscape at the institutions of higher education which is characterized by efficiency, interactivity, inclusivity, innovation, and accessibility. The results of research can be implied by educational institutions to improve the educational process and by EdTech companies to develop educational tools and platforms.

Keywords: automated educational processes, critical thinking, digital literacy, ethics, intelligent tutoring, virtual classrooms.

Introduction

Today, education has experienced a rapidly changing features, mainly due to a number of technological advancements. They have significantly impacted the existing educational practices, leading to spread of online learning, making vast amounts of information accessible to students and lecturers, and offering innovative teaching technologies. Arguably the most impactful aspect of modern education is artificial intelligence (AI) which refers to the simulation of human mental processes by machines, especially computer systems (Rios-Campos et al., 2023). According to Grassini (2023), AI-based technologies possess the potential to serve as a significant instrument in education, enhancing both learning and pedagogical experiences. AI is reshaping education by personalizing learning experiences, automating educational processes, and enhancing teaching and assessment methods (Kamalov et al., 2023). Additionally, AI can bring valuable improvements into students' performance through data analysis (Grassini, 2023) that helps assess students' outcomes, and track their progress.

AI has indeed become an important topic on the international agenda. The organizations such as the United Nations (UN), the Organization for Economic Co-operation and Development (OECD), and the World Economic Forum (WEF) have released reports and recommendations on AI, highlighting its impact on society, economy, governance, and education in particular. Presently, countries and international bodies are increasingly developing policies and regulations related to AI-based technologies. For example, the European Union's General Data Protection Regulation (GDPR) includes provisions related to AI and data protection (GDPR, n.a.). AI has become a topic of discussion in diplomatic circles, with countries engaging in dialogues and negotiations on AI-related issues. This is evident in forums such as the UN, where AI has been discussed in the context of human rights, ethics, and security (United Nations, 2023). Many countries are collaborating on AI research, development, and governance through initiatives such as the Global Partnership on Artificial Intelligence (GPAI) and the

OECD's AI Policy Observatory (OECD, 2023). These collaborations demonstrate the recognition of AI as a global issue that requires coordinated action. Also, international organizations have developed ethical guidelines for AI, such as the OECD's AI Principles (OECD, 2023) and the IEEE's Ethically Aligned Design (IEEE, 2019) which aim to ensure that AI is developed and used in a way that is ethical and respects human rights.

Ukraine does not have specific regulations dedicated to the use of AI; however, several laws and regulations indirectly address aspects related to AI use. Ukraine has laws governing data protection, similar to the GDPR, and consumer protection laws that apply to AI systems used in products or services sold to consumers. Intellectual property laws in Ukraine cover issues related to the ownership and protection of AI-generated content or inventions. Besides, some laws and regulations are related to cybersecurity ensuring counteraction to cyber threats. While Ukraine does not have specific regulations for AI for today, the government has shown interest in developing AI policies. For example, in 2019, the Ministry of Digital Transformation of Ukraine announced plans to develop a national AI strategy (Expert Committee, 2023). At the same time, Ukraine being a member of the Council of Europe has adopted the Convention for the Protection of Individuals with regard to Automatic Processing of Personal Data (Convention 108) (Council of Europe, 2021). This convention sets out principles for the protection of personal data in the context of automated processing, which may apply to AI systems used in education.

According to the Concept on development of AI in Ukraine, the education system requires the increase of level of digital literacy of both lecturers and students, clarification of legal regulation AI, improvement of training of specialists in the field of AI in the institutions of higher education (Pro skhvalennia Kontseptsii, 2020). The Digital Education Action Plan (2021–2027), established by the European Commission (European Education Area, 2021), and the UNESCO Guidance for generative AI in education and research (UNESCO, 2023) prove that digital technologies have a number of possibilities to transform education and training. The documents pay special attention towards the improvement of digital literacy among students and lecturers to ensure they are prepared for the digital age. Other skills include critical thinking, collaboration, ethical awareness and readiness to continuous education (Rios-Campos et al., 2023). In 2023, the US Office for Educational Technology prepared the insights and recommendations on use of AI in education (Cardona et al., 2023). This report highlights how AI technologies, such as machine learning and natural language processing, can personalize learning experiences, streamline administrative tasks, and provide lecturers with valuable experience to enhance teaching practices. It also emphasizes the importance of ethical considerations, data privacy, and the need for ongoing professional development of all the participants of educational process.

All this indicates that AI has the considerable potentials to transform modern education through personalized learning, automated processes, intelligent tutoring, and interactive content (Chichekian & Benteux, 2022; Kamalov et al., 2023). At the same time, efficient use of AI-based technologies at the institutions of higher education requires detailed analysis of AI ethics in education (Choi et al., 2024) and development of specific skills necessary for work with AI tools (Rios-Campos et al., 2023).

Research Problem

AI has significant potentials in revolutionizing education by enhancing teaching methods, personalizing learning experiences, and improving educational outcomes (Demartini et al., 2024). For example, AI can analyze students' learning patterns, preferences, and strengths to create personalized learning paths (Kamalov et al., 2023). Tobler (2024) emphasizes that AI automates grading for multiple-choice questions, improve students' feedback and interaction between the participants of the educational process. A number of works are devoted to AI potentials in providing virtual assistants and tutoring (Chaudhry & Kazim, 2022). Also, AI-based technologies create unique learning experiences

through virtual reality (VR) and augmented reality (AR), allowing students to engage in the real-life landscape (Chmyr & Bhinder, 2023).

In the future, AI may bring even greater potentials to education, transforming the way lecturers teach and students learn. According to recent findings, AI tools will provide advanced personalized learning oriented towards flexible learning paths that adapt to each students' progress. Intelligent tutors will become more emotional and will be able to recognize and respond to students' emotions in a way that mimics human empathy and understanding (Lin et al., 2023). Currently, these technologies use natural language processing (NLP), affective computing, and machine learning, to analyze students' verbal and non-verbal communication and are able to respond accordingly. Some scholars (Lai et al., 2023) admit that emotionally intelligent tutoring has the potentials to enhance the effectiveness of online learning by providing students with personalized and empathetic. In the scientific literature the special attention is drawn to AI-generated educational content (Farrelly & Baker, 2023). It was found that lecturers create relevant quizzes and interactive simulations faster when using AI tools.

While AI is reshaping education, it also presents several challenges, particularly data privacy and security, quality of content, and loss of human connections. The work of Kamalov et al. (2023) shows AI-powered educational tools may increase the existing inequalities in access to education. Besides, since AI becomes more integrated into education, there is a growing need for students and lecturers to develop digital literacy and critical thinking to effectively navigate and critically evaluate AI-powered tools and resources (Rios-Campos et al., 2023). Additionally, using too much of AI technologies leads to a decrease in communication and problem-solving skills among students. Farrelly and Baker (2023) note that relying too heavily on AI tutors or automated grading systems may discourage students and hinder the formation of professional competences. Therefore, studying the potential and challenges of AI-based instruments within the educational process may enhance teaching and learning as well as create sustainable education system in future.

Research Focus

The theoretical analysis of the problem shows that AI is an important topic of contemporary scientific and educational discourse. Extensive use of AI-based technologies facilitates improvements of the educational process and change the institutions of higher education positively. Moreover, in the future AI will definitely become an integral instrument of professional development and will transform teaching and learning practices significantly. Obviously, using AI helps make the learning more personalized and AI tools encourage implementation of innovative teaching technologies and enhance the productivity of the educational process. But to make the transition of traditional education to digital pedagogy smooth, it is necessary to explain the potentials and challenges of using AI in the educational process and outline the measures to be taken to build effective technology-enhanced learning landscape. Special attention must be paid towards the Ukrainian institutions of higher education since they function under the special conditions and, hopefully, AI tools may create the accessible and continuous educational process.

Research Aim and Research Questions

The aim of the research is to specify the role of AI in creation of future education and to outline the potentials and challenges AI can bring within the educational process.

The research addresses the following *research questions*:

1) What purposes of using AI in the Ukrainian institutions of higher education?
2) How do AI-based tools affect the educational process and what skills do they help cultivate?

3) What challenges are faced when AI tools are applied in the Ukrainian institutions of higher education? And what measures are taken to overcome them?
4) What are characteristics of positive AI-based learning landscape? What actions should be taken to create positive AI-based learning landscape at the institution of higher education?

Literature Review

Current trends of the studying AI in education

The scientific sources demonstrate that the trends in the studying AI in education focus mainly on enhancing learning experiences (Chichekian & Benteux, 2022), improving educational outcomes (Demartini et al., 2024), and addressing challenges in the implementation of AI technologies (Kamalov et al., 2023). It was found that recent articles are dedicated to one of the following topics: personalized learning (Demartini et al., 2024), intelligent tutoring (Lai et al., 2023), data analytics and predictive modelling (Gómez-Pulido et al., 2023). According to recent studies (Diwan et al., 2023; Karkera et al., 2024; Snigdha & Akter, 2023), AI is an important instrument to create high-quality educational content which integrates audio and visual materials. Besides, some authors differentiate the problems of ethical responsibility for using AI (Michel-Villarreal et al., 2023) and formation of digital literacy of lecturers and students (Cardona et al., 2023; Ng et al., 2023).

Thus, AI is often used to create personalized learning experiences tailored to individual students' needs, preferences, and learning styles (Pratama et al., 2023). This trend aims to improve engagement and understanding by providing content and activities that are relevant to each student (Kamalov et al., 2023). The recent findings show that AI-powered tutors are being developed to deliver educational materials and assess students' knowledge or skills (Lai et al., 2023). Intelligent tutoring proved to enhance students' motivation, engagement, and attitudes towards professional development during online or blended learning (Yang & Zhang, 2019). Studying data analytics and predictive modelling it was found that AI is used to analyze large datasets to identify patterns and trends in students' performance, behavior, and learning outcomes (Crompton & Burke, 2023; Gómez-Pulido et al., 2023). This trend helps lecturers make data-driven decisions resulted in improvement of teaching and learning strategies.

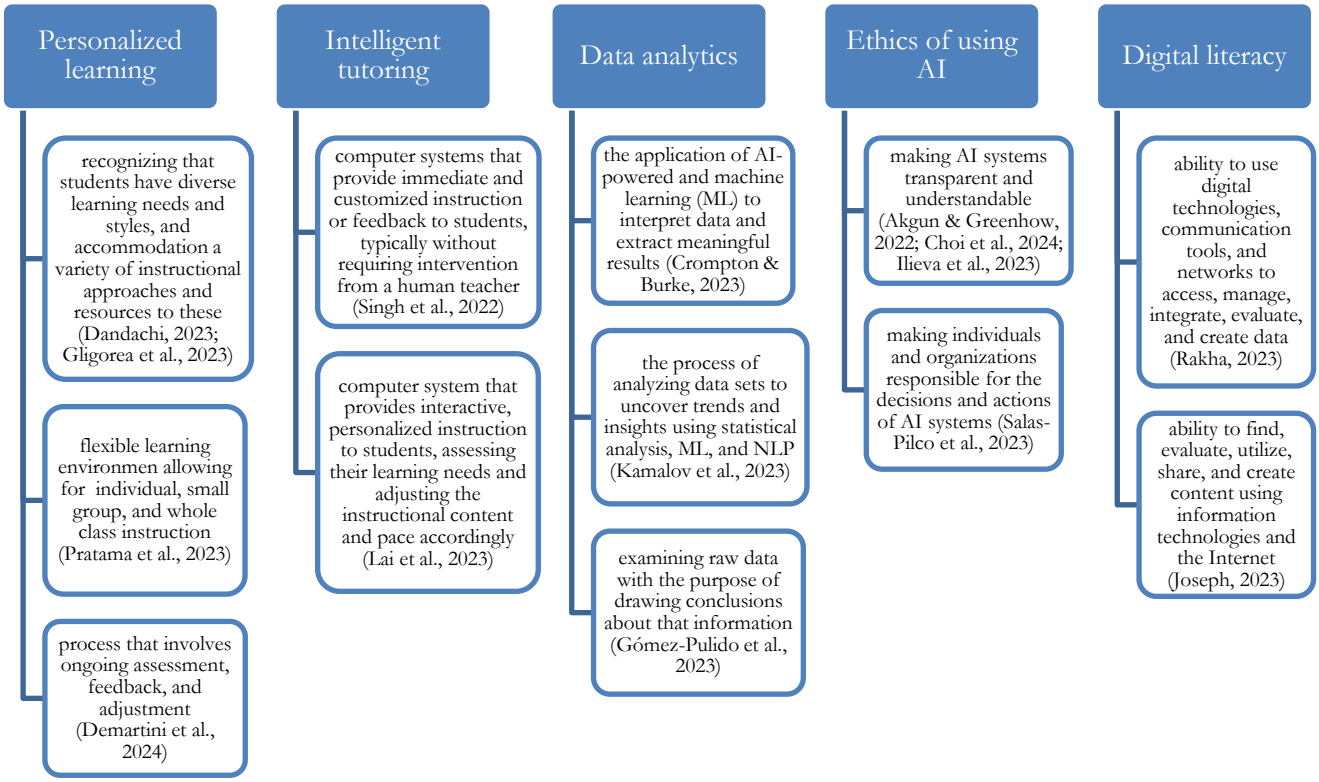
According to the normative documents (IEEE, 2019) and scientific works (Akgun & Greenhow, 2022; Choi et al., 2024), there is a growing emphasis on the ethical and responsible use of AI tools in education, including issues related to bias, privacy, and transparency. It is worth mentioning that the introduction of ethical responsibility for using AI may potentially benefit all students and lecturers (Ilieva et al., 2023). Besides, ethics of AI ensures that educational opportunities are accessible to all learners regardless of their background or other circumstances (Salas-Pilco et al., 2023). Definitely, AI can help create a more sustainable educational system and promote equity and inclusion at the institutions of higher education.

Digital literacy is closely related to the use of AI in education, as both concepts involve understanding of digital technologies for learning and teaching. Rios-Campos et al. (2023) declare that digital literacy includes the ability to understand and use AI technologies effectively. Lecturers and students need to be digitally literate to comprehend how AI works, its potential applications in education, and its implications for teaching and learning. Moreover, digital literacy increases critical thinking skills, which are essential for evaluating AI-powered educational resources and technologies (Joseph, 2023). According to Rakha (2023), digital literacy helps all the participants of the educational process adapt to the changing landscape of education due to AI. It enables them to implement of new technologies, integrate AI into teaching and learning practices, and navigate the ethical and social implications of AI in education.

Therefore, the trends above-mentioned reflect a growing interest in the studying of the role of AI in transforming education and creating more engaging, personalized, and effective educational landscape. Figure 1 analyzes the current trends of the studying AI in the education system based on the literature review.

Figure 1

Analysis of Current Trends of the Studying AI in the Education System



Source: Authors' own development.

Comparative educational analysis on using AI in education

The detailed examination of scientific and pedagogical sources showed that some countries are actively implementing AI in education to enhance teaching and learning experiences. To present the potentials and challenges of using Ai in education requires conducting comparative educational analysis to select the best practices of AI-based pedagogy.

The largest number of educational research are devoted to China. There, in China, AI has been increasingly integrated into various aspects of education, transforming traditional teaching and learning methods. It was found that the use of AI technologies in Chinese education varies at different levels. AI implemented at the early stage in elementary education; more prevalent it is in higher education. As a result, Chinese students are becoming well-trained to face the AI-driven transformations and are able to work together to create an informatized education landscape (Yang, 2019). The results show that AI technology is extensively applied to influence adolescents' emotional perceptions and make the assessments objective (Lai et al., 2023). The special attention is drawn towards the creation of smart classrooms (Nasar et al., 2023) using AI tutoring platforms such as Smart Learning Partner (Niu et al., 2022), and language learning with the use of AI tools (Yang, 2019). Knox (2019) analyses the AI government policy in China stressing on the role of the educational institutions play as influential actors

in national and regional strategies for AI development. Some scholars describe the use of AI for education management tasks, such as student enrollment, scheduling, and resource allocation, helping schools and institutions operate more efficiently (Li et al., 2023).

In the United States, the use of AI in education is growing rapidly, with schools, colleges, and educational institutions adopting AI technologies to enhance teaching and learning (Cardona et al., 2023; Touretzky et al., 2019). It was found that American educational institutions implement AI for creation of personalized learning, analysis of large datasets to identify patterns and trends in students' performance, behavior, and learning outcomes (Lo, 2023). Some works are dedicated to AI-powered tutoring systems which provide students with personalized instruction and feedback (Crompton & Burke, 2023) as well as eliminate the barriers to equity education (Roshanaei et al., 2023). It is necessary to state that in the United States AI is extensively used to create educational games and simulations that engage students and help them learn through interactive experiences. Also, a number of works are related to the necessity of ethics and international collaboration in the field of using AI (Bond et al., 2024).

In the United Arab Emirates (UAE), AI in education is a key focus area, with the government and educational institutions actively adopting AI technologies to enhance the educational process and professional development of future experts. During the research it was found that the UAE Ministry of Education implemented AI-based program called the Adaptive Learning Framework (Alef) in the public high schools. Alef, an interactive shareware program, tailors the content provided to each student based on their individual needs, input, and identified strengths and weaknesses. The Alef program is available for all core subjects and it is aligned with the public high school curriculum (Emara et al., 2023). Besides, AI tools are widely used in special needs education to engage all the students in AI-mediated discussions (Naggar et al., 2024).

Ukraine, being on the brink of significant changes in its higher education system, has been increasingly adopting AI technologies in education. The findings show that the rapid development of AI has affected higher education in Ukraine and some works discuss that AI technologies ensure the sustainability of the educational process and sometimes can replace the teachers at the educational institutions (Okulich-Kazarin et al., 2024). Also, it was found that AI is an integral competent of reforming education in Ukraine and is used to introduce high-quality STEM education (Chmyr & Bhinder, 2023; Kniazkova et al., 2024; Yuskovych-Zhukovska et al., 2022). Fiialka et al. (2023) paid the attention towards peculiarities of using ChatGPT in the Ukrainian education. It is worth mentioning that recent findings demonstrate positive impact of AI-based technologies on Ukrainian education for peace and security (Bakhmat et al., 2024; Matviichuk et al., 2024). Besides, a number of Ukrainian scholars investigated the problem of formation of informational and digital competence among future specialists (Melnyk, 2023; Sagan et al., 2023).

However, it was found that modern pedagogy lacks detailed examination of the role of AI in creation of future education and description of its potentials and challenges. Considering the idea that Ukrainian system of education is moving towards digital transformations, the study on using AI technologies in the Ukrainian institutions of higher education will contribute to enhancement of training algorithms and design the recommendations on application of AI tools for creation of accessible and continuous educational process.

Materials and Methods

General Background

To answer the research questions the case study on the role of AI in the creation of future education was conducted. To examine the potentials and challenges of using AI technologies three Ukrainian institutions of higher education were selected. They represent different regions of Ukraine (Chernivtsi, Kyiv, and Odesa oblasts) and are actively implementing AI technologies. Understanding the role of AI within the educational process three aspects were evaluated: teaching, learning, and administration. When studying teaching, the attention was paid towards effectiveness of AI, pedagogical innovation, lecturer-student interaction, and skills development such as digital literacy, critical thinking, problem-solving, data comprehension, etc. Learning aspect included effectiveness of AI, skills development, personalization of learning, accessibility and inclusivity, orientation towards continuous improvement. And administration aspect studied efficiency and productivity of administrative processes in educational institutions, cost-effectiveness, and organizational change.

The methods included structured interviews among institutions administrators, faculty members, students, and AI developers; survey among students and faculty to collect quantitative data on their use of and attitudes towards AI technologies; classroom observations. Also, institutions normative documents were analyzed to understand the institutional context and AI initiatives. The research adhered to the ethical guidelines, such as obtaining informed consent from participants and maintaining confidentiality of data. The findings were presented in a comprehensive report that included a description of the case, an analysis of the data, and recommendations for future research and practice in Ukrainian higher education.

Sample and Participants

The research was conducted among 56 participants, in particularly 9 institutions administrators, 19 faculty members, 24 students, and 4 AI developers. They represented the institutions of higher education located on Chernivtsi, Kyiv, and Odesa oblasts. The criteria for selecting participants for the case study on the role of AI in education, and its potentials and challenges included the following: involvement of in using AI in education; possession of relevant experience in the field; availability to participate in the research study; and providing the informed consent from all the respondents. Participants represented a diverse range of backgrounds, perspectives, and experiences related to AI in education. This diversity helped ensure that the research findings are comprehensive and reflective of the broader context. Table 1 shows the demographics of survey participants according to the 3 institutions.

Table 1

Demographics of Survey Participants

Institution	Participants	Quantity
Institution 1 (I1)	administrators	2
	lecturer	7
	student	10
	AI developer	1
Institution 2 (I2)	administrators	4
	lecturer	5
	student	11
	AI developer	1
Institution 3 (I3)	administrators	3
	lecturer	7

	student	13
	AI developer	2
	Totally	**56**

Source: Based on the survey results.

Instruments and Procedures

Firstly, a structured interview conducted that included a predetermined set of topics, ensuring consistency across all interviews. The introductory part concerned the personal data of a participant (age, gender, institution, working experience, specialization, experience with AI technologies), explained the purpose of the interview, and obtained consent from the participant to proceed. Main questions covered the following topics: How AI is currently being used in education; The benefits and challenges of using AI in education; The impact of AI on teaching, learning, and administration; The future potentials of AI in education; Ethical considerations related to the use of AI in education. Follow-up part included 5 questions to clarify responses or understand deeper the participants perceptions of the topics. It was found that structured interview helped to collect standardized data from participants and provide valuable understanding of their perspectives and experiences with AI in education.

Secondly, a survey among students and lecturers was conducted to collect quantitative data on their use of and attitudes towards AI technologies. It involved the development of a set of survey questions that addressed the research objectives and study on the role of AI in education. such survey enabled to measure the participants' perceptions of AI's impact on teaching, learning, and administration, as well as concerns about AI, and willingness to integrate AI-based technologies into the educational landscape. Online survey platforms were introduced to make the survey more accessible to the target population. To avoid possible errors clear instructions were provided on how to complete the online survey and ensure that all the respondents understood the purpose of the survey.

Thirdly, classroom observations were carried out to gather qualitative data on the use of and attitudes towards AI technologies. It involved pre-observation preparation when the observers studied the classroom setting and the specific AI technologies being used. afterwards, the observation protocol was developed that outlined the objectives of the observation and the specific behaviors or interactions the activity was aimed at. The permission was obtained from all the lecturers and students to observe the classroom activities. the observation process itself required taking notes on the use of AI technologies and the attitudes of both the lecturer and students towards these technologies. The main attention was paid towards how AI technologies are integrated into teaching, considering the context of the classroom and the objectives of the research.

Data Analysis

The data collected during a case study was analyzed using thematic analysis, pattern matching, and cross-case study. These techniques enabled to identify patterns or themes in the data to understand the role of AI in creation of future education. Descriptive statistics was used to calculating survey frequencies, percentages, and standard deviations. Also, this technique underlined the dimensions in the survey data to reduce complexity and identify specific patterns. Classroom observation protocols were analyzed through content analysis and it was made possible to understand how the participants talked about AI technologies and their perceptions on the potentials and challenges of AI-based technologies. It is necessary to admit that all the data analysis techniques were guided by the research questions and the goals of the research study. The use of multiple techniques helped triangulate the research findings and ensure the validity and reliability of the results.

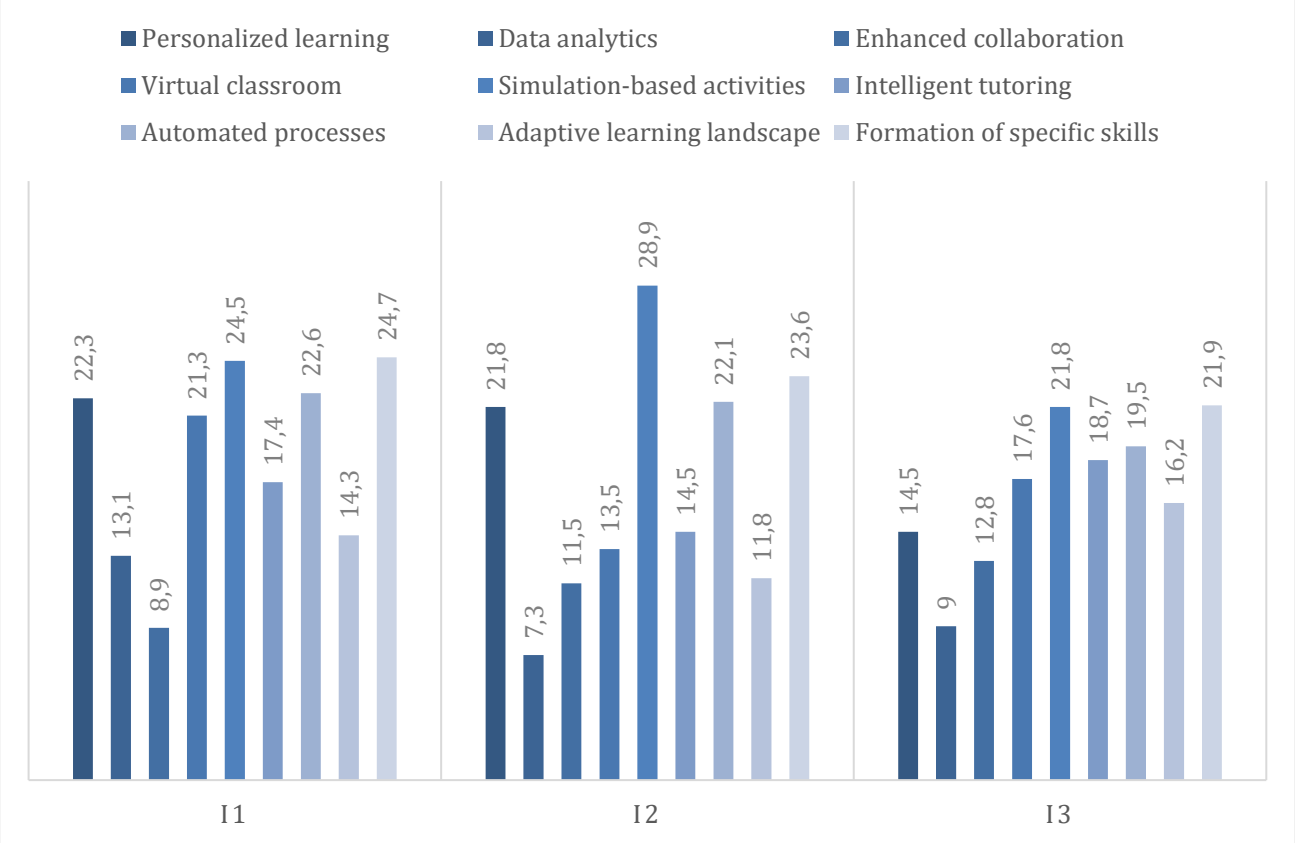
Results

The purposes of using AI in the Ukrainian institutions of higher education

The findings show that AI technologies integrated in the educational process of the Ukrainian institutions of higher education are used for the following purposes: design of simulation-based activities, organization of personalized learning, formation of specific skills among applicants of higher education, and automation of administrative process. The respondents admit that AI-generated simulations facilitate professional development of future experts in the safe conditions, and they stress that personalized learning has extensive potentials to tailor educational content to meet students' needs and learning styles. At the same time, using of AI-based tools encourage formation of specific skills like critical thinking, digital literacy, problem-solving, and data-driven decision-making. Also, automated processes allow for streamline of routine tasks and help design sustainable educational landscape. But it was found that AI has lower potentials for enhanced collaboration and data analytics since it requires using special tools or licensed equipment to ensure data privacy and security. Figure 2 shows the purposes of using AI in the Ukrainian institutions of higher education according to the respondents.

Figure 2

Purposes of Using AI in the Ukrainian Institutions of Higher Education



Source: Based on the survey results.

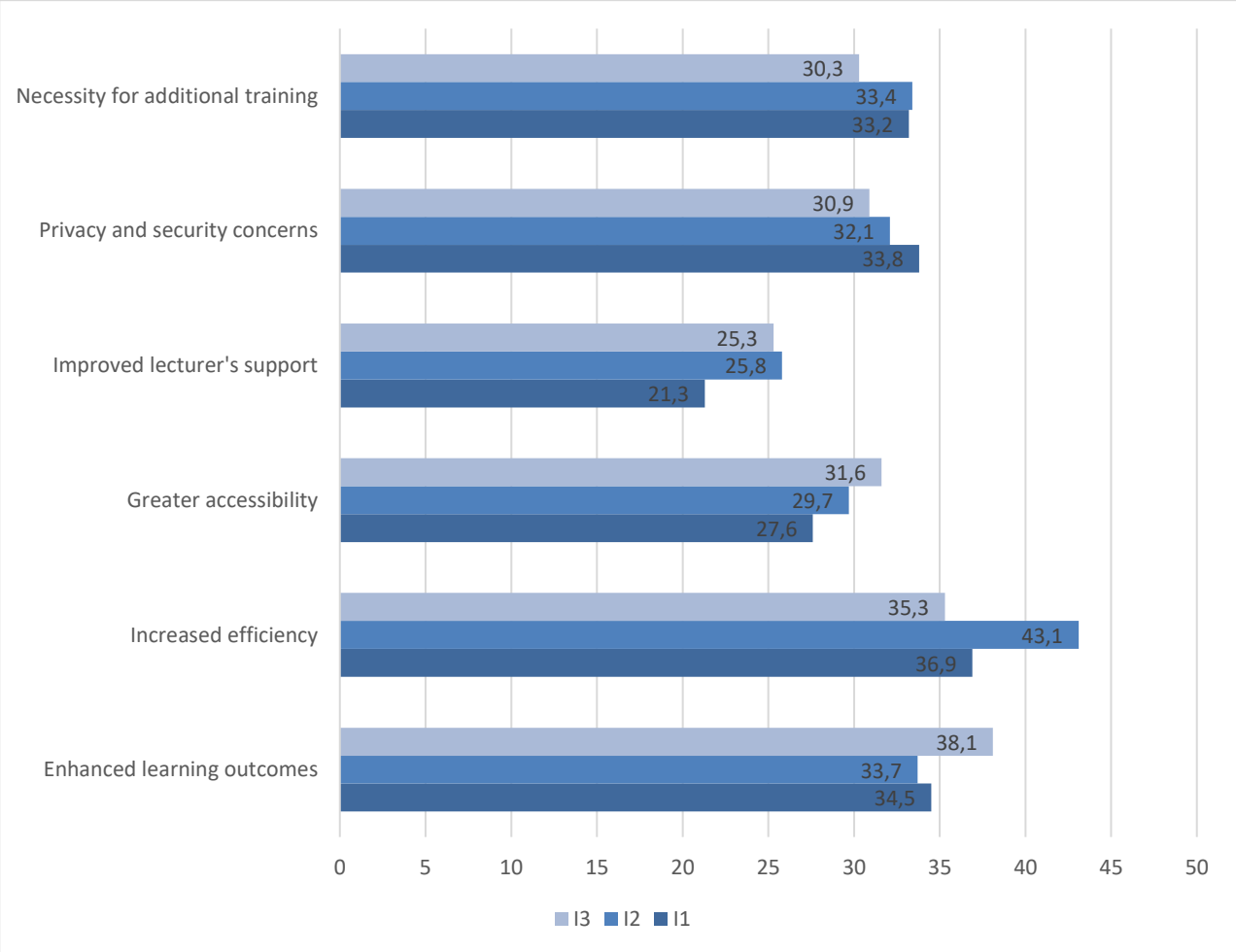
Impact of AI-based tools on the educational process

Studying the impact of AI tools on the educational process, it was found that it leads to enhanced learning outcomes among students, increased efficiency through the automation of routing tasks such as grading or data analysis. Also, the results showed using AI technologies makes education more

accessible to students with disabilities. The lecturers from Ukrainian institutions of higher education admitted that AI provides greater accessibility of education during war when the educational process can be disrupted. Other impacts include the following: improved lecturers' support, privacy and security concerns, and necessity for additional training for lecturers, students, administrators to improve their AI competency. Therefore, the impact of AI tools on the educational process is multifaceted, with the potential to transform teaching and learning in profound ways in future. It may result in creation of future education with greater potentials. Figure 3 demonstrates the impact of AI-based tools on the educational process.

Figure 3

Impact of AI-based Tools on the Educational Process



Source: based on the survey results.

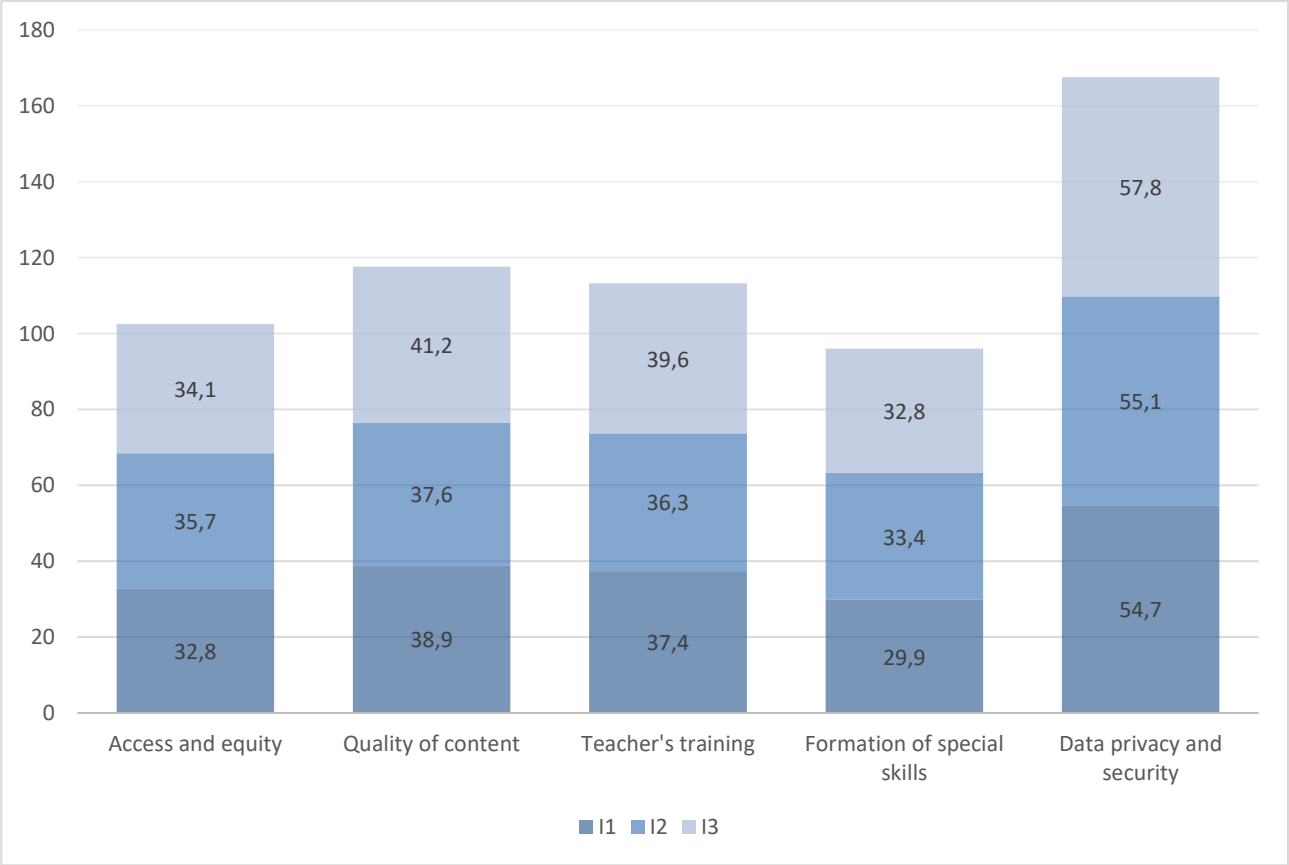
The challenges faced when AI tools are applied in the Ukrainian institutions of higher education. and the measures to overcome them

Using AI in education presents several challenges that need to be addressed for its effective implementation. The findings showed that these challenges include access and equity (I1-32,8 %, I2-35,7 %, I3-34,1 %), quality of educational content (I1-38,9 %, I2-37,6 %, I3-41,2 %), teacher's training and support (I1-37,4 %, I2-36,3 %, I3-39,6 %), formation of special skills such as digital literacy, critical thinking, problem-solving (I1-29,9 %, I2-33,4 %, I3-32,8 %), and data privacy and security (I1-54,7 %, I2-55,1 %, I3-57,7 %). The respondents admitted that addressing these challenges requires

collaboration among lecturers, students, administrators, and AI developers to ensure that AI is used in education in a way that is inclusive, equitable, and beneficial for all the participants of the educational process. figure 4 shows the challenges most often faced when AI tools are applied in the Ukrainian institutions of higher education.

Figure 4

Challenges Faced when AI Tools are Applied in the Ukrainian Institutions of Higher Education



Source: Based on the survey results.

At the same time, it was found that specific measures are needed to overcome the challenges above-mentioned. The respondents were interviewed on the most preferable steps when they are facing difficulties related to using AI. The results showed that the measures usually concern providing access to digital devices, organization of professional development for lecturers of the institutions of higher education, aligning AI-generated content with curriculum to provide high-quality educational materials. The lecturers and administrators paid special attention towards data privacy and security concerns and decided that it is necessary to adopt international guidelines of using AI in education and use students' data ethically. Table 2 described the measures to overcome the challenges of using AI tools in the educational process according to the survey participants.

Table 2

Measure to Overcome the Challenges of Using AI Tools in the Educational Process

Challenges	Measures to overcome the challenges of using AI tools		
	I1	I2	I3
Access and equity	Ensure that all students have access to the necessary technology, such as computers or tablets, and internet connectivity; Provide digital literacy training to students, lecturers and administrators.	Provide devices to students who cannot afford them; Ensure that educational institutions have adequate technology infrastructure; Ensure that AI-powered tools are accessible to students with disabilities.	Ensure that AI tools are affordable for students, taking into account the cost of the technology. Develop and implement regulations that promote access and equity in AI in education.
Quality of content	Align AI-generated content with established curriculum standards and learning objectives; Assess the accuracy, and reliability of AI-generated content; Provide teachers with professional development opportunities; Follow the ethical guidelines for using AI.	Align AI-generated content with established curriculum standards and learning objectives; Establish accurate feedback to provide input on the quality and effectiveness of AI-generated content; Foster collaboration among educators, content developers, and AI experts.	Align AI-generated content with established curriculum standards and learning objectives; Update AI-generated content regularly; Incorporate diverse perspectives and sources into AI-generated content; Adhere to ethical guidelines for the use of AI in education.
Teacher's training	Establish professional development programs; Provide continuous learning opportunities for lecturers; Provide technical support; Offer methodical support for lecturers.	Establish professional development programs; Organize collaborative activities for lecturers from different institutions; Provide technical support; Establish lecturers' feedback on using AI tools.	Provide practical training with AI tools and technologies; Provide technical support; Organize partnership with technical companies.
Formation of special skills	Integrate the development of special skills, such as digital literacy and critical thinking, into the curriculum; Introduce problem-solving tasks that require students to use special skills;	Provide accurate instructions for students when working with AI tools; Provide feedback to students on their use of special skills; Use AI-powered tools and technologies to enhance the development of special skills.	Use project-based learning approaches; Foster collaborative learning landscape; Improve assessment strategies that measure students' digital literacy and critical thinking.
Data privacy and security	Encrypt student data; Implement strict access controls;	Obtain informed consent from students before collecting any personal data;	Encrypt student data; Conduct regular security checking;

	Minimize the data that is used in the educational process.	Ensure compliance with relevant data protection regulations.	Provide training for teachers and staff on data privacy and security.

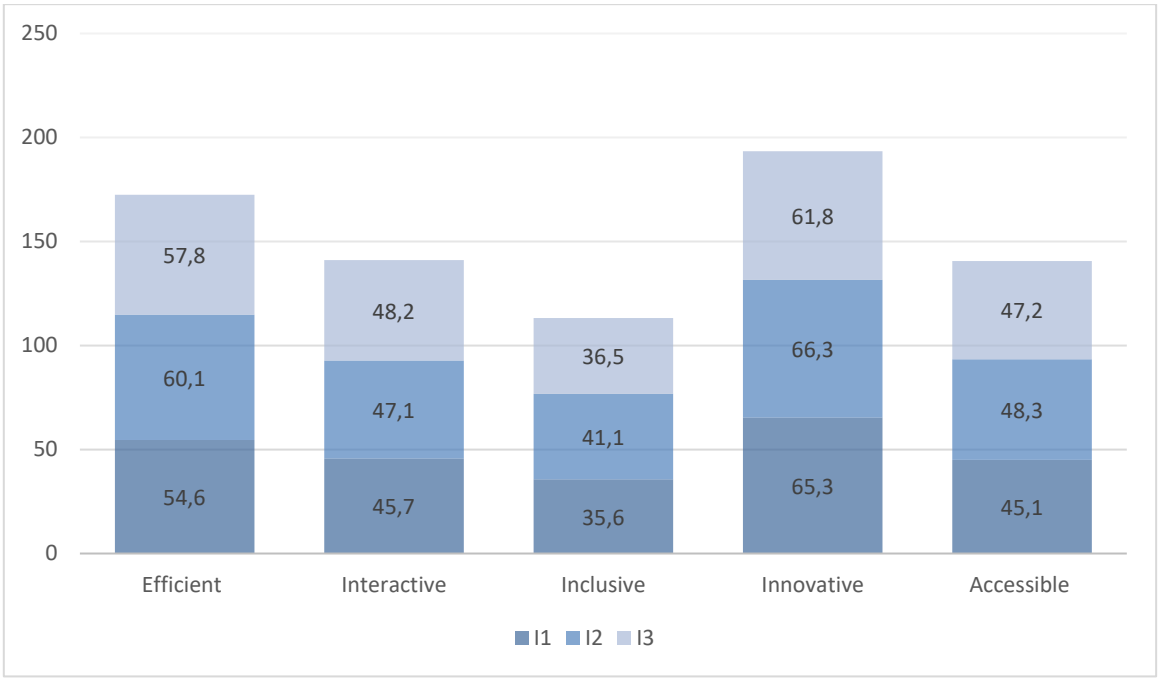
Source: Based on the survey results.

Positive AI-based learning landscape at the institution of higher education

The findings showed that efficient using AI tools within the educational process will lead to the creation of positive AI-based learning landscape at the institutions of higher education. the respondents were asked about the characteristics of positive AI-based learning landscape and it was found that it possesses five qualities. They are the following: efficient, interactive, inclusive, innovative, and accessible. According to the survey, efficient landscape means that AI automates many tasks, such as grading and feedback, saving time for both students and educators. At the same time interactive means that AI-powered tools often facilitate interactive learning experiences, encouraging active participation and collaboration of students. Within the inclusive landscape AI tools provide tailored support for students with diverse learning needs. In the innovative landscape AI enables the development of new and innovative educational approaches, such as personalized learning algorithms and simulation-based activities. Accessible is related to proving students with an access to educational process in remote or war-affected areas, providing them with necessary resources and support. Figure 5 shows the characteristics of positive AI-based learning landscape at the institution of higher education

Figure 5

Characteristics of Positive AI-based Learning Landscape at the Institution of Higher Education



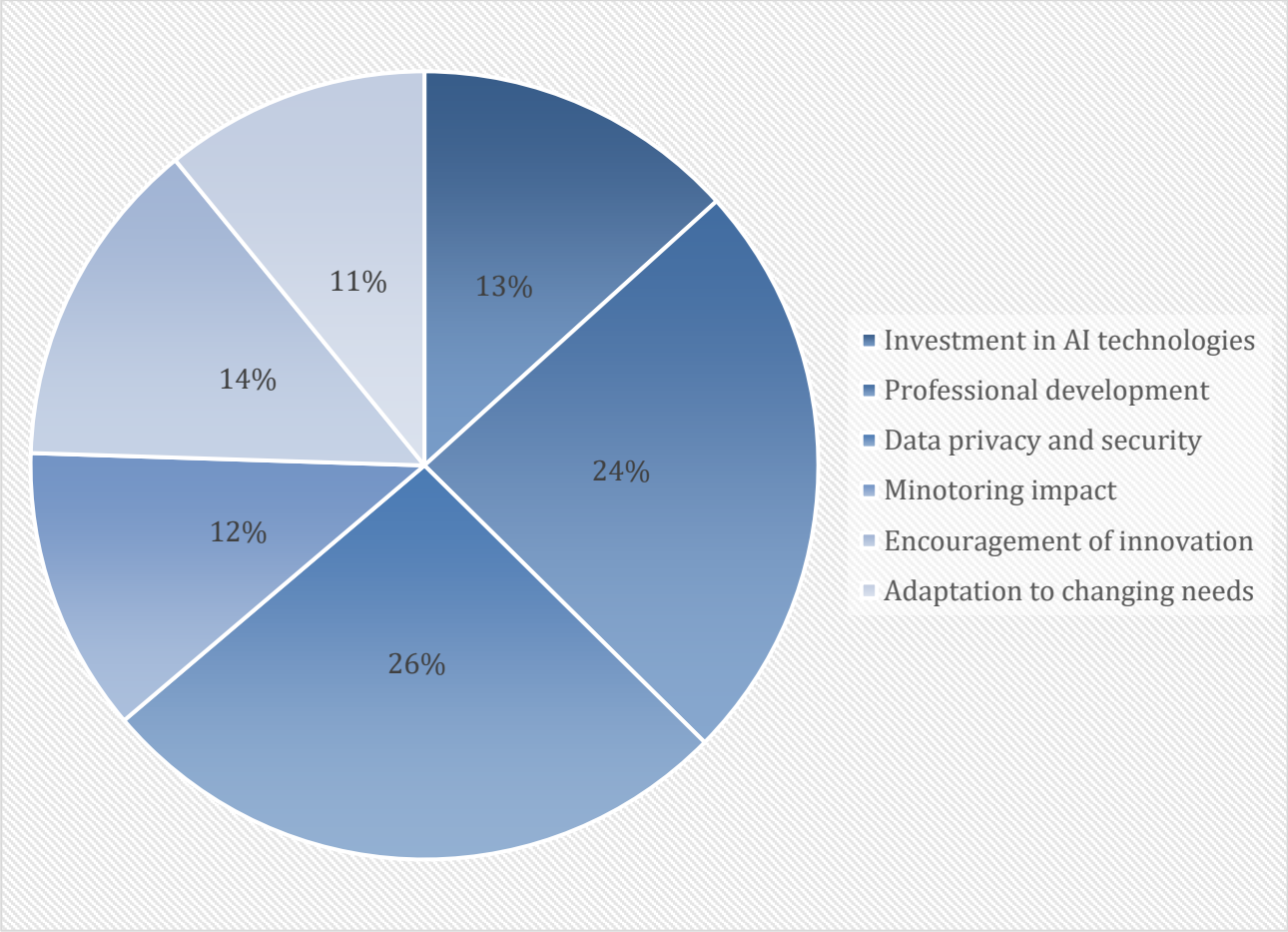
Source: Based on the survey results.

At the same time, building a positive AI-based learning landscape requires a combination of thoughtful planning, investment in technology, and a focus on student's orientation towards continuous development. It was found that the following steps are necessary to build a positive AI-based learning landscape at the Ukrainian institutions of higher education. The first one deals with investment in AI technology and it is related to allocation of financial and material resources appropriately to support the implementation of personalized learning, adaptive assessments, and intelligent tutoring systems at the educational institutions. The second step is related to professional development for lecturers,

administrators, and students to learn how to integrate AI tools into their teaching, learning, and administering practices. Ensuring data privacy and security, the third step, deals with implementation of strict data privacy regulations to protect students' data. Also, the respondents admitted that monitoring of the impact of AI-based learning tools on student outcomes is important for further improvements. The fifth step is related to the encouragement of innovations within the educational process. And the sixth one, adaptation to changing needs, suggests making the educational process flexible and integrate relevant and effective AI tools. Figure 6 shows the steps for creation of positive AI-based learning landscape.

Figure 6

Steps for Creation of Positive AI-based Learning Landscape



Source: Based on the survey results.

Therefore, it is important to state that AI-based tools may enhance the educational process significantly when used appropriately and according with the curriculum. Considering that AI brings a lot of potentials as well as challenges at the learning landscape, it is necessary to analyze the role of AI I education in details. Moreover, maximization of AI potentials is oriented towards the creation of positive AI-based learning landscape that can be an integral characteristic of future-oriented education.

Discussion

The study aimed at the evaluation of the role of AI in education and description of its contributions into creation of future-oriented education. The findings showed that AI tools are used to enhance the students' learning experiences (Chichekian & Benteux, 2022) and improve their educational outcomes (Demartini et al., 2024) fostering the professional development of future experts. Using AI in education

contributes to implementation of personalized learning (Demartini et al., 2024), intelligent tutoring systems (Lai et al., 2023), data analytics and predictive modelling (Gómez-Pulido et al., 2023) that can increase the potentials of the education system. Also, positive usage of AI technologies requires the addressing a number of challenges including data privacy and security concerns, necessity to form specific skills, and quality of content (Kamalov et al., 2023). At the same time, the findings show that incorporating AI into education is not just about adopting new technologies, but about embracing a future-oriented approach that prepares students for the challenges and opportunities of tomorrow (Selwyn, 2022).

The investigation proved that presently a number of AI tools are used within the educational process to fulfill different purposes. The main trend of using AI includes personalized learning (Demartini et al., 2024). It is used to create personalized learning experiences tailored to individual students' needs, preferences, and learning styles (Pratama et al., 2023). At the same time, the respondents showed that organization of personalized learning is an important condition of using AI tools and it improves teaching and learning practices significantly. It is necessary to admit that formation of specific skills among applicants of higher education, and automation of administrative process were considered as important trends of using AI in education.

Studying the impact of AI tools on the educational process, it was found that it leads to more personalized learning landscape (Lin et al., 2023), automation of administrative tasks, such as grading and scheduling (Rahm, 2023), and providing more access to education through online learning platforms, digital resources, or intelligent tutoring systems (Chemnad & Othman, 2024). According to the survey results, AI enhances students' learning outcomes, automates the routing tasks, and makes the educational process more accessible to students with disabilities.

The scholars' attention is paid towards challenges of using AI in education as well. the recent findings showed that data privacy and security concerns are the most discussed in the scientific circles (Ilieva et al., 2023; Karan & Angadi, 2023). Additionally, the problem of formation of digital literacy and critical thinking to ensure that all the participants are aware of AI tools and use them accordingly has been widely studied (Černý, 2024; Rios-Campos et al., 2023). During the survey it was found the challenges of using AI in the Ukrainian institutions of higher education include access and equity, quality of educational content, teacher's training and support, formation of special skills such as digital literacy, critical thinking, problem-solving, and data privacy and security. It was concluded that addressing these challenges will make the educational process efficient and productive.

During the research the attention was paid towards a positive AI-based learning landscape. The findings show that it is related to an educational environment that implement AI technologies to enhance teaching and learning experiences (Bozkurt et al., 2021). As a rule, such landscape is used to personalize learning, improve educational outcomes, and streamline administrative tasks (Kamalov et al., 2023). The recent findings show that positive AI-based learning landscape is characterized by personalization, engagement, efficiency, accessibility, and data-driven decision-making (Jia et al., 2022). Definitely, a positive AI-based learning landscape increases the potentials of AI to create more personalized, engaging, and effective learning experiences for students, while also supporting lecturers in their teaching practices (Grassini, 2023). Moreover, this landscape facilitates the work of administrators and make many routine tasks automated (Tobler, 2024). According to the respondents the characteristics of positive AI-based learning include the following: efficient, interactive, inclusive, innovative, and accessible. Building a positive AI-based learning landscape at the Ukrainian institutions of higher education requires a combination of thoughtful planning, investment in technology, and a focus on student's orientation towards continuous development.

Therefore, the role of AI in the creation of future-oriented education is transformative, offering opportunities to revolutionize teaching and learning practices as well as administration of organizational processes. Implementing AI technologies, lecturers create dynamic and engaging classrooms that tailor to the individual needs of students, preparing them for success in a rapidly changing world. However, realizing the full potential of AI in education requires careful consideration of ethical, privacy, and equity implications.

Conclusions and Implications

AI refers to the simulation of human mental processes by machines, especially computer systems and AI technologies possess the potential to serve as a significant instrument in education, enhancing both learning and pedagogical experiences. It was found that AI has become an important topic on the international agenda due to its profound impact on various aspects of society, including education. The literature review demonstrated that the trends in the studying AI in education focus mainly on enhancing learning experiences, improving educational outcomes, and addressing challenges in the implementation of AI technologies. The recent findings describe personalized learning, intelligent tutoring, data analytics and predictive modelling as the most important topics in the field of AI. The comparative educational analysis of AI related articles seeks to examine and evaluate the adoption, impact, and effectiveness of AI technologies in different educational settings and contexts, with the goal of identifying best practices and informing future developments in the field. In the study we analyzed the experiences of China, the Unites States the UAE, and Ukraine. The analysis resulted in the idea that Ukraine, being on the brink of significant changes in its higher education system, has been increasingly adopting AI technologies in education. at the same time, the rapid development of AI has affected higher education in Ukraine and contribute to the sustainability of the educational process.

The survey showed that AI technologies integrated in the educational process of the Ukrainian institutions of higher education are used for the following purposes: design of simulation-based activities, organization of personalized learning, formation of specific skills among applicants of higher education, and automation of administrative process. Besides, the respondents proved that using AI causes enhancement of learning outcomes among students, increased efficiency, and greater accessibility of education, during war in particularly when the educational process can be disrupted. Other impacts include: improved lecturers' support, privacy and security concerns, and necessity for additional training for lecturers, students, administrators to improve their AI competency. Using AI in education presents several challenges that need to be addressed for its effective implementation. They are related to access and equity, quality of educational content, teacher's training and support, formation of special skills such as digital literacy, critical thinking, problem-solving, and data privacy and security. The respondents admitted that addressing these challenges requires collaboration among lecturers, students, administrators, and AI developers to ensure that AI is used in education in a way that is inclusive, equitable, and beneficial for all the participants of the educational process. At the same time, it was found that specific measures are needed to overcome these challenges. Also, it was found that efficient using AI tools within the educational process will lead to the creation of positive AI-based learning landscape at the institutions of higher education which is characterized by efficiency, interactivity, inclusivity, innovation, and accessibility.

The results of research on the role of AI in education can be implied in various contexts and settings. Firstly, they are important for educational institutions including schools, colleges, and universities to inform about integrating AI technologies into their teaching and learning practices as well as administration processes. The outcomes are valuable for teacher training programs and professional development initiatives because they can help develop the skills and knowledge needed to effectively use AI in the educational practices. Also, EdTech companies can use the research findings to

develop AI-powered educational tools and platforms that are based on relevant pedagogical principles and meet the needs of lecturers, students, and administrators.

Suggestions for Future Research

Future research on the role of AI in education may be related to the impact of AI in teacher practices. It is necessary to investigate how AI technologies impact teacher practices, including instructional strategies, classroom management, and professional development needs. It is worth mentioning that special attention must be paid towards exploration of the ethical and social implications of AI in education, including issues related to data privacy, bias, and equity. Obviously, maintaining strong data privacy and security measures helps build trust and confidence among students, lecturers, and administrators in the use of AI technologies in education.

Studying students' perceptions of AI in education is crucial for understanding how they interact with and respond to AI technologies in learning environments. Students' attitudes, beliefs, and experiences with AI can significantly impact their acceptance and adoption of these technologies. When the investigation is focused on students' perceptions, lecturers can address concerns, tailor educational interventions, and design AI-powered tools that are more engaging and effective. Additionally, studying students' perceptions will help identify barriers to the successful implementation of AI in education, such as privacy concerns allowing for the development of strategies to counteract these challenges and promote positive students' learning outcomes.

Addressing these areas of research, scholars can contribute to a deeper understanding of the role of AI in education and maximize its potentials in future.

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Conflict of Interest

None.

References

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

Bakhmat, N., Romanova, I., Oronovska, L., Rudenko, O., & Mogyl, O. (2024). Ukrainian education for peace and security 2023: Technological convergence, artificial intelligence. *Multidisciplinary Reviews, 6*, Article e2023spe016. https://doi.org/10.31893/multirev.2023spe016

Bond, M., Khosravi, H., De Laat, M., Bergdahl, N., Negrea, V., Oxley, E., Pham, P., Cong, S. W., & Siemens, G. (2024). A meta systematic review of artificial intelligence in higher education: A call for increased ethics, collaboration, and rigour. *International Journal of Educational Technology in Higher Education, 21,* Article 4. https://doi.org/10.1186/s41239-023-00436-z

Bozkurt, A., Karadeniz, A., Baneres, D., Guerrero-Roldán, A. E., & Rodríguez, M. E. (2021). Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. *Sustainability, 13*(2), Article 800. https://doi.org/10.3390/su13020800

Cardona, M., Rodríguez, R. J., Ishmael, K. (2023). *Artificial intelligence and the future of teaching and learning: Insights and recommendations*. Washington, DC: US Office for Educational Technology. https://www2.ed.gov/documents/ai-report/ai-report.pdf

Chaudhry, M. A., & Kazim, E. (2022). Artificial Intelligence in Education (AIEd): A high-level academic and industry note 2021. *AI and ethics, 2*(1), 157–165. https://doi.org/10.1007/s43681-021-00074-z

Chemnad, K., & Othman, A. (2024). Digital accessibility in the era of artificial intelligence: Bibliometric analysis and systematic review. *Frontiers in Artificial Intelligence, 7*, Article 1349668. https://doi.org/10.3389/frai.2024.1349668

Černý, M. (2024). University students' conceptualisation of AI literacy: Theory and empirical evidence. *Social Sciences, 13*(3), Article 129. https://doi.org/10.3390/socsci13030129

Chichekian, T., & Benteux, B. (2022). The potential of learning with (and not from) artificial intelligence in education. *Frontiers in Artificial Intelligence, 5*, Article 903051. https://doi.org/10.3389/frai.2022.903051

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

Choi, J.-I., Yang, E., & Goo, E.-H. (2024). The effects of an ethics education program on artificial intelligence among middle school students: Analysis of perception and attitude changes. *Applied Sciences, 14*(4), Article 1588. https://doi.org/10.3390/app14041588

Council of Europe. (2021). *Convention 108 and protocols.* https://www.coe.int/en/web/data-protection/convention108-and-protocol

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education, 20*, Article 22. https://doi.org/10.1186/s41239-023-00392-8

Dandachi, I. E. (2023). AI-powered personalized learning: Toward sustainable education. In H. El-Chaarani, I. El Dandachi, S. El Nemar, & Z. EL Abiad (Eds.), *Navigating the intersection of business, sustainability and technology. Contributions to environmental sciences & innovative business technology* (pp. 109–118). Springer. https://doi.org/10.1007/978-981-99-8572-2_5

Demartini, C. G., Sciascia, L., Bosso, A., & Manuri, F. (2024). Artificial intelligence bringing improvements to adaptive learning in education: A case study. *Sustainability, 16*(3), Article 1347. https://doi.org/10.3390/su16031347

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 100110. https://doi.org/10.1016/j.caeai.2022.100110

Emara, N., Ali, N., & Abu Khurma, O. (2023). Adaptive learning framework (Alef) in UAE public schools from the parents' perspective. *Social Sciences, 12*(5), Article 297. https://doi.org/10.3390/socsci12050297

European Education Area. (2021). Digital education action plan (2021–2027). https://education.ec.europa.eu/focus-topics/digital-education/action-plan

Expert Committee on the Development of Artificial Intelligence. (2023). *A road map of AI regulation in Ukraine. Ministry of Digital Transformation of Ukraine*. https://ai.org.ua/a-road-map-of-ai-regulation-in-ukraine/

Farrelly, T., & Baker, N. (2023). Generative artificial intelligence: Implications and considerations for higher education practice. *Education Sciences, 13*(11), Article 1109. https://doi.org/10.3390/educsci13111109

Fiialka, S., Kornieva, Z., & Honcharuk, T. (2023). ChatGPT in Ukrainian education: Problems and prospects. *International Journal of Emerging Technologies in Learning, 18*(17), 236–250. https://doi.org/10.3991/ijet.v18i17.42215

GDPR. (n/a). What is GDPR, the EU's new data protection law?. https://gdpr.eu/what-is-gdpr/

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 1216. https://doi.org/10.3390/educsci13121216

Gómez-Pulido, J. A., Park, Y., Soto, R., & Lanza-Gutiérrez, J. M. (2023). Data analytics and machine learning in education. *Applied Sciences, 13*(3), Article 1418. https://doi.org/10.3390/app13031418

Grassini, S. (2023). Shaping the future of education: Exploring the potential and consequences of AI and ChatGPT in educational *Settings. Education Sciences, 13*(7), Article 692. https://doi.org/10.3390/educsci13070692

IEEE. (2019). *Ethically aligned design: A vision for prioritizing human well-being with autonomous and Intelligent systems*. https://standards.ieee.org/wp-content/uploads/import/documents/other/ead_v2.pdf

Ilieva, G., Yankova, T., Klisarova-Belcheva, S., Dimitrov, A., Bratkov, M., & Angelov, D. (2023). Effects of generative Chatbots in higher education. *Information, 14*(9), Article 492. https://doi.org/10.3390/info14090492

Jia, K., Wang, P., Li, Y., Chen, Z., Jiang, X., Lin, C. L., & Chin, T. (2022). Research landscape of artificial intelligence and e-Learning: A bibliometric research. *Frontiers in psychology, 13*, Article 795039. https://doi.org/10.3389/fpsyg.2022.795039

Joseph, S. (2023). Large language model-based tools in language teaching to develop critical thinking and sustainable cognitive structures. *Rupkatha Journal, 15*(4). https://doi.org/10.21659/rupkatha.v15n4.13

Kamalov, F., Santandreu Calonge, D., & Gurrib, I. (2023). New era of artificial intelligence in education: Towards a sustainable multifaceted revolution. *Sustainability, 15*(16), Article 12451. https://doi.org/10.3390/su151612451

Karan, B., & Angadi, G. R. (2023). Potential risks of artificial intelligence integration into school education: A systematic review. *Bulletin of Science, Technology & Society, 43*(3–4), 67–85. https://doi.org/10.1177/02704676231224705

Karkera, S., Devendra, N., Lakhani, B., Manahan, K., & Geisler, J. (2024). A review on modern teaching and learning techniques in medical education. *EIKI Journal of Effective Teaching Methods, 2*(1). https://doi.org/10.59652/jetm.v2i1.128

Kniazkova, L., Sukhorebra, T., Kovalchuk, M., Bogatchuk, S., Malona, S., & Ozhha, M. (2024). Reforming education in Ukraine through the introduction of STEM technologies and artificial intelligence. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 15*(1), 89–104. https://doi.org/10.18662/brain/15.1/538

Knox, J. (2020). Artificial intelligence and education in China. *Learning, Media and Technology, 45*(3), 298–311. https://doi.org/10.1080/17439884.2020.1754236

Lai, T., Zeng, X., Xu, B., Xie, C., Liu, Y., Wang, Z., Lu, H., & Fu, S. (2023). The application of artificial intelligence technology in education influences Chinese adolescent's emotional perception. *Current Psychology, 43*, 5309–5317. https://doi.org/10.1007/s12144-023-04727-6

Li, X., Li, B., & Cho, S.-J. (2023). Empowering Chinese language learners from low-income families to improve their Chinese writing with ChatGPT's assistance afterschool. *Languages, 8*(4), Article 238. https://doi.org/10.3390/languages8040238

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*, Article 41. https://doi.org/10.1186/s40561-023-00260-y

Lo, L. S. (2023). An initial interpretation of the U.S. Department of Education's AI report: Implications and recommendations for academic libraries. *The Journal of Academic Librarianship, 49*(5), Article 102761. https://doi.org/10.1016/j.acalib.2023.102761

Matviichuk, L., Ferilli, S., & Hnedko, N. (2022). Study of the organization and implementation of e-learning in wartime inside Ukraine. *Future Internet, 14*(10), Article 295. https://doi.org/10.3390/fi14100295

Melnyk, O. (2023). Experience of distance education in general secondary education institutions of Ukraine. *Problems of Education, 1*(98), 151–172. https://doi.org/10.52256/2710-3986.1-98.2023.10

Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences, 13*(9), Article 856. https://doi.org/10.3390/educsci13090856

Naggar, A. E., Gaad, E., & Inocencio, S. A. M. (2024). Enhancing inclusive education in the UAE: Integrating AI for diverse learning needs. *Research in Developmental Disabilities, 147*, Article 104685. https://doi.org/10.1016/j.ridd.2024.104685

Nasar, I., Uzer, Y., Aisyah, Ridayani, & Purwanto, M. B. (2023). Artificial intelligence in smart classrooms: An investigative learning process for high school. *Asian Journal of Applied Education, 2*(4), 547–556. https://doi.org/10.55927/ajae.v2i4.6038

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., & Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educational technology research and development, 71*, 137–161. https://doi.org/10.1007/s11423-023-10203-6

Niu, S. J., Luo, J., Niemi, H., Li, X., & Lu, Y. (2022). Teachers' and students' views of using an AI-aided educational platform for supporting teaching and learning at Chinese schools. *Education Sciences, 12*(12), Article 858. https://doi.org/10.3390/educsci12120858

OECD. (2023). *Recommendation of the Council on Artificial Intelligence*. https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449

Okulich-Kazarin, V., Artyukhov, A., Skowron, Ł., Artyukhova, N., Dluhopolskyi, O., & Cwynar, W. (2024). Sustainability of higher education: Study of student opinions about the possibility of replacing

teachers with AI technologies. *Sustainability, 16*(1), Article 55. https://doi.org/10.3390/su16010055

Pro skhvalennia Kontseptsii rozvytku shtuchnoho intelektu v Ukraini [The concept of development of artificial intelligence], No. 1556-p. (2020). https://zakon.rada.gov.ua/laws/show/1556-2020-p#Text

Pratama, M. P., Sampelolo, R., & Lura, H. (2023). Revolutionizing education: Harnessing the power of artificial intelligence for personalized learning. *Klasikal: Journal of education, language teaching and science, 5*(2), 350–357. https://doi.org/10.52208/klasikal.v5i2.877

Rahm, L. (2023). Education, automation and AI: A genealogy of alternative futures. *Learning, Media and Technology, 48*(1), 6–24. https://doi.org/10.1080/17439884.2021.1977948

Rakha, N. A. (2023). Revolution in learning through digitization: How technology is changing the landscape of education. *International Journal of Cyber Law, 1*(3). https://irshadjournals.com/index.php/ijcl/article/view/38

Rios-Campos, C., Cánova, E. S. M., Zaquinaula, I. R. A., Zaquinaula, H. E. A., Vargas, D. J. C., Peña, W. S., Idrogo, C. E. T., & Arteaga, R. M. Y. (2023). Artificial intelligence and education. *South Florida Journal of Development, 4*(2), 641–655. https://doi.org/10.46932/sfjdv4n2-001

Roshanaei, M., Olivares, H., & Lopez, R. (2023). Harnessing AI to foster equity in education: Opportunities, challenges, and emerging strategies. *Journal of Intelligent Learning Systems and Applications, 15*, 123–143. https://doi.org/10.4236/jilsa.2023.154009

Sagan, O., Blakh, V., Perminova, L., Mironenko, O., & Yakovleva, S. (2023). Formation of informational and digital competence of the student of primary education by means of robotics. *Amazonia Investiga, 12*(66), 295–303. https://doi.org/10.34069/AI/2023.66.06.27

Salas-Pilco, S. Z., Xiao, K., & Oshima, J. (2022). Artificial intelligence and new technologies in inclusive education for minority students: A systematic review. *Sustainability, 14*(20), Article 13572. https://doi.org/10.3390/su142013572

Selwyn, N. (2022). The future of AI and education: Some cautionary notes. *European Journal of Education, 57*, 620–631. https://doi.org/10.1111/ejed.12532

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), Article 4167. https://doi.org/10.3390/su14074167

Snigdha, S. S., & Akter, M. (2023). Effectiveness of audio-visual materials in teaching reading for young EFL learners in Bangladesh: An experimental study. *EIKI Journal of Effective Teaching Methods, 1*(4). https://doi.org/10.59652/jetm.v1i4.84

Tobler, S. (2024). Smart grading: A generative AI-based tool for knowledge-grounded answer evaluation in educational assessments. *MethodsX, 12*, Article 102531. https://doi.org/10.1016/j.mex.2023.102531

Touretzky, D., Gardner-McCune, C., Breazeal, C., Martin, F., & Seehorn, D. (2019). A year in K-12 AI education. *AI Magazine, 40*(4), 88–90. https://doi.org/10.1609/aimag.v40i4.5289

UNESCO. (2023). *Guidance for generative AI in education and research*. https://www.unesco.org/en/articles/guidance-generative-ai-education-and-research

United Nations. (2023). *Policy brief, a global digital compact – An open, free and secure digital future for all*. https://indonesia.un.org/en/238874-our-common-agenda-policy-brief-5-global-digital-compact

Yang, X. (2019). Accelerated move for AI education in China. *ECNU Review of Education, 2*(3), 347–352. https://doi.org/10.1177/2096531119878590

Yang, J., & Zhang, B. (2019). Artificial intelligence in intelligent tutoring robots: A systematic review and design guidelines. *Applied Sciences, 9*(10), Article 2078. https://doi.org/10.3390/app9102078

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